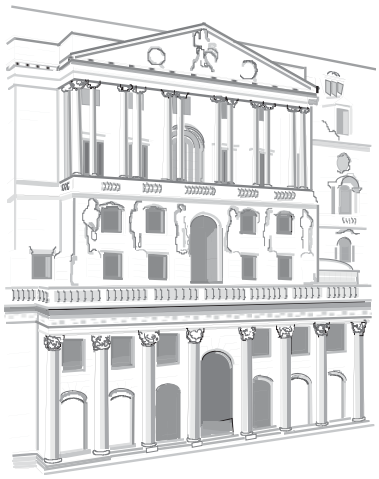
Bank of England Quarterly Bulletin



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The Quarterly Bulletin and Inflation Report

Inflation Report
(published separately)

The *Inflation Report* reviews developments in the UK economy and assesses the outlook for UK inflation over the next two years in relation to the inflation target. The *Report* starts with a short overview section; the second section investigates money and financial markets, and the following three sections examine demand and output, the labour market and pricing behaviour respectively. The concluding sections present a summary of monetary policy since the November *Report*, an assessment of medium-term inflation prospects and risks, and information about non-Bank forecasts.

Markets and operations
(pages 5–19)

The Bank lowered UK interest rates at the beginning of October, but the global financial market turmoil of the third quarter continued into the final quarter of the year. For some time, hedge funds and others had borrowed yen at low Japanese interest rates, and used the proceeds to invest higher-yielding non-Japanese assets. But these positions were swiftly closed as the yen started to appreciate in early October, and investors had to buy the Japanese currency to repay yen debt, which put further upward pressure on the yen exchange rate. Global financial markets were affected as a result. Shortly after these leverage-driven trades were unwound, the US Federal Reserve lowered interest rates in mid October. This cut, and the expectation that US interest rates would be lowered further, helped to stabilise markets. The cut in official US and UK interest rates in November, the second in the quarter, and a coordinated round of interest rate cuts on the Continent in early December, also helped to support markets. By year-end, UK implied interest rates (from futures contracts) and gilt yields had fallen, and the FT-SE 100 had virtually recouped the previous quarter's losses, after a third Bank easing in early December.

The international environment
(pages 20–32)

Japan's economic performance remained weak in 1998 Q4, and external forecasts for growth in 1999 were revised down. But additional policy measures to promote recovery were implemented. US GDP growth was well above trend in 1998 Q3. But the headline growth figures masked an underlying slowdown in final domestic demand growth, and the manufacturing sector weakened markedly in Q3 and Q4. Euro-area growth was relatively strong in 1998 Q3 and consumer confidence remained high, though the outlook in recent months has become more mixed as business sentiment has weakened. Forecasts for GDP growth in 1999 in the major overseas economies were generally revised down during 1998 Q4, largely reflecting the weaker economic outlook in Japan. Inflation in the major industrial economies remained subdued in Q4, partly reflecting continued falls in internationally traded goods prices. Continued recent declines in world commodity prices may dampen inflationary pressures further in the short term. The cuts in official interest rates in North America and Europe were followed by some strengthening of consumer confidence there, and a rebound in equity prices. Corporate and emerging market sovereign bond spreads over US Treasuries also narrowed since the previous *Quarterly Bulletin*. Financial markets remain volatile, and there are significant uncertainties about the outlook for some important emerging market economies in 1999, particularly Brazil.

Sterling wholesale markets: developments in 1998
(pages 33–39)

Sterling wholesale markets grew further in 1998. Outstanding lending appeared to be little affected by the international financial market turbulence of the second half of the year. The gilt repo market consolidated its position as an important form of secured money at the short end of the curve. Yields on gilt-edged securities fell in 1998. The amount outstanding fell very slightly. The Bank made a number of changes to its open market operations during 1998, building on the reforms of the previous year.

The external balance sheet of the United Kingdom: recent developments

(pages 40–47)

This article examines developments in the UK external balance sheet from 1987 to mid 1998. It continues an annual series of articles in the *Quarterly Bulletin* begun in 1985. Gross UK assets and liabilities are analysed in order to discern trends in holdings of different types of investment. The article emphasises the latter part of the period, which was characterised by crises in emerging markets. The external balance sheet is also considered in relation to investment income.

Research and analysis

(pages 48–86)

Research work published by the Bank is intended to contribute to debate, and is not necessarily a statement of Bank policy.

The impact of inflation news on financial markets (by Michael Joyce, of the Bank's Structural Economic Analysis Division and Vicky Read of the Bank's Foreign Exchange Division). This article examines the same-day reaction of UK asset prices to monthly RPI inflation announcements in a sample period from the early 1980s until April 1997. It is found that markets are efficient, in the sense that asset prices do not respond to the expected component of RPI announcements. Generally, only government bond prices appear sensitive to inflation news—particularly after late 1992, when the United Kingdom adopted an explicit inflation target. The responsiveness of implied medium and long-term forward inflation rates after 1992 is consistent with the 'expected inflation hypothesis', a finding that suggests that the pre-independence inflation-targeting framework was not seen as fully credible by the financial markets. But the declining responsiveness of bond yields and implied forward inflation rates to inflation news over the period of operation of the framework suggests that its credibility improved over time.

Monetary policy rules and inflation forecasts (by Nicoletta Batini of the Bank's Monetary Assessment and Strategy Division and Andrew Haldane of the Bank's International Finance Division). This article compares the use of simple backward-looking interest rate rules for monetary policy with policy rules that respond to forecasts of future inflation, in line with monetary policy behaviour in the real world. It appears that these forecast-based rules can better control both current and future inflation, by accounting for the lags in the monetary transmission mechanism, and can ensure a suitable degree of output-smoothing. In addition, they ensure that policy is responsive to most available information. Their superior performance provides support for the practice of basing monetary policy on forecasts of inflation and output, as in the United Kingdom.

The yen/dollar exchange rate in 1998: views from options markets (by Neil Cooper and James Talbot of the Bank's Monetary Instruments and Markets Division). 1998 was a period of unprecedented volatility for the yen/dollar exchange rate. To help to assess market participants' views on exchange rate developments, the Bank of England uses a range of techniques that employ information from the over-the-counter (OTC) currency options markets. This article describes these techniques and shows how they can be used to assist our understanding of market perceptions of the yen/dollar exchange rate over this period.

Risk, cost and liquidity in alternative payment systems (by Maxwell Fry of the Bank's Centre for Central Banking Studies). In this article, Maxwell Fry, director of the CCBS, summarises one aspect of the research conducted at the CCBS as part of its first academic workshop and project. This started with a one-week academic workshop on payment and settlement issues in January 1998, attended by participants from 22 central banks as well as international experts in the subject. After the workshop, six participants—three foreign central bankers and three Bank of England staff—assembled to plan a research programme for the ensuing ten weeks. The research built on the ideas presented at the academic workshop, as well as the specific interests of the team members. The results of the project research were first presented at a conference in March, which was co-hosted by the CCBS and the ESRC-supported Money, Macro and Finance Research Group. The project output also formed the basis for a report prepared for the Bank's 1998 Central Bank Governors' Symposium in June. Routledge will publish the final project output in April 1999.

This summary is also available from the Bank's web site at www.bankofengland.co.uk/summary.htm.

Markets and operations

- *During the fourth quarter of 1998, the Bank's repo rate was reduced three times, by a total of 125 basis points.*
- *Three-month interest rates implied by short sterling futures fell sharply, by around 100 basis points at dates up to September 1999 and around 50 basis points for dates in late 2000 and early 2001.*
- *Nominal gilt yields fell to their lowest levels since the 1950s, and real yields on index-linked gilts fell to the lowest levels since they were introduced in 1981.*
- *Sterling weakened during the fourth quarter, influenced by the yen's rally, a narrowing of the United Kingdom's positive interest rate differentials, and selling of the currency resulting from arbitrage trades related to the transition from the Ecu to the euro.*
- *The US Federal Reserve lowered interest rates, and there were coordinated interest rate reductions in the prospective European single currency area to a common rate of 3% by end December.*
- *The FT-SE 100 recovered almost in full from its fall in the late summer, while the Dow Jones Industrial Average set a record high.*
- *Volatility peaked in many markets in October, and declined thereafter.*

Overview

Financial market turmoil in the third quarter continued into the final quarter of 1998, particularly in early October, when the yen appreciated sharply against the dollar and the Deutsche Mark, as market trading positions were quickly adjusted. For some time, hedge funds and others had borrowed yen at low Japanese interest rates, used the proceeds to invest in higher-yielding overseas assets, and enjoyed a positive investment return.(1) But the Russian default prompted the closure of many of these positions, and more were closed as the yen started to appreciate; investors had to buy the Japanese currency to repay yen debt, which put upward pressure on the yen exchange rate.

The major bond and equity markets were also significantly affected, as leveraged funds in particular swiftly liquidated higher-yielding non-Japanese assets. Several abrupt market moves resulted from this, against a background of relatively illiquid market conditions. Previously, yields in major bond markets had fallen to the low-points for the year. Concentrated sales of government bonds in a short period were reflected in yields moving sharply higher.

Shortly after these leverage-driven trades were unwound, the US Federal Reserve lowered interest rates in mid October. This rate cut, and the expectation that US interest rates would be lowered

(1) These trades are commonly referred to as 'yen carry' trades.

further, helped markets to recover slightly. (UK interest rates were lowered at the beginning of October.)

Equity markets began to recover almost immediately after the sharp yen appreciation. Far Eastern markets rallied on news that an agreement to recapitalise Japanese banks had been reached. UK and US equities were also supported by this news through October and, later in the quarter, by increased merger and acquisition activity.

As the quarter progressed, there were tentative signs that investor confidence was recovering, although trading turnover remained modest. Measures of market volatility declined from their early October peaks, gilt yields fell steadily through November and December, and corporate bond and swap spreads also narrowed, although not to their previous levels. The second lowering of official interest rates in the quarter in the United Kingdom and United States, in early and mid November respectively, and an early-December coordinated round of interest rate cuts in Europe (in preparation for the launch of the euro), helped to support these market moves.

By the end of the quarter, UK asset prices had risen but market liquidity remained fragile. A third cut in interest rates in early December bolstered investor sentiment, and encouraged the market view that UK interest rates would continue to be lowered swiftly. Implied interest rates, as derived from short sterling futures contracts, fell sharply during the three-month period—by more than 100 basis points for short-dated contracts and by more than 50 basis points for longer dates. Gilt yields fell by around 75 basis points for shorts and 30 basis points for longs. In other major international government bond markets, yields fell by less, and in some cases rose. In parallel, by the year-end, the FT-SE 100 had virtually recouped the previous quarter's losses, performing very similarly to US equities.

Chart 1
UK three-month Libor cash and futures markets

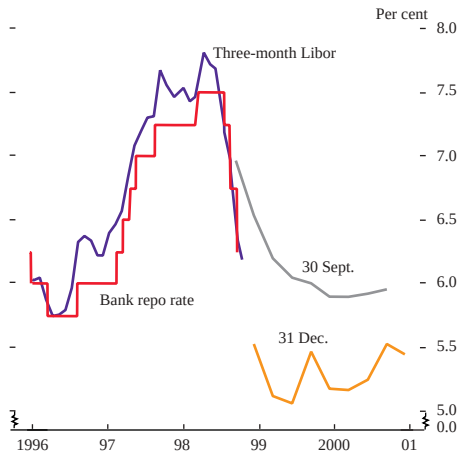
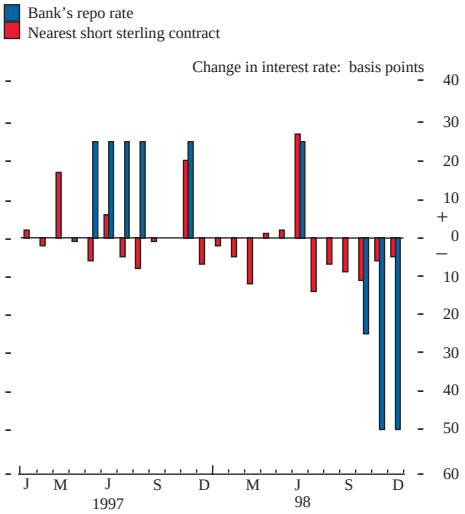


Chart 2
Interest rate announcements: change in rate implied by nearest short sterling contract



Market developments

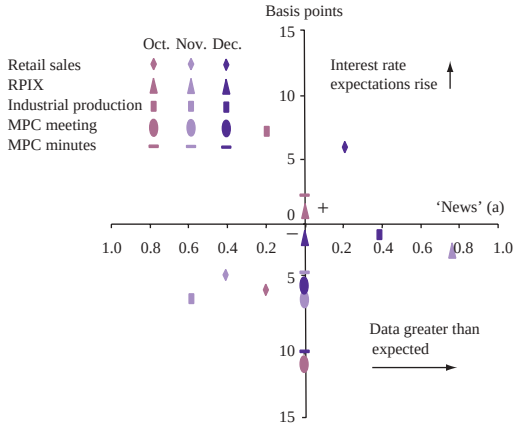
Short-term interest rates

The official repo rate, UK cash Libor rates, and implied interest rates fell sharply in the fourth quarter of 1998, and the degree of inversion in the money-market curve reduced (see Chart 1). Implied rates derived from the March and June 1999 short sterling contracts fell by more than 100 basis points, and rates implied by the late 2000 and early 2001 contracts fell by around 50 basis points. By year-end (excluding the end-1999 spike),(1) short sterling futures discounted three-month Libor falling to around 5.0% by the end of 1999, and rising gently to near 5.5% by 2002.

Domestic factors played a significant role in the fall in implied future interest rates. During the course of the fourth quarter, interest rates reacted to the outcome of MPC meetings, the publication of MPC minutes, economic figures and surveys, and growth projections by public and private forecasters. The official repo rate was lowered by 25, 50, and 50 basis points on 8 October, 5 November, and 10 December respectively, ending the year at 6.25%. On each of these occasions, the resulting fall in implied

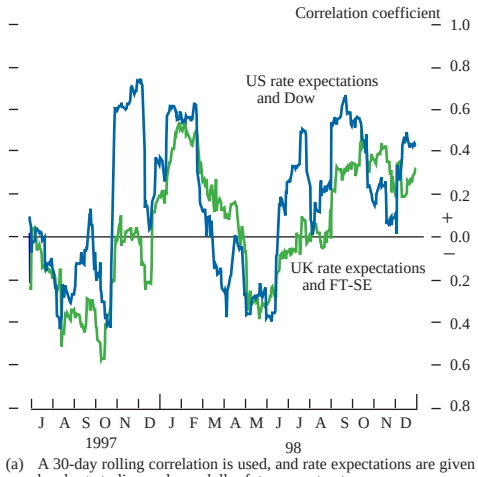
(1) Implied interest rates from futures for the three months spanning end 1999 have been pushed higher in the UK and overseas markets, possibly reflecting speculation that anticipation of systems difficulties could lead to tighter liquidity conditions.

Chart 3
Effect of data releases on interest rate expectations from October to December 1998



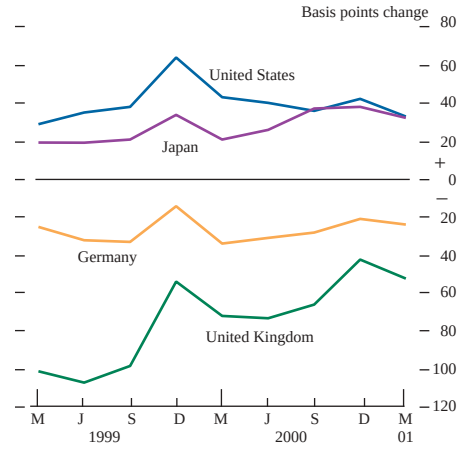
(a) 'News' is measured as data outturn less expected, divided by standard deviation of past surprises. Interest rate expectations are measured by the impact on the nearest short sterling contract.

Chart 4
Correlation between UK and US stock markets and domestic interest rate expectations(a)



(a) A 30-day rolling correlation is used, and rate expectations are given by short sterling and eurodollar futures contracts.

Chart 5
Changes in three-month interest rates implied by futures contracts(a)



(a) Change between end September and end December.

interest rates was less than the change in the repo rate, suggesting either that the market had anticipated the move, or, in November and December, took the view that a larger-than-expected cut brought forward a move that would otherwise have been expected to follow (see Chart 2). The minutes of the MPC discussions also influenced markets; at times they were seen by the market as suggesting that further reductions in the repo rate would be forthcoming. Implied future interest rates rose, however, when the November *Inflation Report* was published; some market participants had expected lower projections for output and inflation, although the expansionary effect of the November rate cut was allowed for within the forecast. The largest fall in implied rates came with the first cut in the quarter, even though it was the smallest.

Domestic economic data releases appeared to have a diminishing influence on short-term interest rates as the quarter progressed. Market responses on the day of data releases were limited to a maximum +/- 6 basis points in October and November, reducing to +/- 3 basis points in December for the short sterling contracts (as shown in Chart 3), with the exception of stronger-than-expected November retail sales.(1) Surveys (seen by the market as forward-looking indicators of the economy and so sometimes more significant than contemporaneous data) continued to attract close market attention through the quarter. For instance, both the November GfK Consumer Confidence survey and the CBI Industrial Trends survey for December (released on the same day as November retail sales) were stronger than markets expected, which prompted a temporary rise in implied interest rates. Official and private forecasts for UK growth were mainly revised downwards during the quarter, tending to underpin expectations of lower interest rates.

Trading remained disturbed in the early part of the quarter. Implied volatility—one measure of market uncertainty—was high; for the December 1998 short sterling contract, the peak was reached in early October.(2) Implied volatility eased later, and ended the quarter at levels closer to those in the first half of the year.

International events also influenced UK short-term interest rates, though to a lesser extent than domestic developments. Much of the international influence came from the United States. As the Dow Jones Industrial Average (DJIA) weakened, the market expectation that US interest rates would be lowered tended to grow, which is consistent with the positive rolling correlation evident in the second half of 1998 (see Chart 4). A similar relationship emerged between the FT-SE 100 and sterling interest rate expectations. The US Federal Reserve lowered both the federal funds target rate and the discount rate in two separate 25 basis point moves on 15 October and 17 November, leaving them at 4.75% and 4.50% respectively. US implied rates derived from eurodollar futures contracts rose by between 10 and 60 basis points during the quarter (see Chart 5), reflecting recovery in stock markets and continued robust economic data. Implied future interest rates also rose in Japan, by up to 40 basis points as measured by euro-yen futures contracts.

(1) These market changes are measured from close of business on the preceding day to close on the day of publication. October and November's moves relate to the December 1998 contract, and the December moves relate to the March 1999 contract.
(2) Implied volatilities are calculated from the price of options on futures contracts, and represent the annualised standard deviation of the percentage changes in interest rates.

The coordinated cut in euro-area interest rates on 3 December prompted a stronger rally in short sterling futures. Both Germany and France lowered official short-term market interest rates by 30 basis points to 3%. With the exception of Italy, all other prospective euro-area national central banks simultaneously lowered their key money-market rates to 3%. Germany announced that the initiative was based on the economic outlook for the euro area, and that it had been made with the approval of the ECB. On 23 December, Italy moved its discount rate for the second time in the month, lowering it to the common 3% euro-area rate. Three-month interbank rates converged from respective highs of 4.79%, 4.24%, 4.25% and 5.5% in Italy, Spain, Portugal and Ireland at the start of the period (by comparison with 3.56% in Germany and 3.38% in the Netherlands) to year-end levels of around 3¼%.

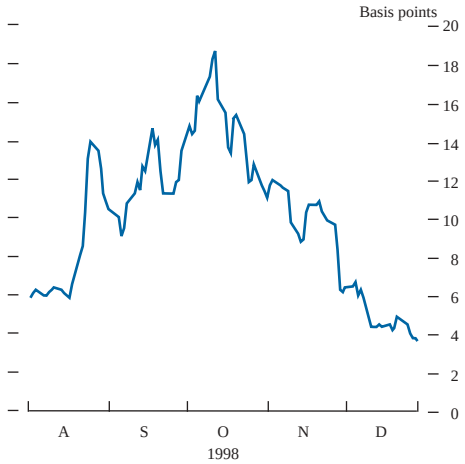
Long-term interest rates

Government bond markets in industrialised countries were particularly volatile in early October, with yields commonly dropping to low levels, but then spiking sharply higher. Much of this movement was associated with portfolio adjustments, as a result, or in anticipation, of flows from leveraged investors. For much of the period, bond prices continued to move inversely to equities, but they were also influenced by falling short-term interest rates. US and Japanese yields finished the quarter higher, significantly so in the case of the latter.

The disturbed trading conditions of the third quarter continued into the early part of the fourth quarter. Investors still sought the high credit quality offered by government bonds, and this helped to drive ten-year benchmark yields to record lows of around 4.16%, 0.70% and 3.73% in the United States, Japan, and Germany respectively. The yen's sharp appreciation in early October (see the foreign exchange section on page 10) occurred in conjunction with an unwinding of yen carry trades and consequential sales of government bonds, principally US Treasuries, but Bunds and gilts were also affected. During this period, yields on benchmark ten-year US Treasuries, Japanese government bonds (JGBs) and German Bunds spiked around 60, 20 and 45 basis points higher respectively, although a significant 'technical' correction followed. Implied volatilities were unusually high in all these markets during October.

A feature of this period was the volatility of the premium attracted by the most liquid 'on-the-run'(1) benchmarks in the US Treasury market, which typically have a lower bid-ask spread than less liquid 'off-the-run' stocks. The yield spread was already wide compared with historical levels at the start of the quarter, having increased sharply in the run-up to Russia's debt default in August, and again in the market disturbances of late September and early October (see Chart 6). The premium reached a peak of 19 basis points on 15 October ahead of the Fed easing, when acute illiquidity and large-scale selling afflicted the long end of the Treasury market. The liquidity premium steadily declined thereafter, to 4 basis points by year-end. Some market participants suggested that as leveraged funds reduced their capital dedicated to arbitrage/convergence

Chart 6
US Treasury five-year on/off-the-run spread



(1) An 'on-the-run' bond is generally classified as the most recently issued, actively traded, and liquid bond; 'off-the-run' bonds are those issued prior to the most recent refunding, less actively traded, and so less liquid.

Chart 7
30-day rolling correlations between ten-year yields and equities for the United Kingdom and United States

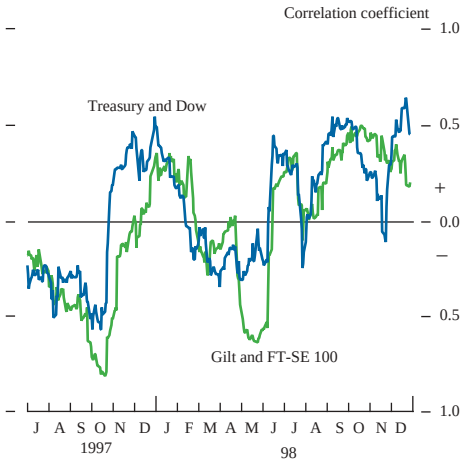
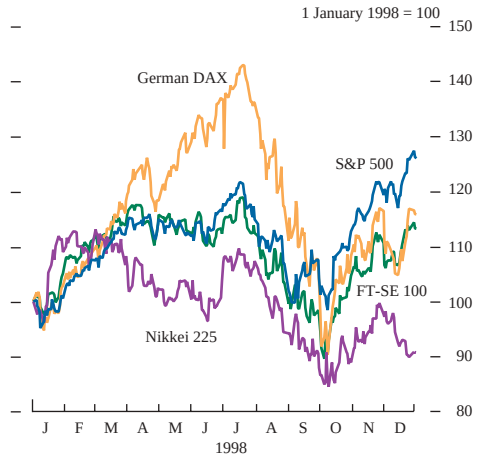


Chart 8
Equity indices (in local currencies)



plays, their ability to provide liquidity and assume market risk was reduced, resulting in the widening of trading spreads.

Early in the quarter, bond prices frequently moved inversely to equity prices (see Chart 7). This appeared partly to be a 'flight-to-quality' phenomenon, with investors attempting to switch out of equities into bonds, but may also have reflected an expectation that equity price weakness, if severe, would ultimately result in an easier monetary stance, particularly in the United States and the United Kingdom. Anticipation of monetary easing had a powerful impact on US Treasuries in October and November, but as the year-end approached, markets increasingly thought that the easing in the United States had run its course. There was some evidence of switching out of US Treasuries and into equities as US economic performance remained buoyant. By quarter-end, yields had risen by around 30 and 10 basis points at the short and long end of the curve respectively.

Japanese government bond (JGB) yields fell to record lows in early October, then rose gradually in the weeks that followed—and sharply in December. Concern about fiscal and debt management policy affected the market increasingly during the second half of the quarter. Initially, the cabinet agreed a larger-than-expected expansionary budget in mid November; then the government warned of a potential shortfall in central and local taxes, giving rise to increased monthly bond sales. In December, it was announced that the Trust Fund Bureau would cease outright purchases of JGBs from January 1999 onwards. After falling to a record low of 0.70% in early October, the yield on the ten-year benchmark JGB rose to 2.22% at end December, the high for the quarter. This was accompanied by a steepening of the yield curve; the differential between two and ten-year yields rose from 42 to 145 basis points.

Trading in the euro-area government bond markets was significantly influenced by the launch of the euro at year-end. Differentials between different countries' government bond yields narrowed within the euro area with the prospective elimination of currency risk. Relative valuation increasingly focused on credit and liquidity issues, rather than domestic economic fundamentals. Bond yield convergence within the prospective euro area continued during November and early December, narrowing ten-year differentials against German Bunds to 10–25 basis points, alongside falling Bund yields and the lowering of German interest rates.

Equities

UK equities rallied in the fourth quarter, in line with international markets, after a weak start. By quarter-end, the FT-SE 100 had nearly fully reversed the previous quarter's sharp decline, largely mirroring the performance of the US sector. The FT-SE 100 finished 15% higher on the year, but some 300 points (5%) below the year's record high, reached on 20 July. This was in spite of slowing UK economic growth in the fourth quarter, and continuing investor concern about earnings potential.

The performance of UK equities during the fourth quarter was heavily influenced by international events, especially those in the United States. During October and November, the DJIA responded positively to the easing of US interest rates. The performance of

Chart 9
US dollar exchange rates in 1998

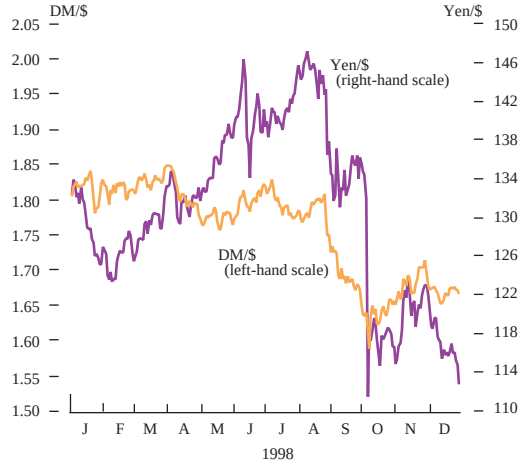


Table A
Emerging market currencies versus the US dollar

	1997	1998			Percentage changes between 30 Sept. and 31 Dec. 1998 (a)
	31 Dec.	30 June	30 Sept.	31 Dec.	
Indonesian rupiah	5,550	14,800	10,700	7,950	34.6
Thai baht	47.1	42.2	39.6	36.4	8.7
Korean won	1,695	1,373	1,391	1,203	15.6
Philippine peso	40.50	41.70	43.75	39.05	12.0
South African rand	4.87	5.97	5.95	5.86	1.6
Brazilian real	1.12	1.16	1.18	1.21	-2.3
Mexican peso	8.07	8.97	10.28	9.92	3.7
Venezuelan bolivar	504.3	553.0	573.5	564.0	1.7

(a) A positive number represents local currency appreciation.

Chart 10
Hong Kong dollar and Brazilian real: twelve-month implied volatility against US dollar

the two indices (in national currencies) was strikingly similar during the quarter; the FT-SE 100 and the Dow index rose by around 16% and 17% respectively during the three-month period. Merger and acquisition activity increased in both markets, which helped to boost valuations. The rebound also reflected broader international developments. Early in the quarter, the Japanese authorities announced a mechanism allowing banks to recapitalise, and news soon followed of banks applying for public funds to boost their capital bases. These events, together with the nationalisation of Long Term Capital Bank, underpinned the Nikkei 225 rally during October and November. The rally was also helped by the mid-November approval of the supplementary budget.

Though the DJIA reached a record high in the quarter (on 24 November) and the FT-SE 100 rebounded, the recovery was not uniform through the three-month period in the world's major stock markets. The Nikkei 225 fell sharply in December, reacting adversely to the strong yen and to concern that the sharp rise in JGB yields might forestall economic recovery. Some Latin American stock markets were showing signs of weakness by the end of the quarter; Brazil's Congress did not endorse some elements of the government's austerity package, upon which the IMF aid package was partly conditioned.

Foreign exchange

(i) International background

The yen strengthened dramatically against other major currencies in early October. The yen's rally may have been influenced by optimism about the prospects for Japanese bank restructuring reforms being passed by the Diet, and concerns about the size of the US current account deficit. But the rapidity and extent of the yen's appreciation also reflected the illiquid market conditions and unwinding of short yen positions associated with the carry trades.(1) The dollar fell from around ¥132 to an intraday low at ¥111.50 between 7 and 8 October, and one-month implied volatility reached an unprecedented level of around 40%. The Japanese yen finished the fourth quarter around 17% stronger against the US dollar and Deutsche Mark.

Chart 9 shows that until the end of November, the US dollar's depreciation against the Deutsche Mark was similar to its fall against the Japanese yen since the start of 1998. But it recovered from its 1998 intraday low against the Deutsche Mark at DM 1.59 (reached on 8 October) to DM 1.67 by the end of the year. Expected interest rate differentials moved in favour of the dollar during the same period, despite cuts in the US target federal funds rate. The recovery in the US stock market towards the end of 1998 was seen by the market as reducing the likelihood of further rate cuts early in 1999.

Emerging market currencies generally appreciated against the US dollar during the fourth quarter (see Table A). The appreciation of East Asian currencies against the dollar partly reflected the yen's rise. In Hong Kong, there was a decline in the expected future volatility of the exchange rate (see Chart 10). Latin American currencies generally benefited from a recovery in Brazilian markets. On 13 November, the International Monetary Fund

(1) For further details, see the article by Neil Cooper and James Talbot on pages 68–77.

announced the terms of a $41.5 billion support package for Brazil. The Brazilian stock market recovered in advance of the announcement, and official interest rates were lowered on 12 November: the key lending rate was cut from 50% to 42%. Expectations of a significant devaluation of the Brazilian real lessened in the fourth quarter, and this was reflected in a pronounced fall in twelve-month implied volatility against the US dollar from the high levels in September (see Chart 10). In the event, the real was devalued in January 1999.

The final stages of convergence of the euro-area countries' exchange rates to the pre-announced bilateral parities went smoothly. On 3 December, as mentioned earlier on page 8, euro-area countries lowered their key official interest rates to a common level of 3%,(1) and exchange rates subsequently remained close to their bilateral parities. On 31 December, the irrevocable conversion rates to the euro were announced by the European Council (see Table B). The final official Ecu rates published by the Commission, which can be regarded as the euro's value at its launch, were US$1.1667 and £0.7055 against the US dollar and sterling respectively.

The oil price weakened further in the fourth quarter, and oil-exporting countries' currencies came under pressure.(2) For example, the Norwegian currency weakened to an all-time low against the Deutsche Mark at NOK 4.7368 on 15 December. It recovered somewhat towards the end of the year.

(ii) Sterling

Sterling's effective exchange rate depreciated by 3½% during the fourth quarter. Chart 11 shows sterling's decline against the US dollar and Deutsche Mark (both by around 2%–2½%) during the quarter. The quarter can be split into three distinct phases: from the beginning of October to the start of November, sterling depreciated considerably; from then through to Christmas, sterling largely reversed that fall; and finally, sterling depreciated further at the end of the year.

Three main factors affected sterling's exchange rate in the fourth quarter. First, sterling's 17½% fall against the yen accounted for more than one third of the decline in the effective exchange rate index during the fourth quarter.

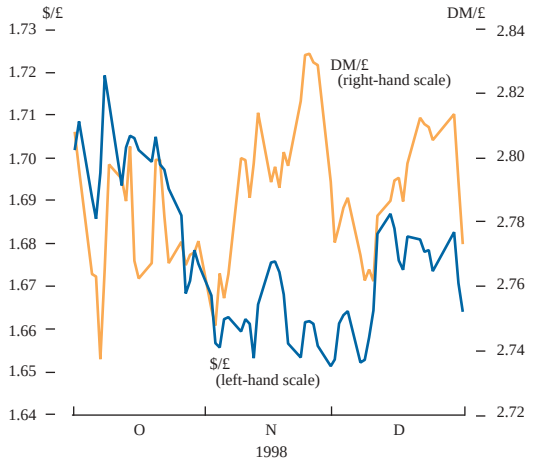
Second, interest rate differentials moved significantly against sterling, although sterling's immediate reaction to reductions in the repo rate was limited. The larger decline in UK interest rates (both at the short end and further out along the yield curve), compared with overseas interest rates, contributed to sterling's depreciation in the fourth quarter.

Third, there was a significant unwinding of arbitrage positions relating to the Ecu market premium over its basket of currencies. The official Ecu was a basket of twelve currencies, in which sterling had a weight of roughly 12%. On 1 January 1999, the Ecu was to convert one-for-one into euros. Until that date, holders of private Ecu were exposed to sterling to the extent of roughly 12% of their Ecu position, while those who were short of private Ecu

Table B
Irrevocable euro conversion rates

	Conversion rate
Belgian franc	40.3399
German Mark	1.95583
Spanish peseta	166.386
French franc	6.55957
Irish punt	0.787564
Italian lira	1,936.27
Luxembourg franc	40.3399
Netherlands guilder	2.20371
Austrian schilling	13.7603
Portuguese escudo	200.482
Finnish markka	5.94573

Chart 11
Sterling exchange rates during the fourth quarter



(1) Italy lowered its discount rate to 3.5%, and subsequently cut it to 3% on 23 December.
(2) See 'The international environment' article on pages 20–32 for discussion of commodity markets.

Chart 12
Market Ecu premium over basket of currencies

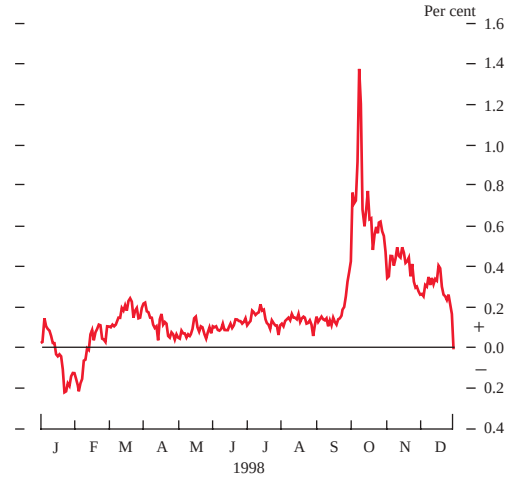


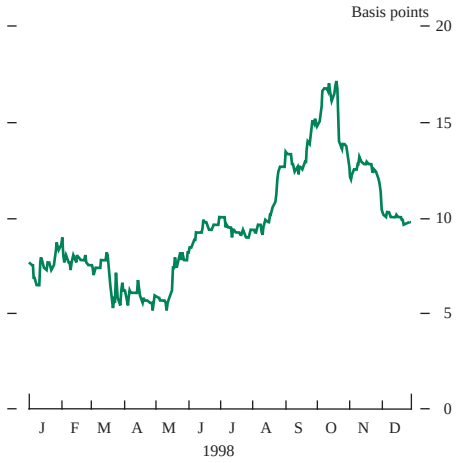
Table C
Official transactions in gilt-edged stocks

£ billions; *not seasonally adjusted*

	1998/99	1998		
	Apr.–Sept.	Oct.	Nov.	Dec.
Gross official sales (+) (a)	6.4	0.1	0.8	0.0
Redemptions and net official purchases of stock within a year of maturity (-)	-2.7	0.0	-3.8	0.0
Net official sales	3.7	0.1	-3.0	0.0
of which net purchases by:				
Banks (b)	5.1	-0.6	-4.4	-0.6
Building societies	-0.2	0.1	-0.1	0.0
M4 Private sector	-5.2	-1.0	1.2	1.0
Overseas sector	3.0	1.6	0.3	-0.4
LGs & PCs (c)	1.0	0.0	0.0	0.0

(a) Gross official sales of gilt-edged stocks are defined as official sales of stock with more than one year to maturity, net of official purchases of stock with more than one year to maturity, apart from transactions under purchase and resale agreements.
(b) Including the central bank.
(c) Local Government and Public Corporations.

Chart 13
UK ten-year gilt: on/off-the-run spread



were exposed to sterling in the opposite way, to the same extent. At the turn of the year, these exposures to sterling (and the Danish krone and the Greek drachma, which were also component currencies of the Ecu)(1) were transformed automatically into exposures to the euro. Those holders of Ecu who wanted to retain their exposure to sterling had to buy sterling against DM or some other participating currency, while those who were short of Ecu and wanted to retain their exposure to sterling had to sell sterling against DM. To achieve precise retention of net exposure, these transactions had to be carried out on 31 December at the exchange rates used to calculate conversion rates into the euro.

Since the private Ecu was a synthetic currency, long and short positions in it were equal and there was no intrinsic reason why transactions in sterling on 31 December should have been expected to generate pressure on the exchange rate in one direction rather than the other. However, the private Ecu had for some time been trading at a premium to the official Ecu (see Chart 12), and active market participants had borrowed private Ecu, in the expectation of convergence at the end-year, in order to generate low-cost funding. These market participants needed to sell sterling to maintain their currency exposures. In practice, these sales began well before the end of December, but their effect on the exchange rate was particularly noticeable towards the end of the year, as trading volumes diminished and such sales were no longer offset by corporate demand. This helps to explain the 1½% depreciation in sterling during the last two days of 1998.

The gilt-edged market

Conventional gilts

The gilt market, like other major bond markets, experienced some turbulence in October. Yields then fell to their lowest levels since the 1950s. The fall in gilt yields was large by comparison with other major bond markets, where yields in some cases had risen. Although remaining downward-sloping, the yield curve disinverted slightly during the quarter.

During the first half of October, yields fell to new lows for the year, and then spiked sharply higher; from the low-point, the yield on the ten-year gilt rose by nearly 70 basis points in just over a week. The gilt yield curve (given by the ten to two-year spread) disinverted by about 40 basis points. At that time, the sharp moves experienced in the gilt market were broadly common to the other major bond markets, as a result of the unwinding of yen carry trades by leveraged funds. Measures of implied volatility were high, but declined to more usual levels thereafter.

Investors reassessed the value of liquidity across a range of marketable instruments. Just as in the US Treasury market, there is typically a liquidity premium in the gilts market, so that the yields on the most widely held and traded stocks are generally lower than on comparable but less frequently traded stocks. In the past, the yield spread between the most and less liquid gilts has typically averaged around 5 to 6 basis points. Last autumn, this increased to around 17 basis points for UK gilts (see Chart 13), as investors sold instruments that they feared would become difficult to trade. By

(1) Sterling, the Greek drachma and the Danish krone were the three currencies in the Ecu basket not converting to euro; sterling had a much larger share in the basket than the other two currencies.

year-end, confidence had returned, but the liquidity premium did not fall to pre-turbulence levels.

A number of factors help to explain the fall in gilt yields since their early October high:

- Market confidence that interest rates would fall grew during the quarter, influenced by the easing of interest rates in the United Kingdom, United States and on the Continent, and the conjecture of lower growth prospects.

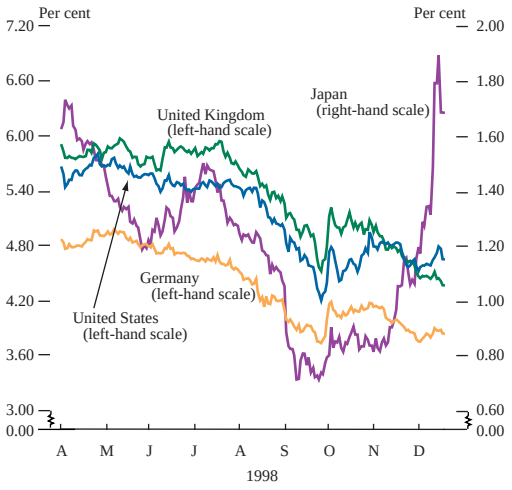
- Following the reduced PSNCR forecast in the 3 November pre-Budget, the Debt Management Office (DMO) cancelled the conventional auction scheduled for March 1999.

- Underlying demand for gilts remained steady, and participants spoke of reinvestment of large redemption and coupon payments.

- The launch of the euro may have played a role. As yields within the euro area converged, largely on German levels, the relative yield attractiveness of gilts increased. There was some suggestion in markets that gilts were used as a 'hedge against uncertainty' while the euro was being launched, and spreads over Bunds declined over the quarter.

By the end of the quarter, two, ten and thirty-year benchmark gilt yields had fallen by 77, 54, and 30 basis points to 4.89%, 4.36%, and 4.26% respectively, reducing the degree of inversion of the curve. The fall in yields for the gilt market was large when measured against moves in other major markets (see Chart 14). In the middle of the quarter, ten-year gilt yields fell below ten-year US Treasury yields for the first time since 1985/86.

Chart 14
International ten-year government bond yields



During the third quarter, net investment fell sharply to £2.9 billion from £19.0 billion in 1998 Q2 and £13.9 billion in 1997 Q3. There was heavy net disinvestment by UK institutions during the third quarter of last year, for the first time since the third quarter of 1991.(1) Institutions sold a net £4.5 billion of gilts during the period, just over 2% of their total stock of gilts. This compares with net investment by institutions of £3.2 billion and £4.9 billion in the previous quarter and the same quarter of 1997 respectively. There was a record £2.7 billion net disinvestment in gilts by long-term insurance funds, which represented about 3% of their total gilt stock. General insurance funds were the next-largest net sellers of gilts, at £1.4 billion, with pension funds (self-administered) and trusts making up the balance during the period.

UK institutions added net £3.1 billion, £2.9 billion, £0.8 billion, and £0.6 billion of UK corporate, overseas, other, and short-term assets respectively to their portfolios in the third quarter of 1998. The increase in overseas assets included a net purchase of £3.2 billion in government securities.

Index-linked gilts

Index-linked gilt (IG) yields largely followed the move in nominal yields during the quarter, falling then rising sharply in early

(1) 'Institutions' comprise insurance companies, pension funds, and trusts.

Chart 15
UK implied spot inflation rates

Chart 16
UK implied spot inflation rates as at 30 September and 31 December

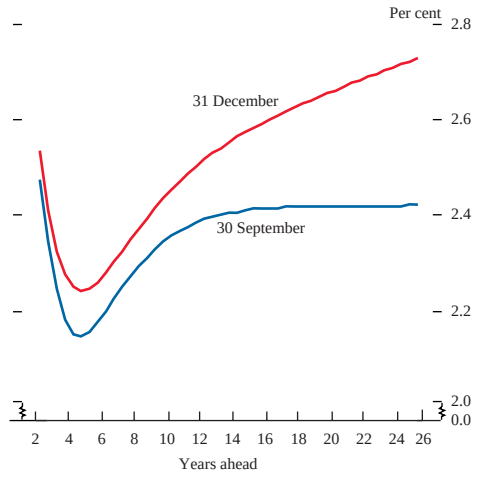
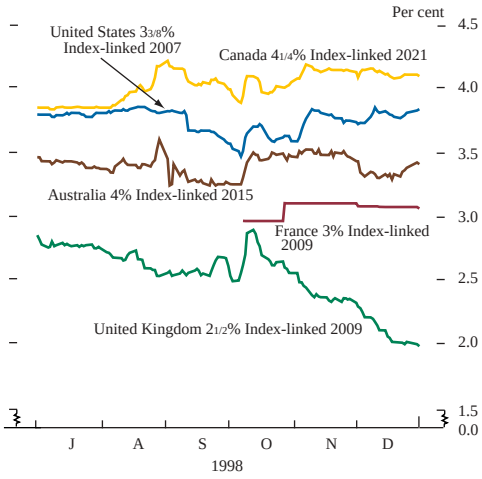


Chart 17
Real yields on index-linked gilt yields



October, only to decline steadily throughout the rest of the period. Record lows were reached at end-year—the ten-year IG yield dipped below 2% for the first time since IGs were launched in 1981, down by 63 basis points during the three-month period. Implied inflation rate expectations, derived from the index-linked and nominal (zero-coupon yield) curves were heavily influenced by the abrupt market moves of early October. After touching record lows of around 2% in early October, implied inflation rates rose to around 2.75% in the first half of November (see Chart 15). As confidence began to return to financial markets following the US and UK interest rate cuts, institutional demand for IGs re-emerged. The UK market may also have been supported by continuing limited government funding needs and the successful first auction. Real yields on IGs fell, whereas in the same period, real yields on other government bond index-linked markets were little changed. With conventional gilt yields also falling, implied inflation stabilised just below the Government's 2½% target in December.

Although the financing requirement was revised down following the Chancellor's pre-Budget Report on 3 November, the DMO announced that it would proceed with the two scheduled index-linked auctions to meet its Government commitment of a minimum index-linked issuance of £2.5 billion cash for 1998/99. It also announced that it would be prepared to issue a further £0.5 billion via taps, if this was necessary to relieve any overall shortage. Consequently, planned sales of IGs for the rest of the year were between £1.6 billion and £2.1 billion in cash terms. The first auction was held on 25 November for £450 million nominal of 2½% 2013. The common strike price of £183.20 gave a real yield of 2.42% (using the market convention of assuming a 3% inflation rate), and cover was 2.29 times. The other auction, for £450 million 2½% 2024, took place on 27 January.

In October, the United States re-opened its ten-year inflation-linked note; $8 billion was sold at a yield of 3.65%, with cover of 1.92 times. From 1999, the United States will auction a ten-year in January and July, and a thirty-year in April and October. France also auctioned its ten-year OATi for the first time in November. Although cover was at 2.8 times, the yield was a little higher at 3.16% than the 2.98% achieved when the bonds were initially syndicated in September. However, the yield has subsequently fallen to just over 3% by the end of the year—the bonds are the only euro-denominated index-linked bonds and, as a result, may have attracted a premium.

Strips

The total nominal amount of potentially strippable stock rose from £95 billion at end September to £98.5 billion at end December. This followed the November conversion of the non-strippable 8% Treasury Stock 2009 gilt into the strippable 5¾% 2009 Treasury Stock gilt. Turbulence and risk-aversion in world financial markets deterred activity, particularly in less liquid instruments. Consequently, the percentage of stock held in stripped form fell slightly in the last quarter of 1998, to 2.5% of outstanding strippable gilts, and average weekly strips turnover fell to £77 million from £150 million in Q3. Strips turnover continues to average less than ½% of turnover by value in the rest of the gilts market.(1)

(1) A section on strips on pages 38–39 looks in more detail at activity and pricing in the UK strips market.

Table D
Gilt issuance

Auctions

Date	Stock	Amount issued (£ millions)	Cover	Yield at lowest accepted price
25.11.98	2½% Index-linked Treasury Stock 2009	450	2.29	2.42%

Note: Real yields are calculated using a 3% inflation assumption.

Table E
Average daily money-market shortages

£ millions

1996	Year	900
1997	Year	1,200
1998	Year	1,400
	October	1,900
	November	1,700
	December	1,300

Sterling market operations

Open market operations

The Bank's open market operations (OMOs) proved relatively smooth during the final quarter of the year, despite the turbulence and illiquidity that characterised much of the international financial markets. The stock of money-market refinancing held at the Bank rose sharply in October to £15 billion, because of the seasonal CGNCR surplus that month. The stock fell in November and December, ending the year at £10 billion. As Table E shows, the daily shortages were consequently high in October, at an average of £1,900 million, and then fell in the next two months.

In December, the Bank conducted swaps out of sterling into euro to finance its provision of €3 billion of intraday liquidity, on a secured basis, to participants in CHAPS euro, as part of the arrangements for TARGET. The net money-market effect of the provision of sterling under these swaps was to reduce the stock of refinancing by around £2 billion. These swaps will be unwound from April 1999 onwards, as Bank of England Euro Bills are issued to act as a permanent source of the financing of intraday liquidity in CHAPS euro.

During the quarter, the Bank announced that from 26 October 1998, it was extending the collateral that it would accept in OMOs (and in the real-time gross settlement system) to include certain sterling bonds issued by other central governments and international financial institutions, held in the central gilts office (CGO). In due course, the pool of eligible assets will be widened further to include certain euro-denominated securities issued by these entities.(1) Towards the end of the quarter, the final discount house emerged from the transitional arrangements put in place at the time of the reform of the Bank's OMOs in March 1997.

The share of instruments used in the Bank's refinancing remained broadly as in previous quarters. During October, the share of gilt repo in the refinancing rose, as repo often acts as the 'swing' element when refinancing rises sharply. The Bank also made use of foreign exchange swaps to provide sterling liquidity. There were £3 billion of swaps outstanding at the end of October, when the stock of refinancing was high; the amount of swaps outstanding fell to £1.1 billion at the end of the year as the stock of refinancing fell.

In December, the DMO issued a paper outlining its plans for a new framework for government cash management.(2) The paper gives details of how the DMO and Treasury intend to operate government cash management when it transfers from the Bank to the DMO. The DMO's operations are intended to offset the

(1) For more detail on this change and on the Bank's OMOs in 1998, see the article on pages 33–39.
(2) *The Future of UK Government Cash Management*, UK Debt Management Office, 4 December 1998.

influence of government spending and revenue flows on overall money-market liquidity.

Gilt repo market

According to the Bank's regular market survey, the value of repo outstanding was £94 billion at end November, compared with £103 billion at end August. The fall may be attributed to the reduction in repo activity towards the end of the year, which may have reflected two factors:

- In the wake of third-quarter market disturbances, participants may have become more risk-averse, reluctant to enter fresh deals and keen to end the year by booking profits (or limiting losses) already made.

- A reduction in balance sheet positions as the year-end approached.

Figures showed that reverse repo remained static over the period from August to November, at £89 billion.

The proportion of transactions in overnight to eight-day regular and reverse repo mainly fell in the November quarter, by comparison with the earlier August period. This may have reflected a reluctance to repo over this period due to some participants' financial year-ends falling in November. In addition, the need for short-term secured borrowing may have been lower than in August. In late summer, the market turmoil and the resulting credit concerns were at their height, and these concerns tailed off to some extent by the end of November.

Chart 18 shows how the spread between three-month interbank deposit rate and the generalised collateral (GC) repo rate widened over the quarter. At the start of the quarter, the spread was 22 basis points; it peaked at 58 basis points, and ended at 48 basis points. A similar trend was noted for one-month rates. In the fourth quarter of 1997, the peak spread for three-month repo versus interbank was around 35 basis points.

The widening of these spreads in the fourth quarter may have reflected greater perceived interbank risk, with a reduced willingness to lend unsecured, and a greater appetite for asset-backed lending. There was also a desire to hold more liquidity, whether raised by unsecured borrowing or reverse repo, over the euro conversion weekend. There were reports of some interbank credit lines being reduced, and this too may have contributed to spread-widening. Technical factors tend to be particularly influential at the year-end, when interbank and CD rates are usually pushed higher by a reduced willingness to acquire assets with a high capital weight, and a desire to reduce balance sheet holdings. But overall, the sterling interbank market functioned smoothly during the fourth quarter. Since the New Year, spreads have narrowed, consistent with the usual seasonal pattern.

This year's trend of lengthening repo maturities was continued in the fourth quarter, as shown in Table G. Outstanding repos of maturity three months or more represented some 22% of the market in November, little changed from the previous two quarters, but up quite sharply from the 1997 average of 6%. This is similar to the

Table F
Influences on the cash position of the money market

£ billions; *not seasonally adjusted*
Increase in settlement banks' operational balances (+)

	1998/99	1998		
	Apr.–Sept.	Oct.	Nov.	Dec.
CGNCR (+)	5.2	-8.0	1.6	2.5
Net official sales of gilts (-) (a)	-3.7	0.5	2.4	0.0
National Savings (-)	-0.6	-0.3	0.0	0.1
Currency circulation (-)	-1.0	-1.7	1.0	-3.2
Other	3.2	0.5	-1.3	4.3
Total	**3.2**	**-8.8**	**3.7**	**3.7**
Outright purchases of Treasury bills and Bank bills	-1.0	0.8	-0.1	-0.6
Repos of Treasury bills, Bank bills, and British Government stock and non-sterling debt	-1.9	5.6	-2.0	-2.4
Late facilities	-0.2	0.1	-0.2	0.0
Total refinancing	-3.0	6.5	-2.2	-2.9
Foreign exchange swaps	-0.1	2.4	-1.5	-0.5
Treasury bills: Market issues and redemptions (b)	0.0	0.1	0.0	0.0
Total offsetting operations	**-3.1**	**8.8**	**-3.7**	**-3.4**
Settlement banks' operational balances at the Bank	0.0	0.0	0.0	0.3

(a) Net of transactions by the central bank.
(b) Issues at weekly tenders plus redemptions in market hands. Excludes repurchase transactions with the Bank (market holdings include Treasury bills sold to the Bank in repurchase transactions) and tap Treasury bills.

Chart 18
Interbank and CD offer rates vs GC repo (three months)

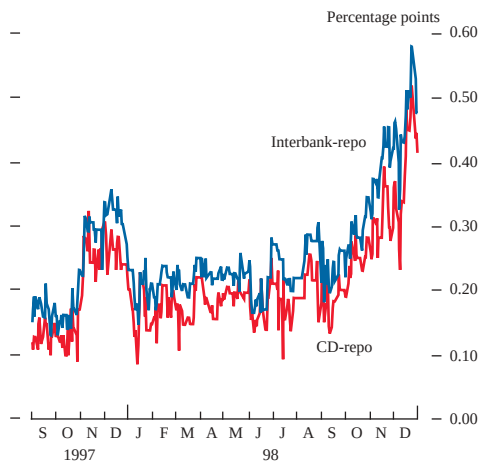
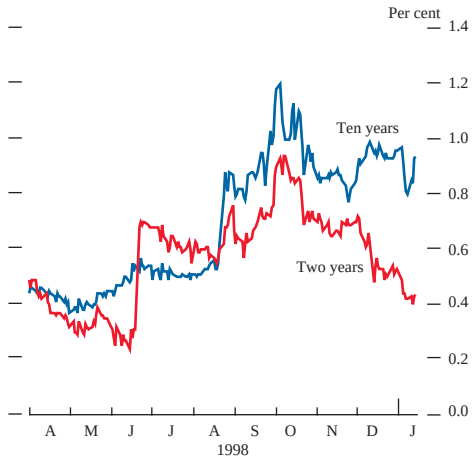


Table G
Maturity breakdown of outstanding repo and reverse repo over time(a)

Per cent	On call and next day	2–8 days	9 days to 1 month	1–3 months	3–6 months	Over 6 months
Repos						
1996 year average (b)	20	34	26	15	4	1
1997 year average	24	24	26	20	5	1
1998 Feb.	14	23	25	19	11	7
May	20	24	19	19	12	8
Aug.	27	15	17	18	11	11
Nov.	23	18	20	16	12	10
Reverse repos						
1996 year average (b)	21	31	19	23	4	2
1997 year average	19	25	25	23	6	2
1998 Feb.	14	29	23	19	10	5
May	22	28	17	13	12	10
Aug.	28	20	18	15	7	12
Nov.	24	14	19	20	11	11

(a) From the data reported under the voluntary quarterly arrangements.
(b) The 1996 year average is calculated by using data from May, August and November.

Chart 19
Sterling swap spreads—ten and two years(a)



(a) These swap spreads are with reference to benchmark gilts.

pattern emerging for reverse repos. Outstanding reverse repos of maturity three months or more represented some 22% of the market in November, up slightly on the previous quarter, and up from the 1997 average of around 8%. This heavier use of longer-dated regular and reverse repo reflects new business entry into this area, rather than utilisation of the middle-maturity area of the market. A detailed account of the repo market's evolution is given in the article on sterling wholesale markets on pages 33–39.

Credit markets

Swap spreads

After widening sharply in September and early October, swap spreads over gilts narrowed somewhat in the fourth quarter, but remained wide in the context of a longer run of data. The move in swap spreads was largely in line with corporate bond spreads (see the section on sterling bond issues). The decline may have reflected three main factors:

- Falling short-term interest rates may have made investors more willing to receive fixed, rather than floating, coupon payments.
- A large number of high-grade sterling fixed-rate bond issues (by supranationals, sovereigns, and sovereign-backed) were brought to the market during the quarter. On issue, the borrowers simultaneously entered into interest rate swap transactions, so as to receive the relatively high fixed interest rate and to pay the relatively cheap floating interest rate. This increased demand to receive fixed-rate interest helped reduce the swap spread over gilts.
- Market confidence that leveraged-fund market disturbances, which peaked in early October, were diminishing.

Corporate bond and swap spreads had stabilised by the end of the year but remained well above the levels in the first half of the year, though significantly lower than the October peak.

Sterling bond issues

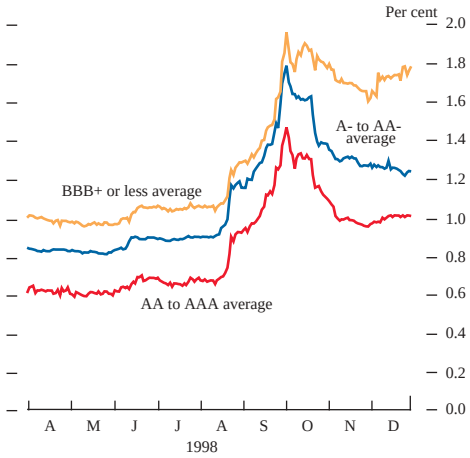
Total fixed-rate issuance in the quarter was £12 billion, bringing total issuance for calendar 1998 to a record £39 billion, up from £31 billion in 1997, itself a record. Short-dated issues in the quarter amounted to £5.5 billion, and issuance of mediums and longs totalled £3 billion and £3.5 billion respectively.(1)

As in previous quarters, low gilt supply and relatively wide swap spreads have stimulated the supply of eurosterling issues, particularly from higher-rated borrowers whose issues are viewed as closely comparable with gilts. The reasonably stable sterling exchange rate also comforted investors. In addition, there were large reinvestment flows in the quarter, resulting from a high level of redemptions of both gilts and eurosterling issues (as the large number of five-year bonds issued in 1993 matured), as well as the 7 December coupons on the strippable gilts.

The market turbulence stemming from the economic and financial problems in the Far East and the Russian debt default continued

(1) Short-dated issues represent maturities of up to seven years, mediums seven to fifteen years, and longs over fifteen years.

Chart 20
Average yields spreads: UK companies vs benchmark gilts



into the fourth quarter, and debt issuance was again mainly by AAA-rated borrowers (supranationals, sovereigns or sovereign-backed) at relatively wide spreads over gilts. As a result of the market uncertainty and reduced liquidity, most issues in the early part of the quarter were pre-placed re-openings of existing issues, timed to take advantage of attractive swap rates (enabling the fixed-rate borrower to achieve cheap floating-rate finance).

A recovery in equity markets, together with increasing expectations of monetary easing and the smooth completion of Long Term Capital Management's auctions of its swap positions helped to restore some market confidence. As heavy swap-driven issuance also depressed swap rates, corporate bond spreads began to narrow and investors began to move back down the credit curve, switching out of the heavily supplied AAA-rated bonds into lower-rated bonds. Towards the end of October, market conditions were such that Thames Water was able to bring the first AA-rated sterling bond since end July. The spread of 180 basis points over the gilt was substantially higher than the 88 basis points achieved by the similarly rated Anglian Water in July, but was in line with the prevailing secondary market conditions. The issue met good demand, and the issue was increased from £200 million to £330 million, encouraging further corporate borrowing in subsequent weeks, mainly by higher-rated names, well known to UK domestic institutions, such as Tesco, BMW, Safeway, Railtrack, Bass, United Biscuits and Anglian Water.

In addition to the substantial fixed-rate issuance, £1.9 billion was issued in floating-rate notes, mainly securitised or asset-backed deals via highly rated special-purpose vehicles, or benefiting from insurance guarantees.

HM Government euro and Ecu issues

The Bank of England, on behalf of HM Treasury, held regular monthly auctions of euro and Ecu Treasury bills during the fourth quarter, each comprising ECU 200 million of one-month, €500 million of three-month and €300 million of six-month bills. The auctions continued to be oversubscribed, with cover averaging 4.2 times the amount on offer. During the fourth quarter, bids were accepted at average yields of 12, 20 and 22 basis points below the Ecu Libid rate for the one-month, three-month and six-month maturities respectively. Secondary market turnover averaged €1.0 billion a month in the fourth quarter and €1.1 billion a month for 1998 as a whole. There are currently €3.5 billion of UK Government euro Treasury bills outstanding.

On 20 October, the Bank reopened the UK Government Euro Treasury Note maturing on 29 January 2001 with a further auction for €500 million, raising the amount of this Note outstanding with the public to €2.0 billion. There was strong cover at the auction of 4.5 times the amount on offer, and accepted bids were in a range of 3.34%–3.36%. The total of Notes outstanding with the public under the UK Note programme thus rose from €5.5 billion in the second quarter to €6.0 billion in the fourth quarter of 1998.

Bank of England Euro Bills

On 5 January 1999, the Bank of England announced that during the course of 1999, it intended to take over from HM Treasury as the issuer of Euro Bills. The Bank plans to make its first issue of

Bank of England Euro Bills in April 1999. Apart from the change in issuer, there will be no other changes to the main features of the programme. The proceeds of Bank of England Euro Bills will be available to the Bank to finance its provision of intraday liquidity, on a secured basis, to participants in CHAPS euro, as part of the arrangements for TARGET. This source of financing for the intraday liquidity will replace the swaps out of sterling mentioned in the open market operations section above.

HM Treasury will replace the part of the financing of the Government's foreign exchange reserves that was previously provided by euro Treasury bills by foreign currency swaps out of sterling. The additional sterling financing requirement that this will create will be taken into account by HM Treasury in setting its sterling financing plans for 1999/2000. HM Treasury will continue to issue Euro Treasury Notes.

The international environment

This article discusses developments[1] *in the global economy since the November 1998* Quarterly Bulletin.

- *Japan's economic performance continued to be weak in the final quarter of 1998, and external forecasts for growth in 1999 were revised down. But additional policy measures to promote recovery were implemented.*

- *GDP growth in the United States was well above trend in 1998 Q3. But the headline growth figures masked an underlying slowdown in final domestic demand growth, and the manufacturing sector weakened markedly in Q3 and Q4.*

- *Growth in the euro area was relatively strong in 1998 Q3 and consumer confidence remained high, though the outlook in recent months has become more mixed as business sentiment has weakened.*

- *Forecasts for GDP growth in 1999 in the major overseas economies were generally revised down during 1998 Q4, largely reflecting the weaker economic outlook in Japan.*

- *Inflation in the major industrial economies remained subdued in Q4, partly reflecting continued falls in internationally traded goods prices. Continued recent declines in world commodity prices may dampen inflationary pressures further in the short term.*

- *The cuts in official interest rates in North America and Europe were followed by some strengthening of consumer confidence in those regions, and a rebound in equity prices. Corporate and emerging market sovereign bond spreads over US Treasuries also narrowed in the period since the previous* Quarterly Bulletin.

- *Financial markets remain volatile, and there are significant uncertainties about the outlook for some important emerging market economies in 1999, particularly Brazil.*

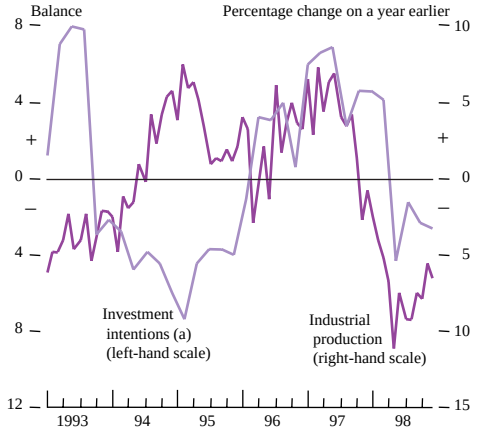
Japan remained in recession in 1998 Q3, and most macroeconomic indicators continued to be weak in Q4. External forecasts for Japanese growth in 1999 were revised down. Additional policy measures were implemented, although it is uncertain whether, and how quickly, these will promote a recovery.

Japanese GDP fell by 0.7% in the third quarter (3.6% lower than a year earlier), its fourth consecutive quarter of negative growth. The effect of the fiscal stimulus packages implemented earlier in 1998 began to be seen in public investment, which contributed 0.3 percentage points to GDP growth. Net exports also contributed positively to growth. However, this was more than outweighed by a sharp decline in corporate investment, and private consumption continued to contract. Revisions raised estimates of GDP growth in 1996 and 1997, but Japan remained in its deepest recession since 1955, when GDP data were first collected.

The December Tankan survey found that business sentiment had deteriorated since September. Firms also revised down their

(1) Based on data up to 29 January 1999.

Chart 1
Japanese industrial production and investment intentions



(a) From December's Tankan survey of business sentiment; series refer to investment for the current fiscal year at each point.

Chart 2
Japanese nominal retail sales and wages

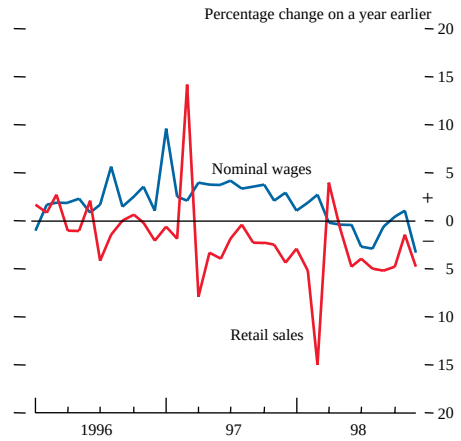
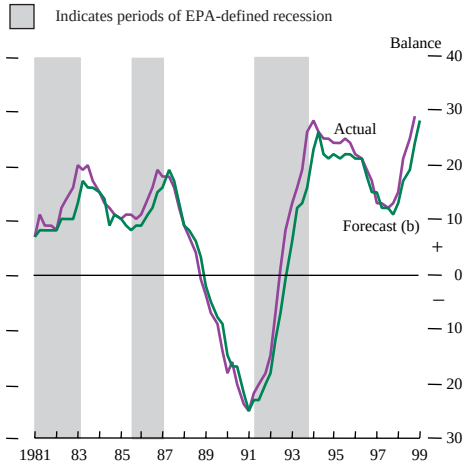


Chart 3
Japanese corporate employment views(a)



Source: December Tankan survey of business sentiment.

(a) Balance of firms reporting excess employees minus those reporting insufficient employees.
(b) Situation expected three months ahead.

forecasts for output in 1999 Q1. Industrial production remained weak; it fell by 6.6% in Q4 compared with a year earlier (see Chart 1). The rate of decline in production slowed as inventory adjustment proceeded, but the Tankan indicated that firms still had a large stock overhang in Q4 of both retail and wholesale goods. Investment was expected to fall by 2.6% in fiscal year 1998 (which ends in March 1999), 0.3 percentage points down from September's Tankan. The prospects for investment remain weak, constrained by falling profitability and restrictions on bank lending. *Consensus Forecasts* in January suggested that business investment is expected to decline by 10% in 1999.

Nominal retail sales fell by 4.3% in the year to Q4, though they rose by 7.4% in Q4 compared with Q3 (see Chart 2). Despite being bolstered by widespread price-discounting in the second half of November, this was a much smaller rise than the 28.4% increase in average nominal wages in Q4, which reflected the payment of year-end bonuses. This may have been because of continued falls in other types of irregular labour income, such as overtime payments, which account for up to 20% of total pay.

If Japanese consumers are attempting to smooth their profile of future consumption, a contraction in expected future earnings because of the weakness of the employment outlook might also help to explain the sluggishness of Japanese retail sales. The Japanese unemployment rate rose to a record high of 4.4% in November, though it fell back to 4.3% in December, and the job offers-to-seekers ratio fell to 0.48 in Q4 from 0.50 in Q3, significantly below its level of 0.69 a year earlier. In any case, the fact that employment cuts are expected to continue (see Chart 3) suggests that the outlook for consumption remains weak.

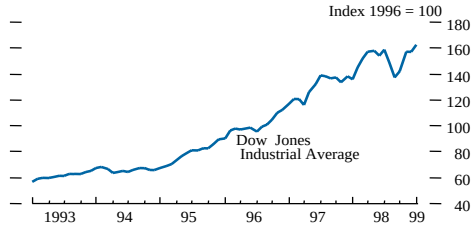
New government policy measures were announced in mid November to help to initiate a recovery. An economic package for the period between January 1999 and March 2000 included new fiscal stimulus measures totalling ¥24 trillion (4.8% of GDP), with ¥18 trillion of extra spending and ¥6 trillion in tax cuts. It was later augmented by a further ¥3 trillion in tax cuts. It remains unclear how far this government spending will offset the continuing decline in private domestic demand.

There were also renewed efforts by the Japanese government to promote financial sector reform. A second tranche of banking sector recapitalisation measures was announced in October, though this included some elements of the first tranche of measures agreed in March. Under the reforms, 15 out of 18 commercial banks in Japan applied for public injections of capital, worth around ¥6 trillion, and Nippon Credit Bank was nationalised in December, having been deemed insolvent by the Japanese Financial Standards Agency. The Bank of Japan also announced that it would provide short-term funding directly to the corporate sector in an expansion of its open market operations, and it established a new lending facility for refinancing bank lending to the corporate sector.

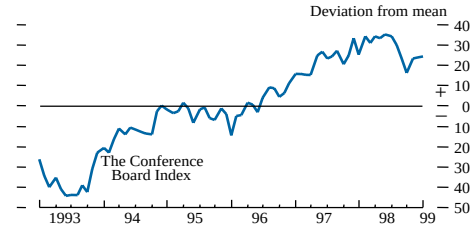
US GDP growth continued to be well above trend in 1998 Q3, though the headline growth figures masked an underlying slowdown in final domestic demand growth and the manufacturing sector weakened markedly in Q3 and Q4.

Chart 4
United States

(a) Equity prices



(b) Consumer confidence



Source: The Conference Board.

Chart 5
US personal sector

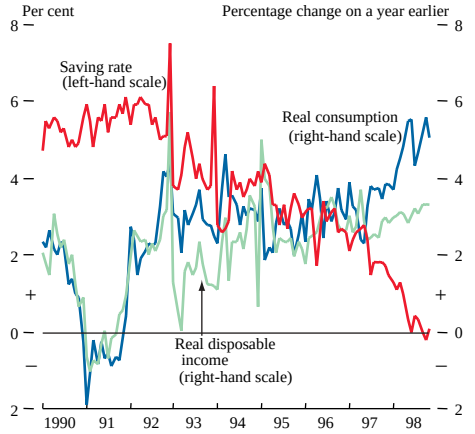
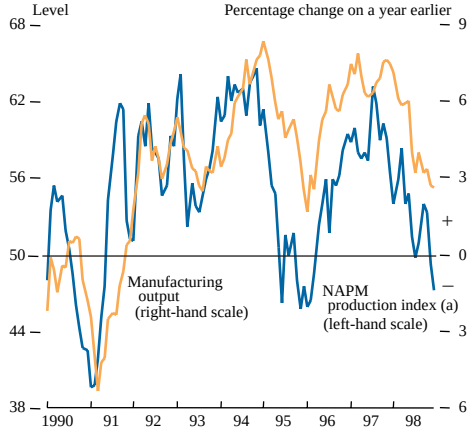


Chart 6
US manufacturing



(a) Source: National Association of Purchasing Managers.

In the United States, GDP rose by 0.9% (3.5% on a year earlier) in Q3. This reflected continued rapid growth in private sector consumption and investment, typical of the 1990s upswing in the United States. Final domestic demand growth slowed compared with previous quarters in 1998, particularly on the investment side, but it remained sufficiently robust to offset a negative contribution to growth from net trade. The strength of the US expansion in Q3 also partly reflected accumulation of stocks. Advance estimates suggest that GDP growth in Q4 was 1.5%, again supported by rapid domestic demand growth. Although these estimates are subject to revision, more disaggregated data also suggest that personal consumption growth remained strong in Q4.

This strong growth partly reflected labour market conditions. The unemployment rate in December fell to the bottom of the 4.3%–4.7% band within which it has fluctuated since the end of 1997, near historical lows. Growth in non-agricultural employment slowed slightly in Q4 to 2.3% on a year earlier, but remained faster than the average long-run rate of growth of the labour force, which is just over 1%. This supported continued strong personal income growth in late 1998. But buoyed by a recovery in equity prices and some rebound in consumer confidence in Q4 (see Charts 4a and 4b), annual growth in consumption over the quarter continued to be even more rapid than income growth. Reflecting similar imbalances in recent years, the US personal saving rate had already declined steadily during the 1990s, from around 5% in 1992 to 0.1% in 1998 Q3; in October, it turned negative, though it recovered to 0.1% in November (see Chart 5).

How long US consumers sustain this consumption growth will partly depend on whether the increase in household wealth associated with rising equity prices during the 1990s continues, and on whether mortgage refinancing continues to be supported by falls in long-term interest rates. It will also depend on households' income growth and their assessment of future income prospects, which Conference Board evidence suggests became more pessimistic in Q4. This increased pessimism is likely to have reflected uncertainty about whether robust employment growth will continue in 1999. Service sector employment growth remains strong, but it slowed slightly in Q4 to 2.8% on a year earlier, from 3.0% in Q3. Manufacturing sector employment was much weaker and slowed more sharply in Q4, to -0.9% on a year earlier, from -0.1% in Q3.

The continued fall in manufacturing employment was in line with the growing weakness in the sector (see Chart 6). Annual growth of total industrial production was even weaker, falling in Q4 to well below growth rates in the 1991 recession. The capacity utilisation rate in industry correspondingly declined in Q4, to below its long-run average. These weak data were corroborated by survey evidence from the Federal Reserve's 'Beige Book' summary of regional economic conditions and the National Association for Purchasing Managers (NAPM), whose reports suggested that weakness in export demand was a key factor in dampening US production.

The slowdown in domestic production against continuing strength in domestic demand was reflected in a further increase in the US

Chart 7
US external position

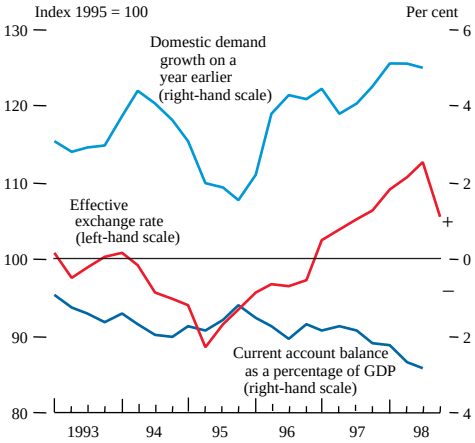
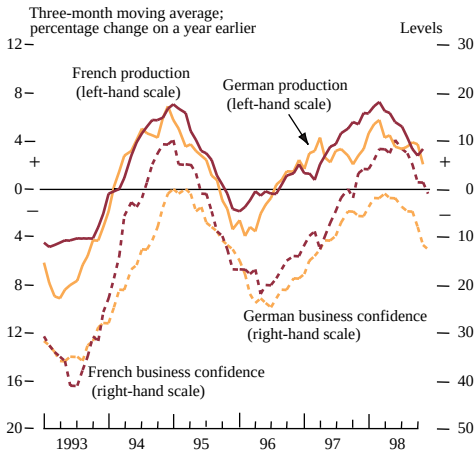


Chart 8
French and German industrial production



Source for confidence indicators: European Commission.

trade deficit in Q3 (see Chart 7). Alongside a fall in net investment income, this increased the US current account deficit to 2.9% of GDP, from 2.7% in Q2. The trend in Q4 was less clear: data between September and November suggested some stabilisation of the trade deficit. However, the balance was distorted during this period by sharp movements in some erratic components of merchandise exports. *Consensus Forecasts* suggested that there were widespread expectations that the US current account deficit would widen further in 1999.

Growth in Germany and France was fairly strong in 1998 Q3 and consumer confidence remained high. However, the outlook in recent months has become more mixed as business sentiment has weakened.

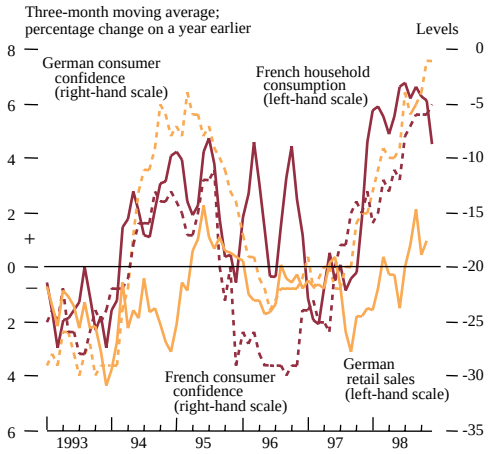
In the third quarter, GDP growth was at or above trend in Germany and France, which together account for more than half of euro-area GDP. German GDP grew particularly strongly, by 0.9% (2.7% on a year earlier), in contrast with zero growth in Q2. One factor accounting for the stronger outturn in Q3 was a rise in private consumption growth, which had been weak in the previous quarter. French GDP growth slowed slightly to 0.5% in Q3 (2.8% on a year earlier), mainly because of a run-down of stocks and a smaller positive contribution from household consumption. Net trade contributed positively to quarterly growth in both Germany and France.

Data from the fourth quarter suggested some slowdown in activity in Germany. Industrial production growth in the first two months of Q4 averaged 1.6% on a year earlier, much lower than in the first half of 1998, and forward-looking industrial indicators also deteriorated. After steadily slower growth throughout 1998, German manufacturing orders fell in October and November by an average of 1.8% compared with a year earlier. By contrast, French industrial production data from the early part of Q4 were stronger than in Q3, when industrial production was static compared with the previous quarter. However, as in Germany, French annual industrial production growth also appeared to be slowing from the rapid rates of expansion during the first half of 1998 (see Chart 8).

Reflecting these trends, French and German business sentiment deteriorated in Q4 (see Chart 8), owing to increased pessimism about both current conditions and forward-looking indicators such as assessments of new orders, production expectations and unwanted inventories. The IFO measure of German business expectations fell particularly sharply, reaching its lowest level since the middle of 1996. In both countries, the change in sentiment was driven by a steep fall in expected foreign demand.

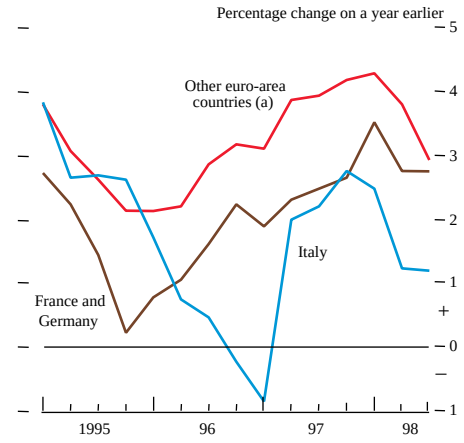
The weaker business outlook has not yet resulted in a slowdown in employment growth. French employment grew by 0.4% in Q3 (2.3% on a year earlier), with a fall of 0.2% in manufacturing employment offset by a rise of 0.9% in service sector employment. INSEE surveys suggest that French firms' hiring expectations in Q4 rose. German employment growth remained weaker than in France, rising by 0.3% in Q3 (0.3% on a year earlier), but it was the first quarter of positive annual employment growth since the pan-German series began in 1993. In October, employment rose by a further 0.1% (0.6% on a year earlier). However, the German

Chart 9
French and German consumption



Source for confidence indicators: European Commission.

Chart 10
Comparisons of euro-area GDP growth



(a) Includes Belgium, Finland, the Netherlands, Portugal and Spain, comprising 22.8% of euro-area GDP; Germany, France and Italy account for 73.2% of the rest.

employment outlook is subject to particular uncertainty, as it remains unclear whether the new government will prolong job creation schemes, which fuelled recent employment growth in eastern Germany.

The sharp falls in confidence in the industrial sector were not mirrored by consumer confidence (see Chart 9), perhaps reflecting the relative stability of employment. French consumer confidence in December was only two points below the all-time high recorded three months earlier, although growth in French household consumer spending began to weaken in Q4. German consumer confidence in Q4 was also significantly higher than a year earlier, though retail sales growth also weakened in Q4 and was lower than in France, possibly owing to greater perceived fragility of recent gains in employment growth.

How different are other euro-area economies from Germany and France?

Taken together, Germany and France grew by 2.7% on a year earlier in Q3. GDP growth in the third-largest euro economy, Italy, continued to be weaker than in Germany and France: GDP was 1.2% higher than a year earlier in Q3. By contrast, economic growth in the smaller countries in the euro area remained faster than in the three largest euro countries in Q3, at 2.9% on a year earlier. This left average euro-area GDP growth in Q3 at 2.4%. But the gap between the faster-growing countries and the slower-growing core of the euro area appeared to narrow in Q3 (see Chart 10).(1) This is consistent with a sharper fall in confidence indicators in the smaller euro-area countries than in the larger ones in late 1998.

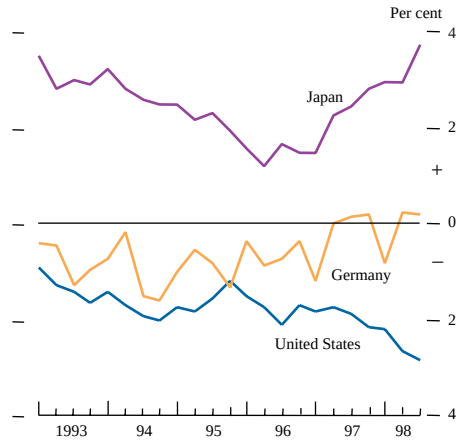
The scope for convergence in growth rates within the euro area will be affected by the different degrees of monetary easing throughout 1998 in countries other than France and Germany. Italian GDP growth may be boosted by the significant interest rate cuts in 1998 Q4, but there was also marked easing of the monetary stance in faster-growing countries. Any widening of the gap between the growth in smaller and larger economies might be reduced by some real exchange rate appreciation, resulting from higher rates of inflation in faster-growing countries within the single-currency area. But fiscal policy could act to maintain the existing differences in growth rates in the euro area. Stability programmes setting out most euro-area countries' fiscal plans for 1999–2001 have been submitted, generally calling for gradual continuing deficit reduction over this period. The relatively large deficits of Germany, France and Italy mean that the Stability and Growth Pact is likely to constrain their fiscal response to any downturn in 1999; this is less true in many of the faster-growing countries with smaller budget deficits.

As in the United States, a central question for the euro area is how much changing trade patterns could weaken the net trade outlook.

Following the increase in financial instability in East Asia in 1997, the IMF estimates that net capital flows to emerging markets fell from almost $150 billion in 1996/97, to around $70 billion in 1998.

(1) All euro-area aggregates are GDP-weighted. Q3 data for the euro area cover 96% of the region's total GDP (comprising Germany, France, Italy, Spain, the Netherlands, Belgium, Portugal and Finland).

Chart 11
G3 current account balances as a percentage of GDP



This led to sharp swings towards current account surplus in the affected emerging market countries, and the counterpart to this was a shift towards deficit in the current accounts of industrialised countries.(1) This occurred most notably in the United States, where the current account deficit reached 2.9% of GDP in Q3. By contrast, net trade made positive contributions to GDP growth in the largest euro countries in Q3. The French current account surplus rose to 3.5% of GDP in Q3, and Italy's surplus was 2.2% of GDP in Q3. The German current account surplus was smaller, at 0.2% of GDP in Q3. However, Chart 11 shows that Germany's current account position also diverged from that of the United States in 1997 and 1998.

The relative strength of current accounts in Germany, France and Italy partly reflected different cyclical positions in Europe *vis-à-vis* key trading partners such as the United States, which was further into an upswing in 1998. Euro-area currencies as a whole also depreciated in real effective terms between mid 1996 and the first quarter of 1998, in contrast with the US dollar; this may have helped to offset the effects of global financial crisis. The euro area's net trade outlook is central to short-term prospects for further growth in euro countries, and it will be affected by similar factors: the degree of any slowdown in the United States in 1999, the effects of recent appreciation of euro currencies, and the fragility of emerging markets. Concern about these issues is reflected in the business sentiment surveys in the main European economies, which suggested that export prospects worsened for European firms in Q4.

International economic growth forecasts have been revised down since the November Quarterly Bulletin.

Table A gives recent projections for GDP growth in 1998 and 1999 in major overseas industrialised economies. Growth in each country is widely forecast to slow in 1999, except in Japan and Italy, and most external forecasts for growth in each country were revised down in Q4.

Table A
Forecasts for GDP growth

Per cent

	IMF (a)		Consensus Economics (b)		*The Economist* poll of forecasters (c)	
	1998	1999	1998	1999	1998	1999
United States	3.6	1.8	3.7	2.3	3.6	2.1
Japan	-2.8	-0.5	-2.7	-0.6	-2.8	-0.7
Germany	2.7	2.0	2.7	2.0	2.8	1.8
France	3.0	2.6	3.0	2.2	3.0	2.2
Italy	1.5	2.0	1.6	2.0	1.5	1.8

(a) Interim *World Economic Outlook* (December 1998).
(b) *Consensus Forecasts* (December 1998).
(c) *The Economist* (30 January–5 February 1999).

The IMF's December forecast suggested that overall GDP growth in the six major overseas economies(2) is now expected to fall from 3.0% in 1997 to 2.2% in 1998 and 1.5% in 1999. Compared with the October forecast, this was an upward revision of 0.2 percentage points for 1998 but a downward revision of 0.4 percentage points to the 1999 projection. This revision for 1999 was the result of a sharper projected slowdown in Europe and the United States, and continued recession in Japan. Between October and December, the IMF revised down its forecast for 1998 GDP growth in Japan by 0.3 percentage points to -2.8%, and by 1 percentage point in 1999, from 0.5% to -0.5%.

Growth in world trade volumes is also widely forecast as slower in 1998 and 1999 than in recent years. The IMF estimates that between 1994 and 1997, world trade grew by an average of 8.9% each year, but its forecasts suggest a slowdown to 3.4% in 1998 and 4.4% in 1999. Particularly in 1998, the slower growth might reflect

(1) However, IMF estimates suggest that the residual on the global current account increased in 1998 compared with recent years. In the absence of any errors or inconsistencies in the data, the residual would equal zero; a growing residual suggests increasing unreliability of cross-country comparisons of current account changes. Hence there is a need for caution when discussing the relationship between current account movements in industrialised countries and emerging markets in 1998.
(2) The United States, Japan, Germany, France, Italy and Canada.

temporary factors such as recent turmoil in emerging markets. It is unclear whether the slowdown might also partly represent a return to a long-run trend. Annual world trade growth averaged 4.5% between 1980 and 1993, and the particularly rapid expansion in world trade in the mid 1990s may have been supported by the effects of trade liberalisation agreements.

Inflation in the major industrial economies remained subdued in the fourth quarter, partly reflecting continued falls in internationally traded goods prices. Further recent falls in world oil prices may continue to dampen inflationary pressures in the short term.

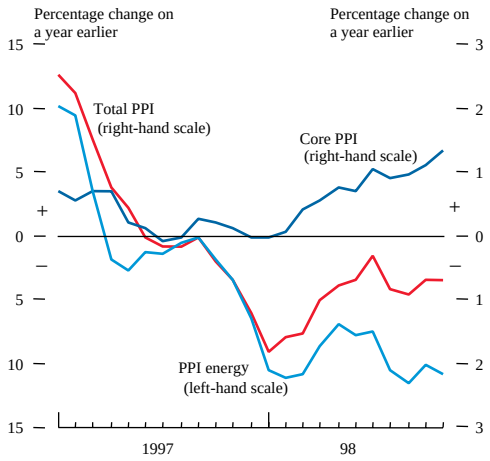
In dollar terms, crude oil spot prices fell by 37% in 1998, and non-oil commodity prices fell by 16%.(1) The fall in commodity prices appears to have reflected both supply and demand factors, and was one reason for a fall in internationally tradable goods prices in industrialised countries in 1998. In GDP-weighted terms, import prices in the three major overseas economies fell by 5.2% in the first ten months of 1998. This continued to be a common influence dampening inflation across industrialised countries in the fourth quarter.

Despite continued strong output and employment growth, US consumer price inflation remained low. It fell to 1.5% in Q4 from 1.6% in Q3, giving a 1998 average of 1.6%, compared with 2.3% in 1997. Core consumer price inflation (which excludes food and energy) was higher, and did not decline between 1997 and 1998, reflecting the importance of past falls in commodity prices in depressing consumer price inflation. But it remained around a historical low of 2.4% in Q4, and displayed no clear upward trend. This partly reflected revisions to the index introduced in 1998, which are estimated to have reduced consumer price inflation by around 0.15 percentage points.(2) The lagged effects of past exchange rate appreciation in the United States also contributed to lower inflation by lowering import prices. Unit labour cost growth also remained fairly stable. Annual growth of hourly labour compensation rose to 4.3% in the first three quarters of 1998 from 3.7% in 1997, but this was offset by gains in productivity.

There were few signs that goods price inflation would pick up markedly in the short term. In Q4, the NAPM index of manufacturing producer prices fell to a historic low. Even including a sharp increase in tobacco prices in December, largely reflecting the costs to tobacco manufacturers of legal settlements with US state governments, producer price inflation for finished goods was -0.5% in Q4. However, Chart 12 shows that growth in core producer prices (which exclude energy and food) rose in 1998; in the longer term, increased inflationary pressure may emerge from the continuing strength in employment growth and depreciation of the dollar since mid 1998.

Inflation in the euro area was low and falling in Q4. German consumer price inflation averaged 0.6%, compared with 0.8% in Q3. Inflation in France was lower still, at 0.3% in Q4, compared with 0.7% in Q3. Upward bias in the German national consumer

Chart 12
US producer prices



(1) Commodity prices quoted in this section refer to the Economist Intelligence Unit US dollar-denominated indices for crude oil and for non-oil general commodities (the 'World Commodity Forecasts' index).
(2) For a discussion of the effects of revisions to the CPI, see 'OECD Economics Surveys: United States 1997', OECD (1997).

Chart 13
Harmonised consumer price indices

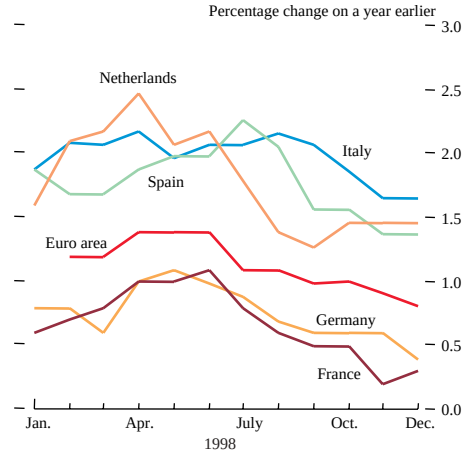


Chart 14
Japanese prices

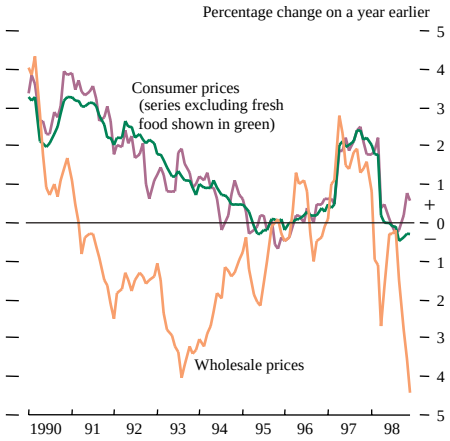


Table B
Real broad money growth

Percentage changes on a year earlier

		United States	EU3 (a)	Japan	M6 (b)
1990–95		-0.9	1.8	2.0	0.8
1996		1.9	0.8	3.1	1.9
1997		2.6	3.3	1.3	2.4
1998	H1	5.2	4.3	3.0	4.1
	Q3	5.8	4.1	3.9	4.6
	Oct.	6.9	4.3	3.7	5.1
	Nov.	7.1	4.1	3.6	

(a) GDP-weighted average for Germany, France and Italy (EU3).
(b) GDP-weighted average for the United States, Japan, Canada and the EU3.

price index—estimated to be around 0.75 percentage points—suggests that the core of the euro area may be close to absolute price stability.(1)

Chart 13 illustrates that other euro-area countries had higher inflation rates (except for Belgium and Luxembourg). Harmonised consumer price inflation across the euro area was 0.9% in Q4. But inflation rates typically fell in the second half of 1998 in all euro countries, reflecting the same commodity price dynamics as in other major industrialised countries. But if these inflation divergences within the euro area persist, they imply that some realignment of real exchange rates will occur within the euro area.

Japanese consumer price inflation rose to 0.5% in Q4 from -0.2% in Q3, owing to a rebound in food prices (see Chart 14). But excluding food, consumer price inflation dropped to -0.3% in Q4, from -0.2% in Q3. The rise in inflation earlier in 1997 was the result of the introduction of a sales tax, and no underlying inflationary pressures are evident. Wholesale price inflation fell to -3.9% in Q4 from -0.2% in Q3. Domestic wholesale price inflation was less negative, reflecting the recent appreciation of the yen and the importance of falling prices for imported commodities.

The decline in crude oil spot prices accelerated in 1998 Q4, when they fell by a further 36% on the previous quarter. Non-oil commodity prices also continued to fall sharply in 1998 Q4, though the rate of deflation slowed to 17% from 19% in Q3. This will dampen inflationary pressures further in the short term, but the longer-term outlook for inflation in the M6 is clearly affected by the prospects for commodity price stabilisation in 1999.

Real broad money growth in major overseas industrialised countries remained faster than earlier in the 1990s, though broad money velocity continued to fall in Q3.

For the six major overseas industrialised economies, real broad money growth was 4.6% in Q3, faster than in the first half of 1998. In October it rose further, to 5.1% (see Table B). However, broad money velocity continued to slow in Q3. The average annual increase in the M1 narrow money measure for the major six industrialised economies rose from 4.5% in August to 5.6% in October, broadly in line with growth rates during the first half of 1998.(2)

US broad money growth remained more rapid than in other large overseas industrialised countries, and it accelerated sharply in late 1998. This may have reflected a shift out of bond finance into bank finance by US corporate borrowers, as corporate bond yields remained higher than before the Russian shock to financial markets in August.

The announcement in October of the ECB's strategy for monetary policy made clear that broad money growth would be an important factor in determining euro-area monetary policy. On 1 December 1998, the reference point for assessing annual money growth was determined at 4.5% for the three-month moving average of

(1) Source: Hoffman, J (1998), 'Probleme der Inflationsmessung in Deutschland', *Diskussionspapier 1/98*, Volkswirtschaftliche Forschungsgruppe der Deutschen Bundesbank.
(2) Aggregates are GDP-weighted averages for the major six overseas industrialised economies. Broad money measures used in each country are M2 for the United States and Italy, M3 in France and Germany, M2+ in Canada and M2 + CDs in Japan. The measure of narrow money is M1. GDP deflators were used to obtain real money growth figures from nominal aggregates.

Chart 15
Official interest rates

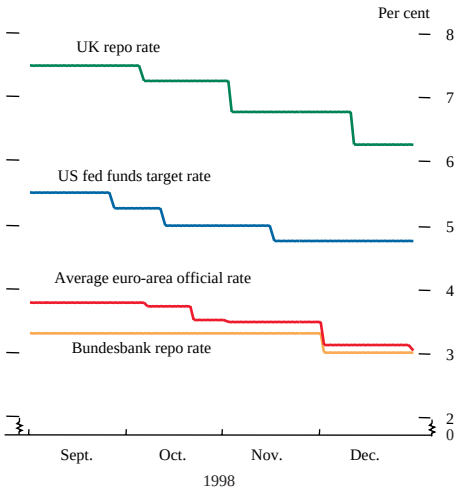
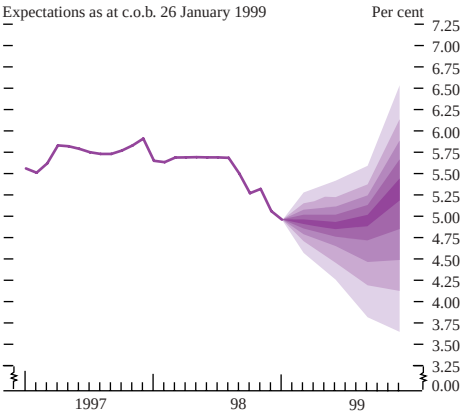


Chart 16
Implied distributions for three-month eurodollar interest rates



euro-area M3. This figure was derived on the basis of the ECB's measures of price stability, trend real GDP growth and the trend decline in the velocity of money;(1) it will be reviewed in December 1999. Annual real broad money growth in the euro area as a whole fell in the second half of 1998, and at 4.7% in the three months to November was close to the reference value.

The Japanese call rate was reduced by 25 basis points to an average of 0.25% in September, but the Japanese economy showed few signs of revival in 1998 Q4. With interest rates so close to zero, there is little scope for any further indirect monetary stimulus. As discussed in the minutes of the Bank of Japan's Monetary Policy Committee meeting on 13 November, future nominal stimuli may therefore have to come from direct increases in the money supply via open market operations.

The low-inflation outlook allowed further easing of interest rates in most industrial countries, in response to weakness in global economic and financial conditions.

On 17 November, the US Federal Reserve Bank reduced the federal funds target rate by 25 basis points for the third time since the financial market turmoil triggered by the Russian debt moratorium in August 1998 (see Chart 15). A statement issued by the Federal Open Market Committee at that meeting was widely interpreted by financial markets to suggest that no further cuts were imminent: 'With the 75 basis point decline in the federal funds rate since September, financial conditions can reasonably be expected to be consistent with fostering sustained economic expansion while keeping inflationary pressures subdued'. The policy action record for that meeting published on 23 December showed that the Committee had also voted to adopt a symmetric policy stance.

Since November, US official interest rates have been unchanged. Chart 16 shows the implied risk-neutral probability distribution of US short-term interest rate expectations, derived from options on 26 January. The mean expectation shown is higher at the end of 1999 than that shown in the implied distribution presented in the November *Quarterly Bulletin*.(2) However, it is relatively flat throughout most of 1999, suggesting that market participants do not expect any further interest rate changes in the United States in the near future.

Following earlier reductions in official interest rates throughout 1998, on 3 December all euro-participating countries except Italy simultaneously reduced their rates to 3.0% (see Chart 15). Italy reduced its interest rate on this date to 3.5%, and then to 3.0% on 24 December. Convergence of official interest rates was necessary ahead of the introduction of the euro on 1 January 1999, and took the form of a coordinated policy easing in response to perceptions of a deteriorating world economic outlook.(3)

Measures of the implied volatility of key European forward interest rates, derived from option prices, suggested that market uncertainty regarding the future monetary policy stance of the ECB increased

(1) Price stability is defined by the ECB to be 'a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of 2%'; its estimates of trend real GDP growth are between 2.0% and 2.5%, and estimates of the trend decline in the velocity of money are between 0.5% and 1.0%.
(2) The rise in interest rate expectations for late 1999, shown in Chart 16, has been interpreted by market commentators as a 'Millennium effect'.
(3) The chairman of the Bundesbank, Hans Tietmeyer, said that the coordinated rate cut 'could lead to a reduction in the current pessimism and a reduction in financial market turbulence'.

Chart 17
Ten-year US corporate bond spreads over US Treasuries

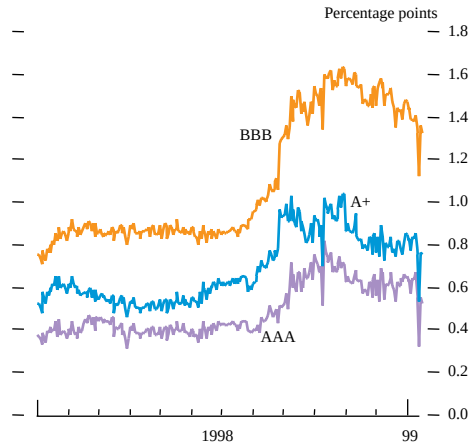
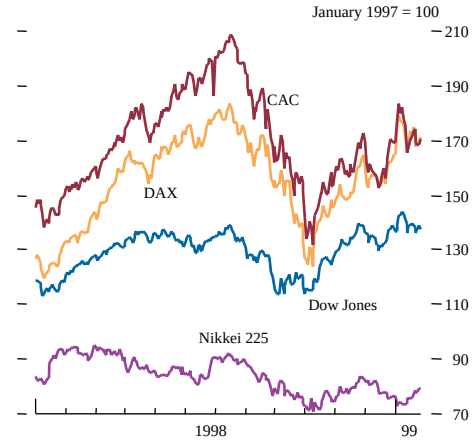
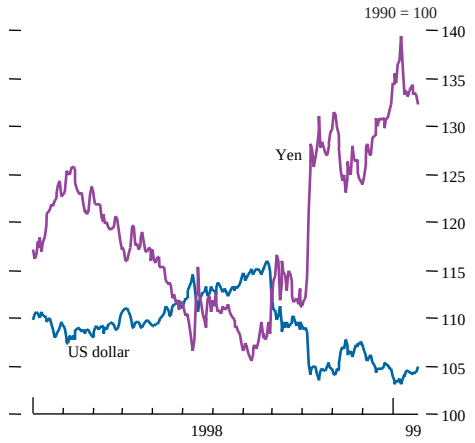


Chart 18
Equity prices(a)



(a) In local currency.

Chart 19
US dollar and yen nominal effective exchange rates



after the interest rate cuts in early December. However, a statement by the ECB Governing Council on 22 December said that it intended to maintain the same level of interest rates 'for the foreseeable future', a stance reiterated in the first issue of the ECB *Monthly Bulletin* in January 1999. In the same statement, the rates of the standing facilities of the European System of Central Banks were announced to be 2% for the deposit facility and 4.5% for the marginal lending facility. But the ECB also set a temporarily narrower corridor of 2.75%–3.75%, for use between 4 January and 21 January 1999, aimed at 'smoothing the adaptation of market participants to the integrated euro money market'.

The effect of this statement appeared to have been to raise expectations of euro interest rates marginally (by 5 basis points), though the variance of market expectations about future euro interest rate levels did not decrease, perhaps as a result of continued volatility in emerging markets.

Since early October, financial markets have become less volatile and risk-averse, but remain more unsettled than in the period before August.(1)

In the two months after the announcement of the Russian debt moratorium in mid August, participants in global financial markets became more risk-averse and increased their demand for liquidity. This resulted in significant volatility in asset prices, even in the most mature financial markets. The subsequent easing of monetary conditions in major industrial countries may have helped to stabilise financial market conditions. Corporate bond yield spreads fell back from their peaks in early October (see Chart 17). An increase in the growth of bank lending cushioned the reduced access to bond finance experienced by some firms in the United States. There was also a sharp global rebound in equity prices in Q4, with key US indices reaching all-time highs (see Chart 18).

However, implied volatility(2) for corporate bond yields and equity prices remained above levels before the shocks in August. Risk premia also remained higher: Chart 17 shows that US corporate bond spreads in Q4 were above their average in the first half of 1998, particularly for borrowers with lower credit ratings. A Federal Reserve survey in November, of senior bank loan officers, also showed that there had been a more widespread tightening of conditions on banks' corporate loans than was evident in the previous survey conducted in September. And the renewed turbulence in global financial markets in January 1999, following the devaluation of the Brazilian currency, illustrated that equity prices in particular remain fragile.

There were also marked movements in key foreign exchange rates in Q4 (see Chart 19). The depreciation in the US nominal effective exchange rate continued from its peak in August: in Q4, its average level was 6% below the average for the preceding quarter. The Japanese effective exchange rate strengthened sharply in Q4, especially in early October. The yen appreciated to a 28-month high of ¥108.6 against the dollar on 11 January, though it later fell back following intervention from the Japanese authorities.

(1) Movements in foreign exchange, equity and bond markets are discussed in more detail in 'Markets and operations' in this *Quarterly Bulletin*, pages 5–19.
(2) Implied volatility is the financial market's *ex ante* expectation of the volatility of an underlying asset's return over the remaining life of an option on that asset.

Chart 20
Change in government bond yields (from 1 October 1998)

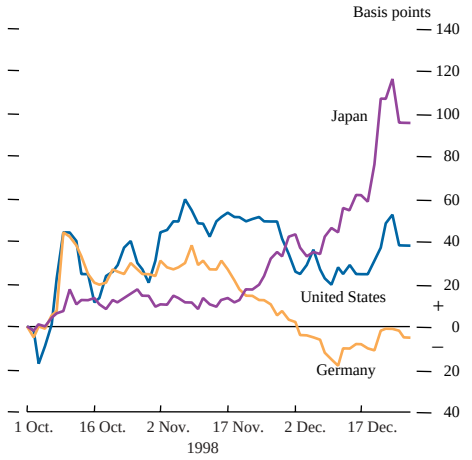


Chart 21
Japan: zero-coupon yields

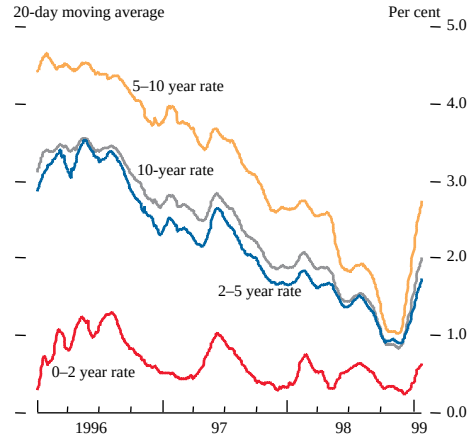
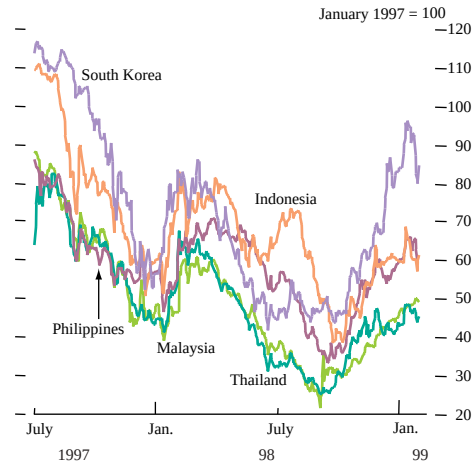


Chart 22
Asian equity markets(a)



(a) In local currency.

The depreciation of the US dollar may partly have reflected concerns about the size of the US current account deficit, which reached 2.9% of GDP in Q3. Slower growth and increasing financial instability in Latin America in Q4 may have also increased perceptions that the US current account deficit would widen further, and may have increased uncertainty about the robustness of US financial markets to potential external shocks from the region.

Japanese government bond (JGB) yields rose particularly sharply in Q4, in contrast with comparable bond yields in other M6 countries (see Chart 20). This may have reflected prospective changes in demand and supply in the JGB market. In particular, the Ministry of Finance announced in December that the single largest investor in JGBs, the publicly owned Trust Fund Bureau (TFB), would withdraw from purchasing JGBs in January 1999.

A decomposition of the rise in the ten-year JGB yield curve into zero-coupon bonds of different maturities (as shown in Chart 21) suggests that the rise in ten-year bond yields was mainly reflected in an increase in the five-year spot rate five years forward (labelled on the chart as '5–10 year rate').(1) This suggests that the government policies and banking reforms announced in Q4 may have raised expectations of inflation and economic recovery in the long term in Japan. The appreciation of the yen may also have been supported by some positive market reaction to these policy measures. However, to the extent that the rise in bond yields and appreciation of the yen persist, these market movements may not promote Japanese recovery prospects in the shorter term.

In East Asian emerging markets, there was some progress towards economic stabilisation.

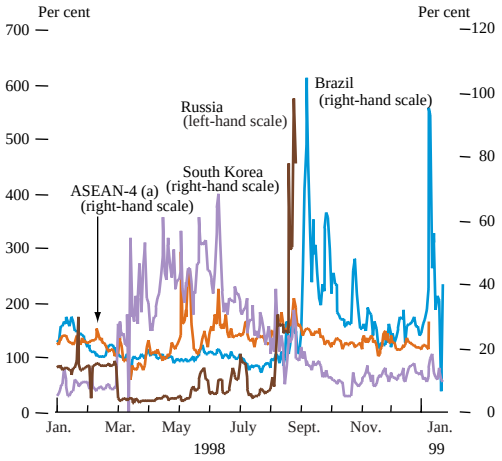
As noted earlier (on page 24), the fall in net capital flows to the five East Asian countries most affected by financial shocks in 1997 (South Korea, Thailand, the Philippines, Indonesia and Malaysia) resulted in significant shifts towards current account surplus in these countries in 1998. This was achieved primarily through import compression, as domestic demand growth slowed sharply. The aggregate current account position in the five countries is estimated by the IMF to have swung towards surplus by $118 billion between 1996 and 1998.

Financial market confidence in the region increased in 1998 Q4. Effective exchange rates continued to appreciate in nominal terms, aided by the weakening of the dollar in late 1998 against other major currencies, in particular against the Japanese yen. Regional equity prices also rose (see Chart 22), though they remained below their pre-crisis levels.

There were also further declines in interest rates in Thailand, Indonesia and the Philippines in Q4 (see Chart 23). The same was true in many other emerging markets, though not in Russia, reflecting its relatively poor prospects for financial stabilisation. All five Asian-crisis countries appear to have remained in recession in Q4, though there were significant differences within the group. Indonesia remains particularly weak; Korea and Thailand appear to have made most progress towards macroeconomic stabilisation.

(1) Similarly, the '2–5 year rate' in Chart 21 is derived from the two-year spot rate three years forward, and the '0–2 year rate' relates to the current spot rate two years forward.

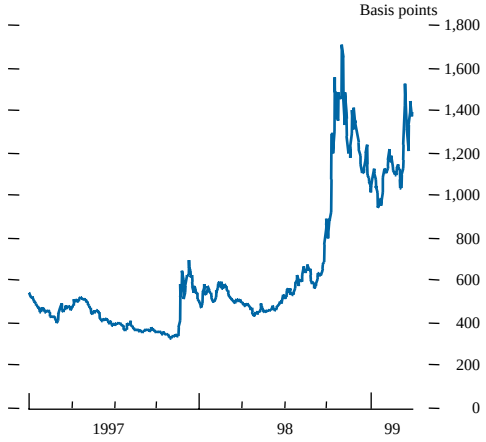
Chart 23
Money-market interest rates



Source: JP Morgan, Emerging Local Markets Index. Russia was suspended from the index from 1 September 1998.

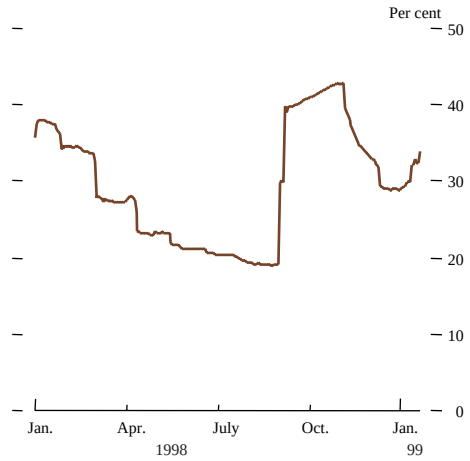
(a) Thailand, Malaysia, the Philippines and Indonesia.

Chart 24
Emerging market sovereign bond yield spreads over US Treasuries



Source: JP Morgan, Emerging Markets Bond Index.

Chart 25
Brazilian short-term interest rate(a)



Source: Bloomberg.

(a) Selic overnight rate.

Concern about emerging market economies remains. One source of particular uncertainty is Brazil, which adopted a floating exchange rate in mid January.

As growth slowed in the Asian emerging markets, significant weaknesses in their domestic banking systems became apparent. The authorities in several countries began to address these problems in 1998, but for economic recovery to become more broadly based and sustainable, the IMF has argued that further restructuring of domestic financial and corporate sectors remains necessary. There are also sources of uncertainty for these countries stemming from the possibility of further regional Asian shocks. Japan accounts for 14% of the five crisis-hit countries' exports, but the outlook for Japanese domestic demand remains weak, and the economy is expected to contract further in 1999. The prospects for China are also important for the region; official data suggest that GDP growth remained robust in 1998, but more disaggregated data are weaker and there are significant domestic financial fragilities.

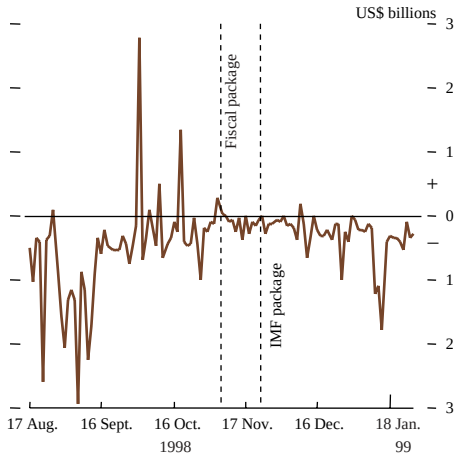
In emerging market economies in general, secondary market bond spreads over risk-free assets narrowed in the early part of 1998 Q4. However, they remained volatile, and wider than before the Russian turmoil of August (see Chart 24).

One particular source of market volatility in recent months was investor concern about the economic outlook for Brazil, the world's eighth-largest economy (in GDP terms). The economy was strongly affected by the large withdrawals in capital flows from emerging markets that occurred in the wake of the Russian debt moratorium in August, as private sector investors reappraised the risk involved in exposure to such markets. Investors' concerns focused on the size and funding requirements of the Brazilian budget and current account deficits, particularly given a slowdown in GDP growth from 3.7% in 1997 to -0.1% in 1998 Q3 in annual terms. The nominal fiscal deficit had risen from 6.1% of GDP in 1997 to 7.4% of GDP in the period January-October 1998. To support financial and economic stabilisation in Brazil, an IMF-led package totalling $41.5 billion was announced on 13 November, conditional on a programme of front-loaded fiscal adjustment by the Brazilian government. This aided a recovery in equity prices and a decline in interest rates in Q4 (see Chart 25).

But net capital outflows from Brazil continued, apparently reflecting uncertainty about whether the fiscal adjustment planned by the federal government would gain the necessary political approval for implementation. The outflows increased in December and early January to a level inconsistent with the IMF programme (see Chart 26), and interest rates began to rise again in January.

The continued drain on net reserves prompted a change in monetary policy, which was intended to allow a reduction in interest rates without significant net capital outflows. Prior to 13 January, the Brazilian authorities maintained a crawling exchange rate peg to the US dollar, which allowed the real to fluctuate within a narrow (1.2%) intervention band. On 13 January, the Brazilian authorities abandoned the narrow intervention band, replacing it with a wider (10.0%) band. At the same time, the centre of the band was shifted so that the ceiling was raised to 1.32 R/$, compared with 1.22 R/$ under the previous system. The real depreciated to its new ceiling

Chart 26
Brazilian daily net capital flows(a)



Source: Bloomberg.

(a) Negative values imply net capital outflows.

during trading on 13 January, and net capital outflows increased further. On 15 January, the Brazilian authorities did not defend the exchange rate ceiling, and on 18 January, the Brazilian central bank confirmed that they would permit the real to float. The exchange rate closed at 2.05 R/$ on 29 January.

There has been widespread concern about the potential repercussions on Latin America as a whole, which accounts for close to one fifth of total US exports. In the days following the first Brazilian policy change on 13 January, yield spreads on Latin American sovereign debt rose and equity prices fell. Subsequently, these changes in equity prices and spreads were largely reversed.

Sharp falls in commodity prices in Q4 further weakened prospects in other Latin American economies such as Mexico, Venezuela and Ecuador, as well as in Middle Eastern economies. Many commodity exporters are not well diversified, and commodity exports often contribute significantly to tax revenues. The potential fiscal shortfall that might result from falling commodity prices could further dampen growth in affected countries.

The New Arrangements to Borrow (NAB) were established at the IMF on 17 November, doubling the resources available under its predecessor, the General Agreements to Borrow. This is intended to improve the international financial community's ability 'to assist countries attempting to forestall or cope with an impairment of the international monetary system or to deal with an exceptional situation that poses a threat to the stability of that system'.(1) However, there is clearly potential for emerging markets to cause further uncertainty in the short-term economic prospects for industrialised countries, through financial market volatility and changes in world trade flows—the same channels that transmitted the Asian and Russian shocks to the rest of the world in 1997 and 1998.

(1) International Monetary Fund (1998) 'World Economic Outlook and International Capital Markets—Interim Assessment', December.

Sterling wholesale markets: developments in 1998

- *Sterling wholesale markets grew further in 1998. Outstanding lending appeared to be little affected by the international financial market turbulence of the second half of the year.*
- *The gilt repo market consolidated its position as an important form of secured money at the short end of the curve.*
- *Yields on gilt-edged securities fell in 1998. The amount outstanding fell very slightly.*
- *The Bank made a number of changes to its open market operations during 1998, building on the reforms of the previous year.*
- *The gilt strips market had a quiet first year.*

Overview

1998 was another year of change in the sterling wholesale markets. Market activity, measured by the amount of business outstanding, increased in all of the major sterling money markets: interbank, certificate of deposit (CD) and gilt repo. The amount outstanding in the gilt-edged market fell slightly. The total amount outstanding in all these markets combined was £635 billion at the end of the year, 9% higher than a year earlier (see Table A).

Table A
Sterling wholesale markets: amounts outstanding

£ billions

	Interbank	CD	Gilt repo	Gilts	**Total**
1997	135	100	72	278	**585**
1998	149	121	94	271	**635**

Note: All data are end November except gilts, which are end December.

The amount of business outstanding was little affected by the global turbulence that characterised much of the second half of the year. Although there was much talk of retrenchment in financial markets during that period, the core sterling wholesale markets remained active, at least for high-quality firms. Sterling markets were, however, affected by the reduction in global liquidity: turnover in some markets was lower in the second half of the year than in the first; credit and swap spreads widened, as did bid-offer spreads for gilts; and benchmark gilts outperformed similar-maturity non-benchmark stocks.

There were also a number of changes to the Bank's operations in the sterling money markets, building on the major reforms in the previous year. Changes in 1998 included the following: foreign exchange swaps were used to provide sterling liquidity to supplement the regular provision of liquidity through open market operations (OMOs); the timetable for the Bank's OMOs was altered, as were the end-of-day (late-lending) arrangements; and the Bank announced extensions to the range of collateral eligible for use in its OMOs. And the remaining discount houses emerged from the transitional arrangements implemented in 1997.

1998 also saw the transfer of sterling government debt management from the Bank to the UK Debt Management Office. The Bank continues to have an operational presence and a close analytical interest in the gilt market, as explained below.

Money markets

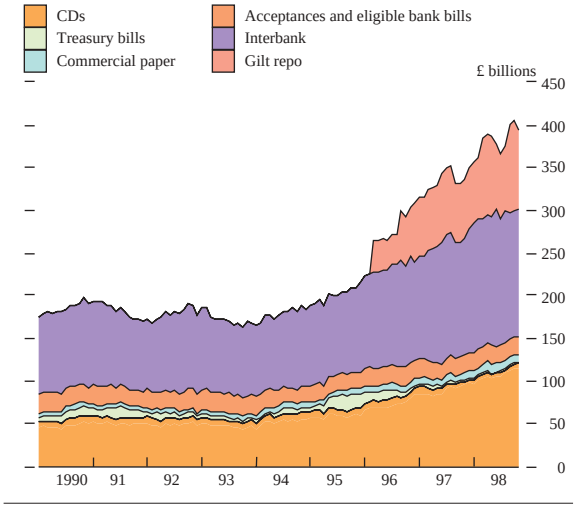
Growth of the sterling money markets

Despite turbulence and heightened credit concerns in most international markets during the second half of the year, total outstanding business in the sterling money market increased.(1) Total funds outstanding rose by around 16% between November 1997 and November 1998.(2)

Chart 1 shows the path of the main components of the sterling money markets during the 1990s. The three main components of the market—interbank deposits, CDs and gilt repo—continued to grow in 1998. The interbank and CD markets are where money-market credit concerns would show up. But there is little evidence that volumes of business fell much in the second half of the year, beyond the

(1) The sterling money market is defined here as the sum of outstandings in the interbank, CD, gilt repo, commercial bill, Treasury bill and commercial paper markets.
(2) The aggregate balance sheet of all UK banks contracted very sharply in December 1998. The contraction was mainly in foreign currency business with non-residents, and was almost certainly linked with the euro-conversion weekend. Amounts outstanding in the main sterling wholesale markets recorded no significant falls.

Chart 1
Size of the sterling money markets



normal seasonal fluctuations seen at the end of the calendar year.

The much smaller amounts outstanding in the commercial bill and commercial paper markets have changed little over recent years, while the stock of Treasury bills has fallen. This illustrates one of the contrasts between the UK and US money markets: the UK money market tends to be predominantly an interbank market, whereas direct corporate borrowing is more common in the US money market, through commercial paper issuance.

As Chart 1 shows, the amount of CDs outstanding has risen quickly in recent years: between 1996–98, CDs outstanding rose by £53 billion, compared with a £13 billion rise in the previous three years. This strong recent issuance is partly explained by the sterling stock liquidity regime, introduced in 1996, which allows banks to offset up to 50% of their five-day wholesale liability outflows with holdings of CDs, making it attractive for banks to fund themselves using CDs. (CDs also continue to be used as collateral in stock-lending transactions, making gilts available to the repo market.)

Turnover of money-market products was little affected by the turbulence during the second half of the year. Daily turnover of the nearest short sterling contract averaged 27,000 contracts, equivalent to nominal principal of £13.5 billion, in the second half of the year, compared with 20,000, equivalent to nominal principal of £10 billion, in the first half (see Table B). So there was no broad-based reduction in turnover, which might have reflected lower position-taking. Open interest in the nearest short sterling contract was 180,000 (equivalent to nominal principal of £91 billion) at the end of the year, around 30% higher than a year earlier. Turnover of other money-market products is more difficult to measure. According to the Central Moneymarkets Office data, CD turnover was little different from normal during the second half of the year. The Bank's gilt repo survey (see below) suggests that repo turnover remained relatively high in the second half of the year, averaging £15 billion a day, compared with £14 billion in the first half. Repo turnover and outstanding business held up, partly because firms may have favoured the security of lending against gilts during the turbulence.

Table B
Turnover of selected instruments in 1998

Average daily turnover	Short sterling (a) (Thousands of contracts)	Gilt repo (£ billions)	Gilts (£ billions)	Gilt futures (b) (Thousands of contracts)
1998 H1	20	14	9	50
1998 H2	27	15	7	37

(a) Nearest contract; each contract is for a notional deposit of £500,000.
(b) Nearest contract; each contract was for a notional amount of £50,000 in H1 and £100,000 in H2.

Open market operations

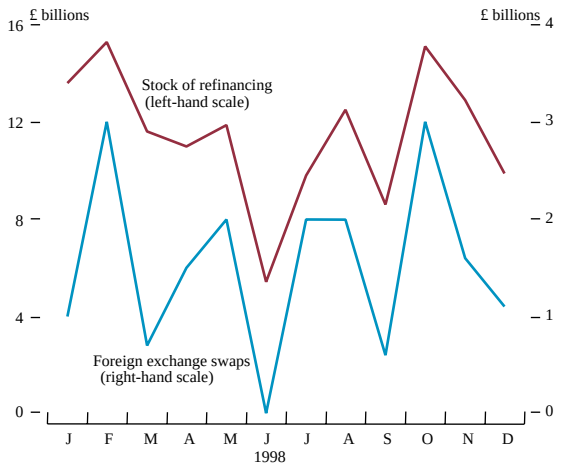
The Bank's OMOs developed further in 1998, following the major reforms implemented in 1997. The 1997 reforms introduced gilt repo as a tool of daily refinancing operations, thereby greatly increasing the range of eligible collateral, and widened the number of counterparties with which the Bank dealt. The three further changes introduced in 1998 built on the principles of these earlier reforms:

(i) Foreign exchange swaps

In January 1998, the Bank introduced foreign exchange swaps as a means of providing sterling liquidity to supplement its usual OMOs. The Bank provides temporary liquidity by sales of sterling for foreign currency and simultaneous matching of forward purchases, at a later date, of sterling for foreign currency. When the swap is unwound, sterling is drained from the market, so both 'legs' of the swap need to be planned carefully. Because the purchase and sale of foreign currency are conducted simultaneously, the Bank takes on no foreign exchange risk exposure. Foreign exchange swaps are used regularly by a number of other central banks to provide money-market liquidity; they may also be used by the European Central Bank. Their introduction in the United Kingdom was a technical change, which had no monetary policy significance.

The Bank has tended to use foreign exchange swaps as a marginal additional source of sterling liquidity when the stock of refinancing held at the Bank is high, so as to mitigate potential strain on the collateral markets. (When they were introduced in January, the stock of money-market refinancing held at the Bank was around £14 billion, compared with an average for the year of £11.5 billion.) As the stock of refinancing fell, so did the Bank's use of foreign exchange swaps; the level of swaps outstanding rose again later in the year as the stock of refinancing increased. Chart 2 shows how the stock of refinancing outstanding and the level of swaps outstanding for money-market purposes moved broadly together during the year.

Chart 2
Stock of refinancing and foreign exchange swaps: outstanding



(ii) New timetable

In June 1998, the Bank took the opportunity of the introduction of extended CHAPS banking hours, and the gradual emergence of the remaining discount houses from transition (see below), to alter the OMO timetable and make more explicit the structure of penal interest rates operating late in the money-market day.(1) When the original reforms of March 1997 were introduced and the group of potential Bank OMO counterparties widened, the discount houses (previously the Bank's sole counterparties) were granted a transition period as they—and the new systems—adjusted to the reforms. One of the transitional features was the retention of the facility whereby the discount houses could borrow late in the day from the Bank between 2.45 pm and 3.20 pm, in the form of overnight repos (after the main rounds of OMOs). This 'safety valve' became less effective as the discount houses gradually moved out of transition, leaving less capacity among those remaining in transition to borrow late from the Bank. If the forecast shortage was not cleared in the final regular round of OMOs, then the overnight interest rate—an indicator of liquidity conditions in the interbank market—sometimes spiked up sharply.

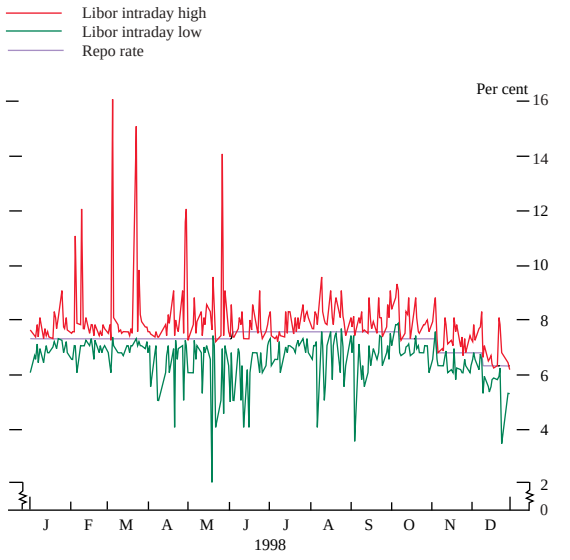
With effect from 1 June 1998, the facility was amended to allow all Bank counterparties to borrow overnight from the Bank after the final round of OMOs, at 3.30 pm. This round of operations is conducted at a penal rate, initially at 100 basis points above the Bank's repo rate.(2)

At 4.20 pm, after the money market has closed, the Bank publishes any further revision to its forecast of the market's liquidity shortage. At that time, the settlement banks have access to an overnight late repo facility. Previously, the facility had been limited to the amount of any late swing in the market's need for liquidity, with any liquidity being provided at 25 basis points above the Bank's repo rate.

From June, the amount supplied in this facility has been determined by the Bank, taking into account the extent of any remaining forecast shortage, including any late swing, and in the light of market indications of the extent of remaining liquidity needs. Use of this facility is at a rate determined by the Bank, which may range from its repo rate to as much as 150 basis points above its repo rate.

The changes to the timetable and the increased capacity to borrow from the Bank at 3.30 pm have been successful in capping short-term interest rates at lower levels than before—very short rates have rarely traded substantially above the Bank's (penal) late-lending rates (see Chart 3).

Chart 3
Repo rate and intraday Libor



(iii) Extension of collateral

With effect from 26 October 1998, the Bank announced an extension of the collateral that it would accept in OMOs, to include certain sterling bonds issued by other European governments and international financial institutions. In due course, the pool of assets will be widened further still, to include certain euro-denominated securities issued by these entities.

In making this change, the Bank's main objective was to assist the smooth conduct of its OMOs by extending the range of eligible securities its counterparties can use in them, subject to the continuing requirement that these securities should be of prime credit quality and traded in liquid markets, and should be capable of regular use without placing undue operational burden on the Bank or its counterparties.

The additional sterling (bulldog) securities added to the list are a natural extension within the present framework. Eighteen sterling bulldog bonds, totalling some

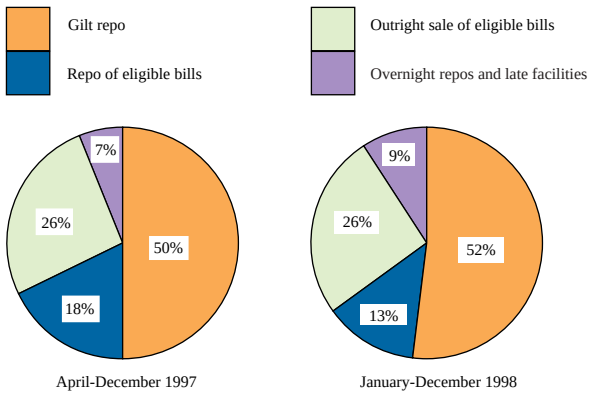
(1) CHAPS provides a same-day real-time payments system and is used to settle money-market transactions.
(2) This reflects the view that counterparties wishing to obtain liquidity from the Bank should whenever possible do so at the two regular rounds of operations at 9.45 am and 2.30 pm. The 3.30 pm round of overnight operations is intended only for counterparties to 'square off' unforeseen late variations in their positions. The Bank seeks to supply the full amount of any remaining liquidity requirement, but may supply more if market conditions suggest such a need (for example, if the overnight interbank rate was under sharp upward pressure).

£2.8 billion, were affected by the announcement; the bonds can also be used to obtain intraday liquidity in the real-time gross settlement system. The second stage of the widening of the collateral pool, to include certain euro debt securities, will increase the pool significantly, and will help to ensure that the Bank's operations and those of its counterparties develop in parallel with the euro area.

Share of instruments in the Bank's refinancing

Chart 4 shows the shares of different instruments in the Bank's refinancing in 1997 and 1998. Gilt repo has consistently accounted for around half of the Bank's money-market refinancing during the past two years. Repo of bills has accounted for a more variable proportion. Outright sales of bills, which until March 1997 were the main tool of money-market refinancing, continued to be a relatively popular instrument with counterparties, accounting for about one quarter of the flow of refinancing for most of the past year. Bill sales allow counterparties some flexibility in the maturity of money that they obtain from the Bank: counterparties can sell bills to the Bank with any maturity from one day up to approximately two weeks (in practice, up to the date of the Bank's longest-dated repo). The amount of refinancing done on an overnight basis late in the day was 9% in 1998, compared with 7% in the previous year.

Chart 4
OMOs—instrument review



Note: Totals may not sum to 100 because of rounding.

Though most of the Bank's refinancing is provided at a maturity of two weeks, the availability of shorter-maturity lending through sales of bills means that the average maturity of the stock of refinancing is less than two weeks.

Gilt-edged market

The price of gilt-edged securities rose in 1998, particularly in the second half of the year. The total amount of gilts outstanding fell by around £7 billion in calendar-year 1998, to a nominal value of £271 billion. Gilt redemptions amounted to £17 billion, but the Government's financing requirement was lower in 1998/99 than in the previous year: the overfund from the previous year reduced the financing requirement, and there were successive downward revisions to the borrowing requirement as revenue exceeded expectations.

Gilt futures turnover fell in the second half of the year, affected by the fall in global liquidity and appetite for risk-taking; cash gilt turnover fell by less. Cash turnover averaged some £9 billion a day for most of the first half of the year and fell to around £7 billion in the second half. Turnover in the front gilt futures contract, which had averaged some 50,000 (equivalent to £2.5 billion) contracts a day during the first half of the year, fell to 37,000 (equivalent to £3.7 billion) a day during the second half. The fall in gilt futures turnover partly reflects the increase in contract value from £50,000 to £100,000 with effect from the September 1998 contract. It also reflects the fact that it is easier and quicker to trade in the futures market than in the cash market, so any reduction in international banks' risk and position-taking is likely to be seen there first. The cash market, though not immune from international turbulence, perhaps retained some natural order-flow from domestic institutions. Also, by the time that confidence had been restored to markets, many market participants were reluctant to take new positions in the futures market, with the imminent year-end and the introduction of the euro.

On 1 April 1998, HM Government sterling debt management was transferred from the Bank to the newly-established UK Debt Management Office, marking the formal separation of debt management from monetary policy. The Bank continues to have an operational presence in the gilt market, and a close analytical interest. For example:

- OMOs are mainly in the form of gilt repos, so the Bank analyses the gilt repo market closely.
- The gilt market is an important source of analytical information both for monetary and financial stability purposes.
- The Bank has an operational role in the gilt-edged market, as the box opposite explains.

Gilt market conventions

A number of changes were made to gilt market trading conventions in 1998. From the end of July, the special ex-dividend arrangement for gilts was abolished. And in November, the calculation of accrued interest switched to using an 'actual/actual' daycount convention. From the same date, gilt prices were quoted in decimals instead of in £$^{1}/_{32}$ per pound. The move to quoting in decimals brought the gilt market into line with other European bond markets.(1)

(1) A more detailed account of the change to gilt trading conventions appears in 'Gilt-edged and sterling money markets: developments in 1997', *Quarterly Bulletin*, February 1998, pages 55–69.

The Bank's operational role in the gilt-edged market

The Bank retains a strong interest in the gilt and associated markets, in pursuit of both monetary and financial stability objectives. Notwithstanding the transfer of responsibility for sterling government debt management to the newly established UK Debt Management Office (DMO), the Bank continues to maintain an operational presence in the gilt market, which helps to retain a direct relationship with the market. The Bank's dealers:

- execute orders for the Bank's customers (including other central banks); and
- execute retail orders for gilts that have been placed with the Bank of England Brokerage Service, operated by the Registrar's Department.

Until the DMO takes responsibility for managing the government's day-to-day cash needs, the Bank will bid for stocks within three months to maturity, in order to smooth money-market shortages ahead of redemption dates.

The Bank also closely monitors other associated markets such as gilt futures and options, swaps, strips, repo and non-government sterling bond markets. The head of the Bank's Gilt-Edged and Money Markets Division is chairman of the Stock Lending and Repo Committee, which brings together practitioners, associations and authorities across the range of repo and stock-lending markets in London, and maintains the Gilt Repo Code of Conduct in line with best practice in the market. The Bank's dealers also operate the 'calendar' for sterling issues. This service, provided at the request of the market, enables lead managers/advisers to pre-notify the Bank of sterling issues of more than £20 million, in order to spot and avoid potential clashes.

The Bank's operational role in the gilt market is as follows:

- Calculating and publishing coupons on index-linked bonds, on release of the Retail Price Index (RPI).
- The Bank is also responsible for determining whether there has been a 'material change' to the RPI, and whether the redemption 'trigger' clause in index-linked gilt prospectuses should therefore be invoked.
- Setting and publishing dividends for floating-rate gilts. The Bank's dealers obtain three-month LIBID rates from a panel of banks. These rates are then used to determine the next quarterly dividend on such stocks.
- In accordance with the prospectus, every six months the Bank certifies whether the average price of 3½% Conversion Stock has been above or below £90 in the preceding dividend period. An average price below £90 requires the DMO to purchase stock for the sinking fund over the following six months.

The gilt repo market

The gilt repo market began in 1996. In the past three years, it has grown into one of the main components of the sterling money market. Gilt repo outstandings—some £94 billion—now represent about one quarter of the total sterling wholesale money market. Gilt repo turnover—around £15 billion a day—is typically twice the turnover of cash gilts.

The Bank has been conducting a survey of the main participants in the gilt repo and gilt stock lending markets since the start of the market, covering details of trades outstanding and turnover at various maturities.(1) According to the survey, the amount of gilt repo outstanding was £94 billion in November 1998 (see Table C). The market grew rapidly by £22 billion during the year, following a rise of £13 billion in 1997. More than 100 firms complete the survey. Although a small number of 'core' market participants account for a large share of the market, the degree of market concentration has fallen. At the start of 1996, the top five firms by share accounted for around 55% of the market; by November 1998, the top five firms accounted for about 40% (see Chart 5). A small number of players were active in the market at the very start—mostly firms that had been involved in the old stock-lending market and/or those that had experience of repo in overseas markets. They were gradually joined by more firms, as the market in what was for some an unfamiliar product became more established and deeper.

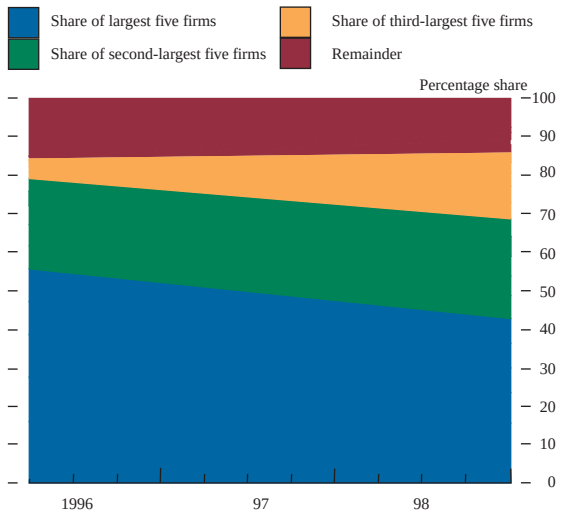
Table C
Gilt repo and reverse repo outstanding

£ billions

		Repo	Reverse repo
1996	Feb.	37	34
	Nov.	69	60
1997	Feb.	71	67
	Nov.	72	71
1998	Feb.	95	94
	Nov.	94	90

(1) An article by Jonathan Bailey in the November 1998 edition of the Bank's *Monetary and Financial Statistics* describes the survey and compares it with repo data reported as part of the monetary statistics.

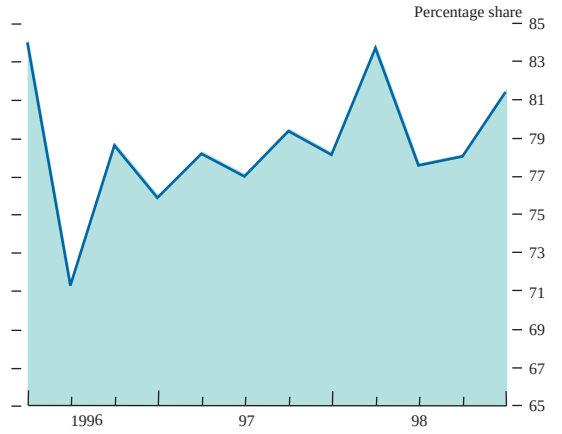
Chart 5
Concentration of the repo market(a)



(a) Shares of firms by amounts outstanding.

Most of the large players in the sterling repo market are also counterparties of the Bank in its daily OMOs: in November 1998, OMO counterparties accounted for around 80% of all repo outstandings in the Bank's survey (see Chart 6). Not surprisingly, the size of the stock of refinancing held at the Bank influences the repo activity of these counterparties.(1) When the stock is high, counterparties of the Bank have to be more active in order to supply collateral to the Bank and distribute sterling liquidity to the private sector.

Chart 6
Bank OMO counterparties' share of the repo market



The repo market has matured in the past three years. During the market's first two years, there was little repo activity beyond three months, but since then activity at that maturity has grown to about 20% of total outstandings. With a larger number of counterparties active in the market, firms have become more confident about using repo for long-term transactions to take views on interest rates.

Repo is a flexible and tradable instrument that allows firms to reduce (or increase) their balance sheet size more quickly than in the interbank deposit market. Some firms have used this flexibility towards the end of financial reporting periods (year-ends and quarter-ends), tending to reduce repo transactions to minimise the use of their balance sheet for credit-rating purposes. This effect has also occurred in the monetary statistics collected by the Bank, with the repo component of M4 falling at balance sheet reporting periods, with consequent effects on M4.

End-investment institutions, such as pension funds and insurance companies, have been slower to become involved in the repo market, and have tended to continue to offer gilts to the stock-lending market for a flat fee. Banks and securities firms borrow these stocks and repo them into the wholesale market. So though few end-investors participate in the repo market directly, they do supply some of the gilts to the repo market indirectly through stock-lending. Because of this broader access to gilts, the market as a whole may be less vulnerable to shortages of particular stocks. This might in turn explain why activity in the specials repo market has been lower than in the repo market's first year. Special rates have also been less volatile than in the first year of the market.

The Bank intervened in the specials market once during 1998. In response to the special status of 9% Treasury 2008 that developed during late 1997 and early 1998, the Bank announced that it was prepared to repo the stock overnight against cash at 0% to GEMMs where they, or their customers, had experienced failed repo returns or failed deliveries in the cash market.(2) In the event, no use was made of the facility but its availability led to an easing of the specialness of the stock.

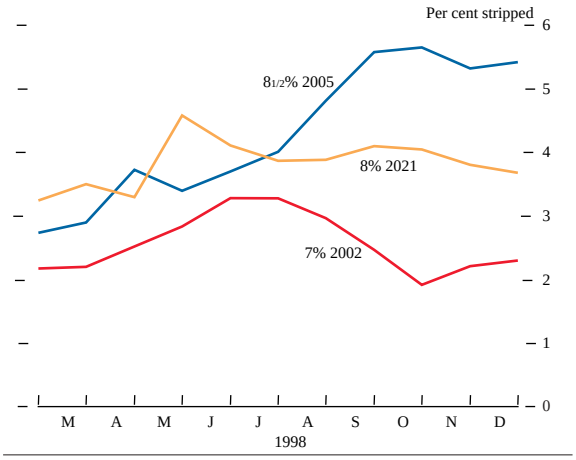
The gilt strips market

The gilt strips market has grown slowly since its launch on 8 December 1997. About one third of the total amount of gilts outstanding is eligible to be stripped, though less than 3% of potentially strippable stock had been stripped by the end of 1998. Daily turnover in the strips market averaged £40 million during 1998, about ½% of average turnover in the unstripped gilt market. Turnover in gilt strips fell in the second half of the year, in line with the fall in turnover in the underlying gilts market, as market participants attempted to reduce risk and position-taking.

Though less than 3% of the market has been stripped, some strippable gilts have been more popular than others (see Chart 7). Longer-maturity gilts have tended to be stripped more than short gilts, with the exception of 8½% 2005, of which 5% was held in stripped form. One reason for the popularity of that gilt is that its principal strip has been the highest-yielding strip beyond a maturity of five years and has similar duration to the unstripped 7¼% 2007. This

(1) Repos with the Bank as part of the OMOs are included in the repo totals, and the correlation between the total stock of refinancing and total repo outstanding is 0.64.
(2) For more details, see pages 111–13 of the May 1998 *Quarterly Bulletin*.

Chart 7
Stripping activity by selected gilts



means that investors can take a view on the shape of the short-medium part of the yield curve without affecting the duration of their portfolio.

A number of reasons have been suggested for the slow growth of the strips market in its first year. Because the yield curve is downward-sloping, strip yields lie below unstripped gilt yields of similar maturity. This may deter some investors who view strips as 'dear' relative to unstripped gilts. The turbulence of the second half of 1998 may have deterred strips activity, as investors favoured the liquidity of the underlying gilt market. Also, because strips are not yet included in benchmark indices for the investment industry, there is little pressure from actuaries to buy strips.

The Bank started to accept strips as collateral in its daily deliveries-by-value OMOs from 27 April 1998, and it also accepts strips as collateral for intraday liquidity in the real-time gross settlement system (RTGS). By the end of the year, strips had been used in a limited way as collateral in the OMOs and in RTGS.

In principle, strips provide a direct way of observing the term structure of zero-coupon interest rates. For gilts, which provide a stream of income, a more indirect procedure of yield curve estimation has to be followed to derive a theoretical zero-coupon curve. Charts 8a and 8b show the zero-coupon curves derived using coupon strips prices at the beginning of 1998 and at the end. Yields on principal strips are shown separately. Because the principal strips have much greater amounts outstanding, they are more liquid and trade at a greater premium—and hence lower yield—than equivalent-maturity coupon strips.

Developments in sterling products on LIFFE

The London International Financial Futures and Options Exchange (LIFFE) made a number of changes to its sterling interest rate and bond market products in 1998. LIFFE launched a new five-year gilt future on 26 February. Trading volumes have so far been very light: typically, the front contract has traded fewer than 1,000 bargains a day (equivalent to £0.1 billion of stock), compared with 40,000 (equivalent to £4 billion of stock) for the existing ten-year (long) gilt futures contract. Also, with effect from the September 1998 contract, the long gilt contract size was increased from £50,000 to £100,000. In May, the long gilt contract was altered to reflect a change in the deliverable gilts maturity band from 10–15 years to $8^{3}/_{4}$–13 years (effective from the December 1998 contract). LIFFE also began listing a fourth maturity year on its sterling interest rate futures products from 30 June 1998 (though volumes have also naturally been low).

Chart 8a
UK zero-coupon curves (derived using strips prices) on 4 February 1998

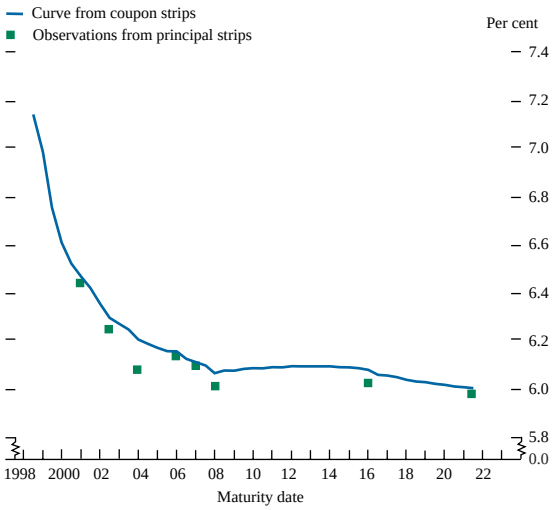
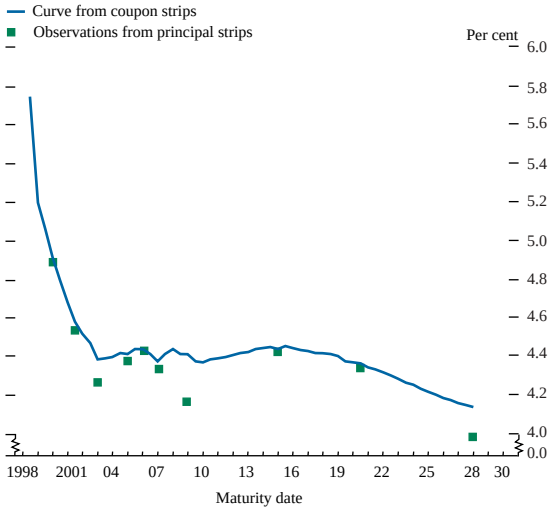


Chart 8b
UK zero-coupon curves (derived using strips prices) on 30 December 1998



The external balance sheet of the United Kingdom: recent developments

This article[1] *examines developments in the UK external balance sheet from 1987 to mid 1998. It continues an annual series of articles in the* Quarterly Bulletin *begun in 1985.*[2]

Gross UK assets and liabilities are analysed in order to discern trends in holdings of different types of investment. The article emphasises the latter part of the period, which was characterised by crises in emerging markets. The external balance sheet is also considered in relation to investment income. The box on page 42 describes the recent changeover to the latest (1995) version of the European System of National and Regional Accounts and the 1993 IMF Balance of Payments Manual, Fifth Edition (BPM5).

Overview

The external balance sheet comprises the United Kingdom's investments in the rest of the world (assets) and investments in the United Kingdom from the rest of the world (liabilities).

Table A shows how the net asset position changed from 1987 to mid 1998, and identifies the separate contributions from actual financial flows and valuation effects.

Table A
Changes in the net asset position

£ billions

	1987–92 (average)	1993	1994	1995	1996	1997	1998 to Sept.
Current account	-14.1	-10.6	-1.5	-3.7	-0.6	6.1	-0.4
Capital account	0.3	0.3	0.0	0.5	0.7	0.8	0.3
Financial flows	-12.1	-9.3	7.1	-0.9	-1.8	6.5	14.7
Revaluations (a)	6.5	4.6	-21.3	-13.7	-7.7	n.a.	n.a.
Change in net assets	-5.6	13.9	-14.2	-14.6	-9.5	n.a.	n.a.
Net assets	28.3	36.4	22.2	7.6	-1.9	-81.6	-58.2
Net errors/ omissions (b)	1.7	1.0	8.5	2.3	-1.9	-0.5	14.8

n.a. = not available.

Sources: ONS and Bank of England.

(a) Revaluations are calculated as the residual element after financial flows have been subtracted from the change in the net asset position published by the ONS.
(b) Net errors and omissions account for the discrepancy between the current and capital accounts and financial flows. Every credit entry in the balance of payments accounts should be matched by an offsetting debit entry, so that total credits equal total debits. In practice, there is a discrepancy (discussed below).

At the end of 1997, the United Kingdom had a record net external liability of £81.6 billion (11% of GDP),[3] though this masks the rapid growth of both sides of the balance sheet over the year. Gross assets were £1,949 billion, up by 19.3% from £1,634 billion at end 1996. Liabilities were £2,031 billion, up by 24% from £1,636 billion at end 1996. This article looks behind the fluctuation of the net asset position, and investigates developments on both sides of the balance sheet.

The Office for National Statistics (ONS) points out that comparison of the 1997 net asset position with that of previous years is potentially misleading. This is why the 'revaluations' and 'change in net assets' boxes must be left blank for 1997 and 1998, until 1998 data are published in the next *Pink Book.*

UK assets at end 1997 were revised downwards by £47.9 billion in the September 1998 First Release, largely because of new data received from the triennial Share Register Survey; the external asset positions for 1996 and previous years will be revised in the next *Pink Book*. The Share Register Survey data have boosted the ONS estimates of foreign investment in British equities. (The rising share of investment in equities and other portfolio securities on both sides of the balance sheet is highlighted in the next section, 'UK external assets and liabilities'.)

The data discussed in the article are based on the latest published official statistics. They contain substantial revisions to the data published in previous versions of this article. Some of these revisions were caused by receipt of new data from annual and triennial surveys; some were caused by the changeover to the new balance of payments standard, BPM5 (see box on page 42).

The ONS warns of imperfections in measuring the international investment position.[4] Direct investment items are recorded at book value rather than at market value, and are therefore underestimated. Stocks of some assets and liabilities are estimated imperfectly by adding identified transactions to the previous level and estimating valuation changes.

For the balance of payments as a whole, every credit entry should be offset by a debit entry. For example, the credit arising from the export of a good from the United Kingdom would be matched by an offsetting debit entry in the financial account, which could be an increase in UK assets abroad (the exporter receives foreign currency in payment), or a decrease in UK liabilities (the non-resident pays for the

(1) Prepared by Andrew Colquhoun of the Bank's Monetary and Financial Statistics Division.
(2) Previous articles in this series have appeared in November *Bulletins.* This year's article was delayed to allow incorporation of balance of payments data compiled on the new basis (see the box on page 42).
(3) *United Kingdom Balance of Payments*, 1998 edition (the *Pink Book*).
(4) *United Kingdom Balance of Payments*, 1998 edition, methodological notes (pages 125–30).

goods out of his deposit with a British bank). Total current, capital and financial account credits should be offset by total debits. In practice, there is a discrepancy in the recording of total credits and debits, accounted for by 'net errors and omissions'. The ONS thinks it likely that most of the net errors and omissions total reflects unidentified inflows on the financial account (as opposed to the current account), probably foreign investment in British corporate bonds, which is difficult to measure directly.

The next section, 'UK external assets and liabilities', analyses the balance sheet into its components, first highlighting the rising share of portfolio investment, and the declining share of deposit-taking and lending. Second, it looks at the evolution of the UK reserve asset position over the period. Third, it uses the most recent direct investment data, and banking data from the Bank's Monetary and Financial Statistics Division, to examine some of the implications of recent economic slowdowns in emerging markets.

The third section, 'Investment income and the UK external balance sheet', considers the evolution of investment income, part of the current account, in relation to the balance sheet.

Following the standard components of the balance of payments accounts, international investments are classified into four categories:

- Direct investment—acquisition of 10% or more of the equity of an enterprise (implying a degree of ownership or control), and all subsequent financial transactions (equity or debt).
- Portfolio investment—acquisition of less than 10% of the equity or debt of an enterprise.
- Other investment—residual category; mainly deposits and loans, and trade credits.
- Reserve assets—external assets controlled by monetary authorities.

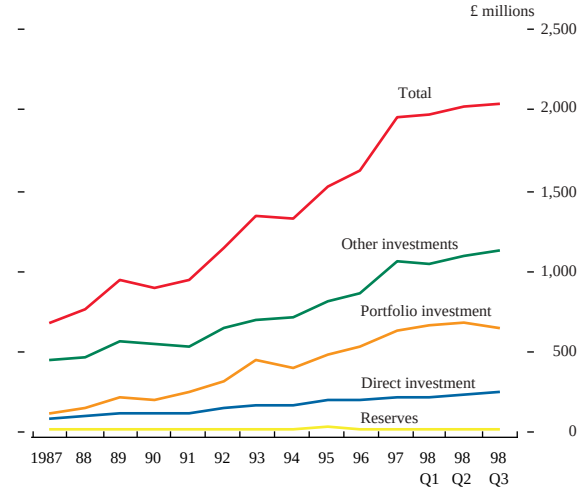
Chart 1 shows the evolution of the United Kingdom's asset and liability positions for each category from 1987 to the third quarter of 1998.

UK external assets and liabilities

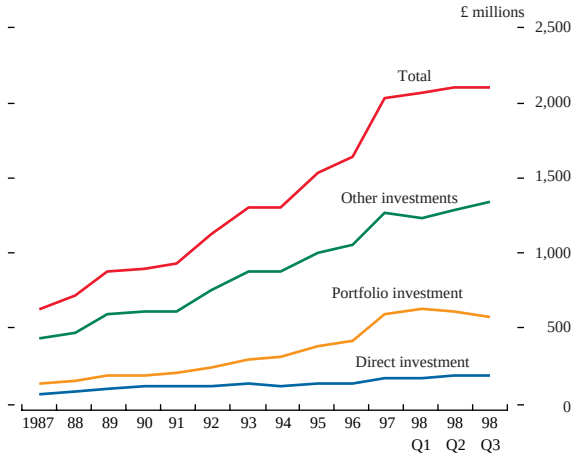
This section explores how the United Kingdom's external assets and liabilities have changed since 1987.

Chart 2 shows that on both sides of the balance sheet, the proportions of portfolio securities have increased substantially since 1987. Portfolio investments represented 17.8% of total assets at end 1987 and 34% of assets at end 1997. Similarly, portfolio investments rose from 20.3% of liabilities at end 1987 to 29.1% of liabilities at end 1997.

Chart 1
UK external assets



UK external liabilities



Whereas stocks of portfolio investment have been increasing as a proportion of the balance sheet, 'other investment' stocks have been declining, from 66% of assets at end 1987 to 55% by end 1997. Similarly, 70% of liabilities at end 1987 were other investments; by end 1997, the proportion was 63%.

Increases in the stock of portfolio and other investments are composed partly of financial transactions and partly of revaluations of already-held assets and liabilities. Financial account data indicate that acquisitions of portfolio investments, particularly debt securities, are driving the increase in portfolio assets and liabilities. UK residents' portfolio assets increased by £47.9 billion between end 1995 and end 1996. There were recorded equity purchases of £10.5 billion over the year, and debt security purchases of £49.3 billion. So revaluations lowered the stock of portfolio assets and their increase was driven by purchases of debt securities. (Again, the data for 1997 and later are affected by the Share Register Survey results and cannot be compared directly with 1996 data.)

Portfolio liabilities increased by £43.3 billion in 1996. Non-residents purchased £6.1 billion of equities and £44.2 billion of debt securities; revaluations again

Changeover to ESA95 and BPM5[1]

The European System of National and Regional Accounts (1995) is the basis on which statistics are to be compiled throughout the European Union (EU). Fulfilling the standards of ESA95 is a legal requirement of all EU Member States from 1999. ESA95 is designed to be consistent with the latest statistics collection guidance from the United Nations, the System of National Accounts (1993) and its companion IMF Balance of Payments Manual (BPM), Fifth Edition (1993). BPM5 is particularly relevant to the international investment position statistics used here.

The UK National Accounts were published on an ESA95 basis for the first time in the 1998 *Blue Book*. The international investment position and investment income data were correspondingly published on an ESA95/BPM5 basis in the 1998 *Pink Book*. The data in this article all use the new basis. The Office for National Statistics revised old data, for some series as far back as 1946. So there is no 'break' in series when the new standards were introduced.

There are five main differences between the old statistical system and the new that are relevant to the balance of payments data.

- **Introduction of a new 'Capital Account'.** Capital transfers (such as a government investment grant for a project in a developing country) are now separated out and recorded in the capital account, to distinguish them from current transfers in the current account. Debt forgiveness is included in capital transfers; under the old standard, debt forgiveness was excluded from the balance of payments. Acquisition or disposal of non-produced, non-financial assets (such as land or patents) are also now included in the capital account, rather than (as previously) in trade in services. The new financial account broadly equals the old capital account.

- **Accruals accounting of interest income.** Receipts and payments were previously recorded as they occurred. Reporters are now required to accrue receipts and payments over the lifetime of the underlying asset or liability.

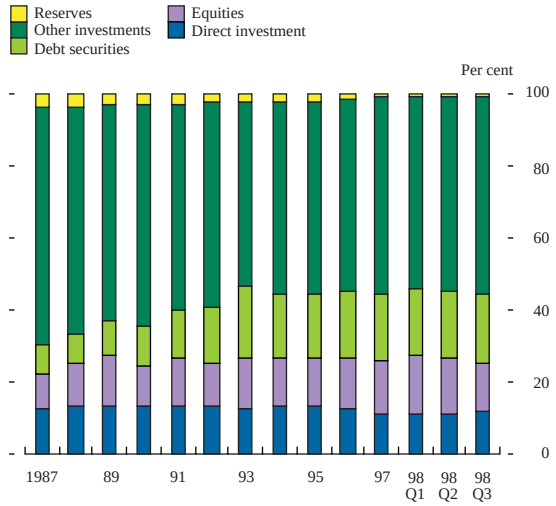
- **Redefinition of direct investment.** Direct investment was previously classified as a holding of 20% of the equity of an enterprise. The threshold has now been lowered to 10%. Direct investments are identified separately to capture the conceptual distinction between general investment and the acquisition of an 'effective voice' in the running of an enterprise. It is thought that a 10% threshold is a truer indication of such an effective voice than 20%. The ONS believes that the reclassification of the direct investment threshold has had very limited effects on the aggregates.

- **Reclassification of offshore islands as non-resident.** The Channel Islands and the Isle of Man have been reclassified as non-resident to the United Kingdom. Thus transactions between UK residents and the islands are accounted for in the balance of payments, but transactions between islanders and the rest of the world are no longer counted in the UK balance of payments. The islands are not politically part of the EU, so their official statistics are not under a legal requirement to comply with ESA95. They therefore have to be excluded from the United Kingdom's economic territory to ensure full UK consistency with ESA95. This treatment is also technically consistent with the IMF's recommendations. BPM5 states that 'In a maritime country, economic territory includes islands that belong to the country and are subject to the same fiscal and monetary authorities as the mainland; goods and persons move freely to and from the mainland and the islands…'.[2] The offshore islands are subject to their own fiscal authorities and have their own tax systems. And there are impediments to taking up residency on the Channel Islands. So it is sensible not to consider them part of the United Kingdom's economic territory.

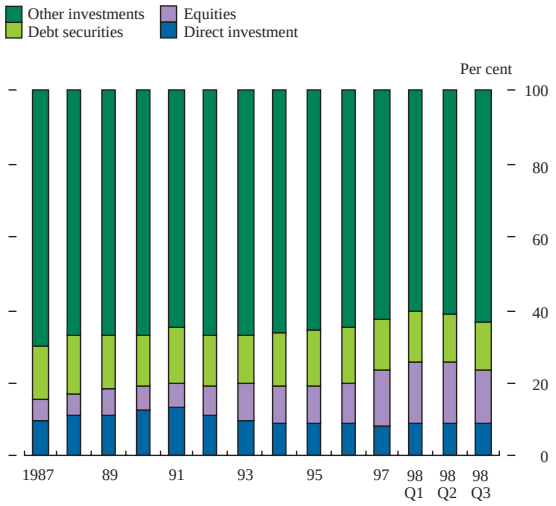
- **Separate collection and publication of money-market instruments data.** The ONS now publishes these data separately, and as part of the portfolio investment category, rather than as part of other investment.

(1) For further information, see the *Quarterly Bulletin*, November 1998, 'Recent changes to the national accounts, balance of payments and monetary statistics', pages 361–67.
(2) See BPM5, page 20.

Chart 2
UK external assets—proportions



UK external liabilities—proportions



depressed the total, whose increase was also driven by purchases of debt securities.

These figures suggest a process of disintermediation in cross-border finance. Traditional bank lending has not stopped growing, but portfolio investment is rising more quickly—borrowers are increasingly tending to go straight to lenders by issuing debt or equity. A Bank of England analysis of global figures in 1997 identified an increase in the proportion of international bonds issued by industrial and commercial companies, from around 22% in 1993 Q1 to 52% in 1997 Q4. The analysis argued that US companies, in particular, were seeking to achieve greater name recognition (and thus a more liquid market for their debt) by issuing bonds internationally, rather than relying on the domestic market. The same factors could influence British companies, if anything more strongly, given the smaller size of the British domestic bond market. Furthermore, long bond yields in the United States and Europe have fallen to their lowest levels in decades, making debt cheaper to issue.

This argument can be tested against the sectoral breakdown of data presented in the *Pink Book*.(1) Because of the difficulties in measuring inward portfolio investment, the only sectoral breakdowns of liabilities provided by the ONS are banks/building societies, government, and 'other', which includes other financial intermediaries as well as non-financial companies and households. The available data indicate that bonds and equity issued by non-financial intermediaries are increasing as a proportion of UK external assets and liabilities. At end 1987, 50% of portfolio liabilities were issued by banks and building societies, 16% by central government, and 34% by all other sectors, including non-financial companies, households, and other financial institutions such as pension funds. By end 1997 the top two rankings had been reversed: banks and building societies had 27% of portfolio liabilities and other sectors had 58%.

On the other side of the balance sheet, between 1987–97, 'other' assets held by banks and building societies—mainly their lending overseas—roughly doubled, from £408 billion at end 1987 to £821 billion at end 1997 (a 100% increase). But their portfolio investment assets increased even more sharply (by 410%), from £36.7 billion to £187 billion. These figures indicate a relative decline of traditional lending on banks' balance sheets. This will partly be because of corporate restructurings in the period, in which securities trading houses have been merged with their parent banks. It could also reflect a rise in 'securitisations', in which loans are repackaged and sold to back bonds.

Reserve assets

Reserves were £31.8 billion at end 1995, having risen every year since 1990. By the end of 1998 Q3, they had fallen to £22.4 billion, down by £9.4 billion. However, the fall in net reserves is not so large when computed in dollar terms, because of the strength of sterling over this period (which lowers the value of foreign currency assets). Converted at market rates, UK external reserves were $43.1 billion at end 1995, and $33.6 billion at end September 1998—a fall of $9.5 billion. Each component of the reserves is converted into dollars in separate currencies in these data, so a straightforward re-conversion to sterling of the difference is not possible without a full breakdown by type of asset. But a rough estimate can be made using the average of sterling/dollar market rates over the period between end 1995 and end September 1998, and this values the difference at £5.9 billion.

Direct financing of current account imbalances from the reserves is only relevant for countries with closed financial accounts (ie those that operate capital controls, assuming that there are no upward valuation effects on external assets that have similar effects to financial inflows in the accounts). This is no longer the situation in the United Kingdom. The UK current account deficit could comfortably have been funded out of reserves in any single year of the period considered. When a country continually

(1) *United Kingdom Balance of Payments*, 1998 edition, pages 84–92.

runs a current account deficit, one question is how long the reserves would last. From Table A, the United Kingdom's cumulative current account deficit for the period 1993–96 was £16.4 billion. Net reserves in 1993 were £29.7 billion. So 1993's reserves could hypothetically have funded the 1993–96 current account deficit and more.

The external balance sheet and emerging markets

Geographical analysis of the external balance sheet is complicated by the fact that geographic splits of stocks of external assets and liabilities are not published. However, an analysis is available for 1997 direct investment data,(1) and for banking data (collected by the Bank of England).(2) (The ONS points out that the direct investment data for 1997 are subject to revision.) These sources throw some light on how the recent crises in emerging markets have affected the UK balance sheet.(3)

Table B presents banks' portfolio and other investments in a selection of relevant countries since the start of the crisis.

Table B
UK resident banks' lending and portfolio investments (PI) in selected countries

£ billions

	Category	1997		1998		
		Q3	Q4	Q1	Q2	Q3
World	Lending	745.0	812.0	792.0	817.0	871.0
	PI	*193.0*	*195.0*	*204.0*	*222.0*	*235.0*
Hong Kong	Lending	28.0	22.0	18.0	17.0	16.0
	PI	*2.0*	*0.7*	*0.9*	*0.7*	*1.1*
Indonesia	Lending	0.6	0.6	0.5	0.4	0.5
	PI	*1.1*	*0.5*	*0.5*	*0.4*	*0.3*
Malaysia	Lending	1.0	1.2	0.8	1.0	0.6
	PI	*0.5*	*0.5*	*0.6*	*0.5*	*0.6*
South Korea	Lending	7.1	6.1	4.4	4.6	4.1
	PI	*2.7*	*2.2*	*2.0*	*2.0*	*2.0*
Russia	Lending	2.8	3.1	3.8	4.2	2.7
	PI	*2.5*	*2.7*	*2.8*	*3.5*	*0.7*
Brazil	Lending	4.0	3.7	4.0	4.2	3.3
	PI	*3.8*	*2.7*	*3.2*	*3.3*	*3.0*
South Africa	Lending	4.2	4.0	3.8	3.4	3.4
	PI	*1.8*	*1.6*	*2.1*	*1.7*	*1.4*
Mexico	Lending	1.6	2.3	2.1	2.2	2.3
	PI	*3.5*	*3.0*	*3.4*	*2.7*	*2.0*

Source: Bank of England.

Detailed analyses of UK banks' country exposures are available from Bank of England statistical returns. Banks accounted for 52% each of gross UK assets and liabilities in 1997, so their data comprise a substantial proportion of the overall balance sheet.

World totals of stocks of UK banks' investments in non-residents continued to grow in all categories, except equities. It can be noted that stocks of investment in emerging markets are a small proportion of UK banks' total investments in non-residents. UK banks' lending to all the countries listed above was only 6.6% of their total non-resident lending at end Q3 1997, and this proportion fell to 3.8% at end Q3 1998. Their portfolio investment in the listed emerging markets fell from 9.4% to 4.8% of their total portfolio investments in non-residents.

The most striking feature of the data for the emerging markets is the extent to which lending to, and equity purchases from, affected countries have fallen since the crisis began, though portfolio investment has held up more strongly. But there are exceptions, both by country and by category.

Malaysia appears to have fared relatively better than other south-east Asian countries. UK banks' lending to Malaysia did decline sharply, from £1 billion at end Q3 1997, to £0.6 billion at end Q3 1998. But investment in debt securities rose from £0.5 billion to £0.6 billion, and UK banks held £42 million of Malaysian equities at end Q3 1997 and £48 million at end Q3 1998.

Portfolio investment in Malaysia contrasts strikingly with that in Indonesia and South Korea, two very different economies, both affected by the Asian crisis. UK banks heavily reduced their portfolio investments in both countries. Apart from a slight rise in UK banks' holdings of short-term Korean bills, there were falls in all other categories for both countries. Most noticeably, stocks of investment in Korean equities sank from £83 million to £9 million. Part of the explanation for the relative strength of Malaysian debt security and equity investment compared with lending is that lending tends to be shorter term. Stocks of portfolio investment in Malaysia may have been kept artificially high by the imposition of capital controls by the government in the first week of September 1998, leaving non-residents' portfolio capital locked in the country.

As noted above, UK banks increased their holdings of portfolio and other investments, except equities, in the rest of the world between end Q3 1997 and end Q3 1998. Equity stocks declined from £6.9 billion to £4.7 billion over the period, mostly relating to investment in Hong Kong. Portfolio equity investment in Hong Kong fell from £1.4 billion to -£0.2 billion, which means that in aggregate, UK banks had a short position of £0.2 billion.

The direct investment data shed more light on how international developments are affecting the UK external balance sheet. The most striking feature of the data is again the small size of the worst-affected emerging markets in the United Kingdom's external asset levels. It is also notable that until the end of 1997 (the most recent available geographic data), the crisis seems to have had little effect on foreign direct investment data. This is plausible, given the more lasting nature of direct investment compared with portfolio and other investments. It is more difficult for investors to unwind their direct investments; it is also possible that the incentive to unwind direct investments is not very strong. An emerging market that devalues its currency becomes a cheaper place to do business in sterling or dollar terms. The comparison with Mexico, below, gives some indication of how direct investment levels in crisis-hit countries might develop over time.

(1) ONS Direct Investment First Release, December 1998.
(2) From Bank of England surveys of Bank for International Settlements international banking statistics.
(3) See 'The international environment' article in the *Quarterly Bulletin* each quarter since February 1998 for an account of recent developments in emerging markets.

Table C shows UK direct investments in a selection of countries since 1993. Brazil and South Africa are included, given their significance to the United Kingdom's direct investments in emerging markets. Data are currently only available to end 1997.

Table C
Stocks of UK direct investments overseas

£ billions

	1993	1994	1995	1996	1997
World	165.8	177.1	196.7	194.7	224.4
Hong Kong	3.6	3.4	4.0	4.6	4.4
Indonesia	0.3	0.3	0.4	0.4	0.3
Malaysia	1.8	2.1	1.8	2.2	2.3
South Korea	0.2	0.2	0.3	0.2	0.2
Russia	0.0	0.0	0.1	0.2	0.4
Brazil	2.0	2.1	2.3	2.4	2.2
South Africa	2.6	2.2	2.8	2.4	2.5
Mexico	0.4	0.3	0.4	0.6	1.3

Stocks of direct investment in the United Kingdom from selected countries

£ billions

	1993	1994	1995	1996	1997
World	121.0	121.3	128.9	134.7	157.0
Hong Kong	0.3	0.2	0.0	0.0	0.0
South Korea	0.0	0.0	0.0	-0.2	-0.3
Russia	0.0	0.0	-0.1	-0.2	-0.2
South Africa	0.6	0.5	0.7	0.6	0.7

Source: ONS.

The stock of direct investment in 'other Asian countries' (all Asia except the Near and Middle East and Australasia—ie including the crisis countries and Japan) was £18.4 billion at end 1997. This accounted for only 8.2% of total outward UK direct investment. Investment in Russia, £0.4 billion at end 1997, was a negligible 0.2% of the UK total. Furthermore, the United Kingdom's overall rate of return on its direct investments has remained strong over the period (see Table D on page 46).

The stock of inward investment in the United Kingdom from the 'other Asian countries', at £7.3 billion, was 4.7% of total investment from abroad. Excluding Japan, the rest of 'other Asian countries'—including South Korea—accounted for only £0.8 billion of investment into the United Kingdom, 0.5% of the total from abroad. Russia's direct investments in the United Kingdom were £0.2 billion at end 1997, or 0.1% of inward direct investment.

There does appear to have been a small retrenchment in UK outward direct investment to affected countries, but the pattern is not uniform. Total investment in 'other Asian countries' fell from £19.2 billion to £18.4 billion, but this includes a decline of investment in Japan of £0.8 billion. Investment in Indonesia fell by £0.1 billion, while investment in Malaysia increased by £0.1 billion.

Inward investment from 'other Asian countries', at £7.3 billion, was up on the end-1996 total of £6.8 billion. Japan had investments of £6.5 billion at end 1997, up from £5.9 billion at end 1996, thereby accounting for most of both the total and the year-on-year increase.

The Mexican figures give a useful comparison that draws attention to the rapid recovery of direct investment when the financial crisis was over. The Mexican government's official devaluation of the peso occurred in December 1994; the currency continued to slide in early 1995. A US-led $11.2 billion (£7.3 billion) aid package was announced in February 1995. The end-year level of UK direct investment in Mexico was lower in 1994 and 1995 than the end-year 1993 figure of £0.4 billion, but it rose to £0.6 billion by end 1996 and more than doubled by end 1997, to £1.3 billion. (The figures for direct investment in the United Kingdom from Mexico are not large enough to be recorded separately in the published statistics.)

It appears to have taken less than two years for confidence in Mexico to be restored among investors. In addition to the $11.2 billion aid package, the Mexican government announced an IMF-approved economic reform programme (to curb inflation and the trade deficit). Mexico's links to the strongly growing United States through the North American Free-Trade Agreement could also have contributed to the return of investor confidence.

Investment income and the UK external balance sheet

This section considers UK investment income in relation to the external balance sheet.

Comparing investment income credits and debits with gross assets and liabilities allows implied 'rates of return' to be calculated. These express the proportion of income to stocks of investment; the stock of investments is expressed at market valuations, and thus includes revaluations. Chart 3 gives 'rates of return' on each category of investment for assets and liabilities since 1987 on this basis.

In broad terms, the rate of return both on assets and liabilities dropped significantly in 1992, and subsequently fell further, largely because of falling rates of return on other investment assets and liabilities, in line with falls in interest rates in major economies since the early 1990s.

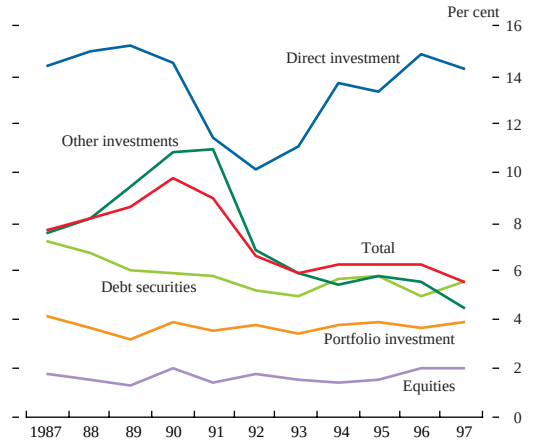
Sectoral analyses are provided by the ONS for direct investment and portfolio investment assets items, allowing rates of return to be calculated sector by sector; these are shown in Table D.

Monetary financial institutions (MFIs), ie banks and building societies, clearly have the most profitable direct investments overseas in 1997, even given that the rates of return on direct investment are probably overstated, because of the downward bias to valuations of direct investment (normally book rather than market value). There is no reason to suppose that MFIs are relatively more prone than other sectors to undervalue their direct investments. However, the MFIs' figures are more volatile and have made large negative contributions to direct investment income in the past.

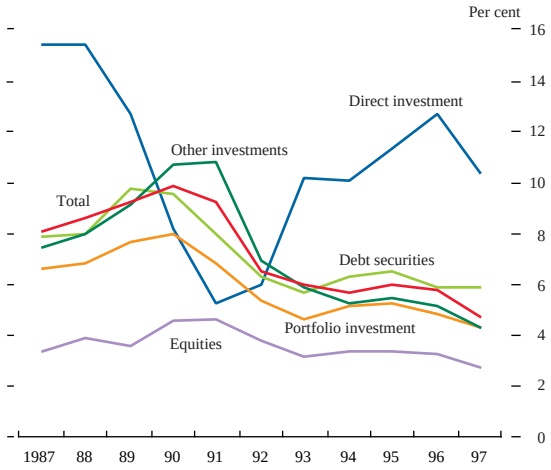
Other financial institutions (OFIs), such as securities dealers and pension funds, are the next most profitable sector and the only other one enjoying a rate of return above that of the

United Kingdom as a whole in 1997. This is unsurprising, as many OFIs (such as securities dealers) have similar businesses to the investment banking operations of MFIs. OFIs' rates of return are also volatile.

Chart 3
UK external assets—rates of return



UK external liabilities—rates of return



Private non-financial corporations (PNFCs) have a rate of return slightly below average, and insurance companies appear to be slightly lower again. However, both are much less volatile than MFIs or OFIs and steadily make positive contributions.

A different picture emerges from the sectoral breakdown of rates of return on portfolio investment. MFIs are the only sector to have consistently outperformed the average rate of return on portfolio investment assets. PNFCs come close, having outperformed the average in every year except 1987 and 1994. Households (including non-profit institutions serving households) come next, followed by OFIs and insurance companies.

The United Kingdom's liabilities generally earned a higher rate of return for their owners than UK residents earned on their assets until 1990. The difference narrowed between 1990–94, with assets earning more than liabilities in 1990 and 1992. After 1994, assets started to earn more than liabilities by a clear margin. So there is a reversal in the period, from non-residents earning 0.3% more on investments in the United Kingdom than British residents earned from abroad, to British residents earning 0.8% more than non-residents earned from the United Kingdom. This development must be seen in the context of falling rates of return on both assets and liabilities, consistent with falls in interest rates in both the United Kingdom and other major economies.

The greatest divergence between rates of return on assets and liabilities is in direct investment. The rate of return on the United Kingdom's assets declined from 14.4% to 14.3% over the period, which may be characterised as flat overall, with a significant dip to 11.5% in 1991 and 10.2% in 1992. The rate of return earned by non-residents on direct investment in the United Kingdom fell from 15.5% in

Table D
Sectoral rates of return on UK direct investment assets

Per cent

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Monetary financial institutions	-1.4	13.7	2.5	-5.5	-18.2	13.8	2.5	14.2	4.6	29.8	44.6
Insurance companies	9.6	7.9	4.1	2.9	3.2	5.1	8.0	5.4	10.5	8.2	9.6
Other financial institutions	119.0	6.4	86.0	2.8	52.6	36.2	19.1	20.7	22.5	23.9	19.2
Private non-financial corporations	15.8	15.8	16.4	15.8	12.3	10.5	11.4	14.1	13.6	14.6	14.2
Total	**14.4**	**15.0**	**15.1**	**14.5**	**11.5**	**10.2**	**11.2**	**13.7**	**13.4**	**14.9**	**14.5**

Sectoral rates of return on direct investment in the United Kingdom

Per cent

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Monetary financial institutions	1.2	13.3	-1.4	-8.0	-12.4	0.9	27.2	12.4	16.3	15.4	8.5
Insurance companies	4.5	6.4	3.1	-3.2	-5.5	-0.1	7.6	21.4	16.3	10.8	6.3
Other financial institutions	-0.9	-2.5	15.0	5.4	15.4	10.3	19.2	-6.0	5.8	11.4	6.9
Private non-financial corporations	18.4	17.0	14.1	10.4	7.0	6.5	7.3	10.5	11.0	12.5	11.6
Total	**15.5**	**15.5**	**12.7**	**8.2**	**5.3**	**5.9**	**10.1**	**10.0**	**11.3**	**12.7**	**10.4**

Sectoral rates of return on UK portfolio investment assets

Per cent

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Monetary financial institutions	7.9	7.6	7.1	7.7	7.0	7.1	5.5	7.5	7.3	7.2	7.7
Insurance companies and pension funds	3.1	2.7	2.3	2.9	2.6	2.3	2.2	2.2	2.3	2.1	2.3
Other financial institutions	2.7	2.0	1.9	3.2	2.8	4.3	4.4	4.3	5.8	5.3	8.0
Private non-financial corporations	4.5	4.8	4.9	6.9	8.6	6.9	5.4	4.2	6.7	2.7	2.4
Total	**4.6**	**4.0**	**3.5**	**4.4**	**3.9**	**4.4**	**3.7**	**4.5**	**4.4**	**3.9**	**4.4**

1987 to 10.4% in 1997 (with a dip in 1991–92 down to the 5%–6% range). Earnings on direct investment in the United Kingdom should be lower in 1998, because of the large losses reported by foreign-owned banks in the third quarter of the year.

Splitting direct investment rates of return by sector, MFIs' rates of return increased strongly in the last two years of the period, up to 44.6%. Although this figure may be distorted by asset undervaluation (see above), the rate on assets is still well above the return earned by non-residents on UK liabilities. The return earned by the United Kingdom's investments in PNFCs abroad declined only marginally, from 15.8% in 1987 to 14.2% in 1997. The return earned by non-residents on their assets in British PNFCs fell from 18.4% to 11.6%.

The divergence between rates of return on portfolio assets narrowed over the period from -2.4% (assets-liabilities) to -0.3%, further contributing to the reversal. The ONS *Pink Book* contains a full split of portfolio investment assets but not liabilities. However, it can be seen that the rate of return on assets held by UK-resident MFIs, the second-largest sector of British asset-holders, declined only from 7.9% to 7.7%, while non-residents' earnings on portfolio holdings in British MFIs fell from 6.9% to 5.2%.

The impact of inflation news on financial markets

By Michael Joyce of the Bank's Structural Economic Analysis Division and Vicky Read of the Bank's Foreign Exchange Division.

This article(1) examines the same-day reaction of a variety of UK asset prices to monthly RPI inflation announcements over a sample period from the early 1980s until April 1997, the month before the Bank of England was given operational independence for setting interest rates. These announcements are decomposed into their expected and unexpected, or 'news', components using survey data on financial analysts' inflation expectations. It is found that markets are efficient, in the sense that asset prices do not respond to the expected component of RPI announcements. Generally, only government bond prices appear sensitive to inflation news—particularly after late 1992, when the United Kingdom adopted an explicit inflation target. The responsiveness of implied medium and long-term forward inflation rates after 1992 is consistent with the 'expected inflation hypothesis', a finding that suggests that the pre-independence inflation-targeting framework was not seen as fully credible by the financial markets. But the declining responsiveness of bond yields and implied forward inflation rates to inflation news over the period of operation of the framework suggests that its credibility improved over time.

Introduction

How financial markets respond to announcements of economic data is of interest for two main reasons.(2) First, it enables an assessment of the efficiency of financial markets in processing information—provided that the announced information can be decomposed into its expected and unexpected components, we can test whether asset prices only respond to the unexpected component of new data, or 'news', as the 'efficient markets hypothesis' would suggest. Second, how financial markets react to news may tell us something about the markets' perception of the authorities' reaction function, and so about the credibility of monetary policy.

This article focuses on the second issue—the credibility of monetary policy—examining the same-day reaction of a variety of UK asset prices to monthly retail price index (RPI) inflation announcements from the early 1980s until April 1997, the month before the granting of operational independence to the Bank of England.(3) In this period, the UK monetary policy framework underwent several important changes (moving from various forms of monetary targeting to informal and then formal exchange rate targeting within the ERM, and then to inflation targeting), but low inflation remained the ultimate policy objective. So we would expect financial markets to have been sensitive to inflation news throughout the period, though it seems plausible that the potential significance of inflation news may have increased after October 1992, when the United Kingdom adopted an explicit inflation target. We examine this possibility by focusing on sub-samples of the data.

The identification of RPI inflation news is clearly critical to the analysis. This article uses survey data on financial market analysts' expectations of RPI inflation made available by Money Market Services (MMS), which enable us to construct a consistent measure of inflation news back to the early 1980s,(4) without the need to identify expectations using an econometric model of inflation. However, repeating the analysis using inflation expectations generated from a simple autoregressive time-series model (ie an econometric model that predicts inflation on the basis of past inflation behaviour) produces results broadly similar to those reported below.(5)

The rest of the article is structured as follows. The second section discusses the two principal theories that explain why asset prices may change in response to news about inflation; the third section sets out the empirical framework used in the analysis; the fourth section discusses the raw data and the measure of inflation expectations used to derive inflation news; the empirical results are set out in the fifth section; and the final section concludes.

(1) This article summarises some of the analysis in 'Asset price reactions to RPI announcements', *Bank of England Working Paper,* forthcoming.
(2) See Wachtel (1992).
(3) For an earlier study of the impact of UK RPI announcements, see Goodhart and Smith (1985), who also examine the impact of money, PSBR and visible trade announcements. Previous studies of inflation announcements in other countries are Urich and Wachtel (1984), Smirlock (1986) and Fischer (1993). A more recent descriptive analysis of the effects of various UK data releases, including RPIX, on the sterling markets from January 1996 to June 1998 appeared in the *Quarterly Bulletin*, August 1998, pages 192–93, entitled 'News and the sterling markets'.
(4) The MMS series we use refers to the month-on-month percentage change in the RPI and goes back to December 1981.
(5) These results are omitted for brevity. Details are contained in the forthcoming *Working Paper* (see footnote 1).

Underlying theories

Why might asset prices respond to inflation news? The literature on announcement effects suggests two main theories: the 'policy anticipations hypothesis' (PAH) and the 'expected inflation hypothesis' (EIH).[1] The PAH implies that current inflation outturns that are higher/lower than expected will lead the markets to anticipate that the authorities will tighten/loosen monetary policy, in other words raise/lower (real) interest rates.[2] So the PAH can be thought of as broadly consistent with monetary policy credibility, as it assumes that the authorities are committed to offsetting any underlying inflationary pressures signalled by unexpected rises/falls in measured inflation.[3] The EIH, by contrast, suggests that when current inflation outturns are higher/lower than expected, the markets revise up/down the inflation they expect in the future—an outcome unlikely to be consistent with monetary policy credibility. This could reflect a belief that the authorities will be unwilling to offset fully any future inflationary implications signalled by the inflation news, because they are not committed to a specific inflation objective. Alternatively, the news might have no implications for immediate inflationary pressures, but might be taken as a signal of the authorities' true inflation preferences. So for example, higher-than-expected inflation might be interpreted as suggesting that the authorities were more tolerant of inflation than previously thought, thus leading the markets to raise their longer-term expectations of inflation. Of course, the PAH and EIH hypotheses need not be mutually exclusive, and the reaction we observe in practice could result from a combination of these effects—the authorities might be expected to react to an inflationary shock by raising (real) interest rates (consistent with the PAH), but not by enough to prevent a rise in expected inflation (consistent with the EIH).

The symmetry assumption implicit in both theories, that the market will react equally strongly whether inflation is higher or lower than expected, need not always hold, even if policy is viewed as fully credible (see Fischer (1993)). If, for example, the authorities are undershooting their inflation target, then a positive inflation shock need not require any response (unchanged expected real interest rates and higher expected inflation), while a negative inflation shock may enable them to relax policy (lowering expected real interest rates, with ambiguous effects on expected inflation).[4] Nevertheless, by definition, such asymmetries would be consistent with credibility only if they were restricted to expectations in the shorter term (ie within the two to three-year period in which monetary policy changes are likely to have their biggest impact on inflation). We allow for asymmetric responses in our empirical analysis below.

Using financial market reactions to inflation shocks to discriminate between the PAH and EIH is difficult in practice, because expected inflation and real interest rates are rarely directly observable. For this reason, other studies have looked at a range of asset price reactions in order to test these theories. The difficulty is that the predictions of the PAH and EIH for some asset prices are either the same or ambiguous. For example, if inflation turns out higher than expected, the PAH predicts that nominal interest rates, at least at shorter maturities, will rise in response to higher expected real interest rates (and to higher inflation in the short run to the extent that some inflation inertia is unavoidable whatever the policy reaction of the authorities), through the Fisher equation.[5] But the EIH also predicts this, as higher-than-expected inflation would be expected to raise future inflation and thereby current short-term, as well as longer-term, nominal interest rates. (It is also possible that the inflation risk premium would rise, either in line with or independently of any change in the expected average level of inflation, reflecting greater uncertainty about future inflation, but again this would indicate that the authorities lacked credibility.)

In principle, looking at longer-term expected nominal interest rates gets round this problem, because real interest rates (and any real rate risk premium) are likely to be invariant to monetary policy at longer maturities, and so the response of longer-term nominal rates to inflation news would be more likely to reflect an effect from expected inflation (as implied by the EIH hypothesis). But since spot rates at all maturities will still be affected by movements in short-term interest rates (because under the expectations hypothesis of the term structure, long rates are an average of expected future short rates), it is necessary to examine the behaviour of longer-term forward interest rates, in order to separate out the effects of any movements in the shorter end of the yield curve. This requires 'fitting' forward rate curves to data on spot rates.

Apart from longer-term forward interest rates, the predictions of the PAH and EIH are only unambiguously different in the case of exchange rates: the PAH predicts an appreciation in line with higher expected short real interest rates, whereas the EIH predicts a fall in line with higher expected inflation (and hence a higher expected price level relative to overseas). So particular attention is given to the reaction of exchange rates and forward interest rates (derived by the Bank of England) to RPI news in the empirical analysis below. But the existence of a UK market for index-linked government bonds (IGs) enables us to go one step further, by comparing the differing reaction of conventional gilts and IGs to infer movements in real interest rates and expected inflation

(1) See Cornell (1983).
(2) The assumption is that (at least on average) today's inflation news provides information on incipient inflationary pressures in the economy which, under the PAH, it is believed the authorities will want to offset in order to maintain their inflation objectives. If one month's inflation news has no future implications for inflation, then clearly there would be no need for a monetary policy response.
(3) Full credibility would require the anticipated policy response to be sufficient to offset fully any future longer-term inflationary implications signalled by the news.
(4) The discussion here and throughout this section abstracts from the impact on very short-term real rates, which could be different. See discussion below.
(5) In its simplest form, the Fisher equation states that the nominal interest rate is equal to the real interest rate plus expected inflation. A more general version would also include various risk premium terms, most importantly the inflation risk premium.

more directly.[1] Although comparisons between individual bond prices are distorted by idiosyncratic coupon, tax and maturity effects, the implied real rates and inflation rates calculated by the Bank of England (see Deacon and Derry (1994a),(1994b)) explicitly adjust for these effects, and these data are used in the analysis. Of course, some problems remain with these data—notably, the impact of any inflation risk and liquidity premia is not directly identified—but as long as risk premia remain broadly constant on inflation announcement days, then the daily changes in real/inflation rate measures that we examine will not be seriously distorted.[2] And as mentioned above, even if movements in implied forward inflation rates primarily reflect changes in the inflation risk premium, rather than changes in the expected level of inflation, the implications for the credibility of policy would be the same. Nevertheless, as a further check on the robustness of our findings and for consistency with other studies, the analysis is also conducted in terms of a range of other asset price reactions.[3]

Empirical framework

To assess the impact of inflation news on asset prices, we use the time-series event-study methodology that has typically been used in the literature on money announcement effects. Thus we first estimate the following model:

$$\Delta Y_t = \alpha + \beta_1 (\pi_t - \pi_t^e) + \beta_2 \pi_t^e + u_{1t} \qquad \textbf{(1)}$$

where ΔY_t is the change in the relevant asset price/yield from close of business on the working day prior to the announcement to close of business on the day of the announcement; π_t is that day's inflation announcement (which refers to the month-on-month percentage change in the RPI of the previous month); π_t^e is expected monthly inflation; α, β_1 and β_2 are parameters; and u_{1t} is an error term.

Our primary interest is in the first term, $(\pi_t - \pi_t^e)$, which represents the unanticipated inflation component. The second term is the expected component, which should be irrelevant in the regression if markets are efficient. So we expect (and typically find) that $\beta_2 = 0$, and for this reason most of the regression results we report in Annex B have the simpler form:

$$\Delta Y_t = \alpha + \beta (\pi_t - \pi_t^e) + u_{2t} \qquad \textbf{(2)}$$

We also want to test for asymmetric effects of inflation being higher or lower than expected. So we also report results from the following regression:

$$\Delta Y_t = \alpha + \beta_+ D_+(\pi_t - \pi_t^e) + \beta_- D_- (\pi_t - \pi_t^e) + u_{3t} \qquad \textbf{(3)}$$

where $D_+ = 1$ if $(\pi_t - \pi_t^e) > 0$ and 0 otherwise, and $D_- = 1$ where $(\pi_t - \pi_t^e) < 0$ and 0 otherwise. If the response to higher-than-expected inflation is of the same absolute magnitude as the response to lower-than-expected inflation, then obviously $\beta_+ = \beta_-$.[4]

Equations **(1)**, **(2)** and **(3)** are potentially vulnerable to a problem of omitted variables. But by focusing on the same-day movement in asset prices, we hope to minimise this problem and, provided that any other relevant news on the day is uncorrelated with inflation news, the parameter estimates remain unbiased. It is nevertheless important to pay close attention to outliers in the analysis, which may reflect other important news items.

The sample period for the empirical work runs from January 1982 to April 1997, but as there were major shifts in the monetary policy framework in this period, the sample is broken into three sub-periods: January 1982 to September 1990, a period that included various attempts at targeting (first broad and then narrow) money aggregates, as well as a brief period of informal exchange rate targeting, when sterling shadowed the Deutsche Mark, from March 1987 to March 1988; October 1990 to September 1992, a period of formal exchange rate targeting inside the ERM; and October 1992 to April 1997, a period when the government pursued an explicit inflation target, but before the Bank of England was given operational independence for setting interest rates.

Data

Inflation news

To assess the impact of unanticipated inflation on asset prices, we first need a measure of expected inflation. The MMS data on expected RPI inflation used in this article are based on a monthly telephone survey of around 20 market analysts, who are asked for their forecast of the month-on-month percentage change in the RPI figure to be released that month. Given publication lags, this refers to monthly RPI inflation in the previous month. The survey is normally conducted a week to a fortnight before the release of the RPI data.[5] We measure the inflation surprise as the

(1) Earlier studies by Tessaromatis (1990) and Peel, Pope and Paudyal (1990) examined the impact of M3 announcements in this way. One problem with these sorts of comparisons is that index-linked gilts are not perfectly indexed for inflation because of an indexation lag, which means that they are not protected in the eight-month period prior to maturity. Therefore, especially at shorter maturities, movements in real interest rates may also reflect changes in inflation expectations. This problem is controlled for, in principle, by the Bank's method of estimating the inflation term structure.

(2) Of course, risk premia are likely to be time-varying, but the assumption that they are slow-moving and therefore change little on a daily basis seems plausible. And, for reasons stated in the text, our analysis does not depend on this assumption.

(3) We have also examined the announcement-day effect on individual index-linked and conventional bonds. These results were broadly consistent with those reported using the Bank's estimated term structure and are therefore not reported here.

(4) In principle, it might be expected that asymmetries could also arise according to whether the inflation outturn was greater or less than the authorities' inflation target. We do not examine this hypothesis in what follows, because of difficulties in quantifying the implicit inflation target before 1992, but since the sample period we consider was broadly one of disinflation, it seems likely that inflation was always on the same side of the objective through most of the period.

(5) Ideally, we would want to measure expected inflation immediately prior to the release of the RPI data, so that expectations would incorporate all the relevant information available up to that point. If we assume that markets are efficient, then any news during the intervening period between the survey and the announcement will already have been factored into asset prices by the time of the announcement, and our measure of the responsiveness of asset prices to news will potentially be distorted. Our results have to be seen in the light of this caveat. However, this problem may be less serious if market participants nevertheless use the MMS survey forecast as their best guide to market sentiment.

difference between the actual monthly RPI outturn and the median estimate from the MMS survey.(1)

Of course, the UK inflation target since October 1992 has been specified in terms of RPIX rather than RPI inflation, but using RPI expectations as the basis for our measure of inflation news throughout enables us to derive a consistent measure over the full sample period; MMS only began sampling RPIX inflation expectations from the time of the February 1991 release. Moreover, given the focus of the media and markets on the 'headline' RPI figures over much of the sample period, it is unclear whether or not RPI or RPIX news is the more relevant variable for our purposes.

Asset price data

We examine the reaction of a range of asset prices to RPI announcements, as well as movements in the estimated forward interest rate term structure for UK government bonds, decomposed into their implied real and inflation components.(2) These variables are listed in Table A.

Table A
Asset price data

FT-SE 500 price index	Jan. 1962 = 100
Three-month Libor rate	Per cent per annum
5, 10 and 20-year bond yields	Per cent per annum
£ effective exchange rate	Jan 1990 = 100
DM/£ exchange rate	DM/£
$/£ exchange rate	$/£
2, 5 and 10-year forward nominal rates	Per cent per annum
2, 5 and 10-year forward real rates	Per cent per annum
2, 5 and 10-year forward inflation rates	Per cent per annum

The asset price response is measured by the change from close on the day prior to the RPI announcement to close on the day of the announcement. Average responses and the standard deviations of responses are given in Annex A (Tables 1 and 2). These statistics suggest that the majority of asset prices varied most in the ERM period; this conclusion remains robust to the exclusion of large movements on the dates of the United Kingdom's entry and exit. They also show that implied forward nominal, real and inflation rate movements have generally been much less volatile during the 1990s than in the 1980s, perhaps reflecting higher and more variable inflation during the earlier period.

Results

Asset prices

The starting-point for our empirical analysis is equation **(1)**. Running this regression for each of our asset price measures over the full sample and each sub-period, we find that expected RPI inflation does not explain movements in asset prices on the day of RPI announcements—the hypothesis that β_2 equals zero cannot be rejected at the 5% confidence level. This suggests that asset markets are efficient with respect to inflation announcements, in the sense that only the unexpected component of the announcement (if anything) is correlated with price changes. The results are reported in Annex B, Table 1.

The results for equations **(2)** and **(3)**, which exclude the term for expected inflation (assuming, in other words, that only the news element of the RPI announcement affects asset prices), suggest that government bond yields show the most sensitivity to unanticipated inflation (see Annex B, Tables 2 and 3). This response is particularly marked both in size and statistical significance in the third sub-period, during which the United Kingdom pursued an inflation target. (This result also holds if we measure inflation news using the time-series model forecasts mentioned earlier.) In the period since October 1992, the estimated β coefficients imply that an unanticipated 1 percentage point increase in monthly RPI inflation was associated with an announcement-day rise in five, ten and twenty-year (spot) bond yields of about 20 basis points on average; and the R^2 statistics suggest that inflation news explained between 20% and 25% of yield movements on RPI announcement days. Re-running the regression with news disaggregated into positive and negative components suggests that there is an asymmetric response: only the response to lower-than-expected inflation is statistically significant at conventional levels, and the absolute size of the response is larger at the longer (ten and twenty-year) maturities.

There is also some evidence that bond yields responded to inflation news in the pre-ERM period. Yields at all maturities show positive coefficients, though only the results for five-year yields are statistically significant at the conventional 5% level, and the overall explanatory power of the regression is quite low. Again, when the regressions are re-run disaggregating news into positive and negative components, there are strong asymmetries, but in this case it appears that yields responded more sharply when inflation was higher than expected. As explained earlier, we cannot draw direct inferences from these results for the validity of either the policy anticipations or expected inflation hypothesis, though the responsiveness of long bond yields in both periods seems more likely to be consistent with the latter.

The only other asset prices that showed any significant response to inflation news over the sample period were the DM/£ rate and the £ effective rate during the United Kingdom's ERM membership. These results appear consistent with the PAH, since they imply that sterling appreciated when inflation was higher than expected, suggesting that it was responding to an expected policy tightening. But the response is again asymmetric: sterling showed no tendency to depreciate relative to the currencies of its trading partners if UK inflation turned out lower than

(1) We tested the MMS data to see if they satisfy rationality, using standard tests for 'unbiasedness' and 'weak efficiency', which are both needed for rationality to hold. The forecasts were found to be unbiased predictors of inflation outturns, and weak inefficiency (ie a situation where the forecasts do not fully incorporate past inflation information) was only found in the first sub-period, perhaps because survey participants did not fully take into account seasonality in the RPI data caused by Budget tax changes (including a Budget dummy in the regression eliminates the statistical significance of the seasonal lag). Raw data, unadjusted for Budget/seasonal effects, were used for the results reported in the Annex, but these results were also tested for robustness to the inclusion of additive and interactive Budget dummy variables, as well as dummies for possible outliers. See forthcoming *Working Paper*, Joyce and Read (1999) for further details.
(2) Data from the Bank of England's daily estimated interest rate term structure, see Deacon and Derry *op cit.*

anticipated. One possible interpretation is that the authorities were perceived to be overshooting their (implicit) inflation target in this period, and so were thought likely to accommodate weaker-than-expected inflation, while tightening in response to bad inflation news. But given the small sample, we need to be particularly cautious in interpreting these results. Moreover, their statistical significance is sensitive to the inclusion of dummies for April 1992 (which coincided with a general election) and September 1992 (the UK exit from the ERM).(1)

The responses to RPI news of the FT-SE 500 index, three-month Libor rate and $/£ rate are all statistically insignificant in each sub-period. The fact that three-month interest rates do not respond to inflation news is consistent with the results of previous studies,(2) though it represents something of a puzzle in the ERM period if we interpret the exchange rate results as reflecting a policy anticipations effect. But again, the absence of a response may reflect small-sample problems.

The possibility that movements in the three-month rate may be affected by perverse movements in very short-term real interest rates may also be relevant in explaining these results. So, for example, higher-than-expected inflation last month might be expected to continue in the short term, thereby reducing very short real interest rates, even if (as under the PAH) the authorities are expected to want to act (but not instantaneously) to raise nominal and hence real interest rates. This reflects the fact that very short-maturity nominal rates are directly controlled by the monetary authorities, through their money-market dealings. Since three-month rates are market-determined, they would also be affected by any perverse reaction of very short real interest rates. So, for this example of higher-than-expected inflation (the results obviously apply with the opposite sign when inflation is lower than expected), the fall in ultra-short real interest rates could conceivably partly offset the impact on nominal three-month rates of higher expected inflation, and higher real interest rates for horizons beyond the policy reaction lag of the authorities. If this effect were important, then our regression results could be misleading. (It is certainly interesting in this context that, though statistically insignificant, all the news regression coefficients reported are negatively signed, but, of course, this does not establish the validity of the argument.)

Inflation term structure

The results in Annex B clearly suggest that gilts react to RPI inflation shocks, and that their responsiveness increased sharply during the period when the United Kingdom explicitly targeted inflation. But whether we should interpret this in terms of a policy anticipations effect or an inflation expectations effect (or as evidence of the authorities' credibility or lack of it) is unclear. As noted earlier, the sensitivity of nominal bond yields to inflation news could be consistent with either hypothesis. This is why examining movements in the Bank's estimated inflation term structure is potentially useful, because it provides explicit, though not unproblematic, measures of expected inflation and real interest rates. And by focusing on movements in forward rather than spot rates, we can isolate the impact at various maturities, which may otherwise be obscured by the averaging effect of looking at spot yields, as discussed above. Results from regressions of announcement-day changes in forward nominal rates, forward inflation rates and forward real interest rates are reported in Annex B, Table 4. The results show that the sensitivity of nominal forward rates to inflation news follows a similar pattern to that for bond yields. The recent period of inflation targeting stands out, in that only during this period are the response coefficients at both five and ten years statistically significant (the response of two-year nominal forward rates was not significant in any period). By contrast, during the ERM period, none of the nominal forward rates responded significantly to inflation news, and in the pre-ERM period, only the response coefficient on the five-year nominal rate is statistically significant.

The response of nominal forward rates to inflation news during the inflation-targeting period could in principle (as with spot bond yields) be consistent with either the EIH or the PAH (or some combination). But the fact that forward nominal rates respond to inflation news more at longer than at shorter horizons suggests that these movements primarily reflect changes in expected inflation rather than changes in expected real interest rates, and the regressions for implied forward real rates and inflation rates seem to support this interpretation. Though implied forward real rates at the five-year maturity show a statistically significant response to inflation news, implied forward inflation rates also show a positive and statistically significant response at both five and ten-year maturities. So though the market appeared to expect some eventual policy tightening in response to higher-than-expected inflation (though not in the short term, at least judged by the results for two-year forward real rates), this accompanied higher expected inflation in the longer term. As discussed earlier, this change in inferred inflation expectations might reflect a revised view of the extent of incipient inflationary pressures or risks(3) in the economy and/or a revised view of the authorities' true inflation target. Overall, yield curve movements, at least at the medium to long end, are therefore consistent with the expected inflation hypothesis.

These results suggest that the post-1992 inflation-targeting framework lacked full credibility. Further insights into this emerge from re-running the regression including positive and negative news components separately (see Annex B, Table 5). This shows that during the inflation-targeting period, longer-term expected inflation, both at five and

(1) When dummy variables for both these dates are included, the response coefficient in the DM/£ regression is only weakly statistically significant.
(2) See, for example, Goodhart and Smith (1985) for the United Kingdom, and Urich and Wachtel (1984) or Roley and Troll (1983) for the United States.
(3) As discussed earlier, movements in implied forward inflation rates might reflect changes in the inflation risk premium, as well as (or even instead of) changes in the level of expected inflation. But neither explanation would be consistent with monetary policy credibility.

ten-year horizons, responded significantly to RPI announcements only when inflation outturns proved to be lower than expected. One interpretation of this asymmetry is that it reflected a period when the authorities were in the process of building up credibility for the new monetary framework. So the markets required evidence of lower-than-expected inflation to revise down their long-term inflation expectations towards the stated target. But further analysis shows that this result is sensitive to one large downward movement on 12 February 1993, and so this interpretation has to be tentative.(1)

The results for the post-1992 inflation-targeting period are also sensitive to which part of the sample is chosen. If we split the sample into two broadly equal sub-periods (October 1992 to December 1994, and January 1995 to April 1997) and re-run the regressions, we cannot reject the hypothesis that the responsiveness of implied forward inflation rates to inflation news (whether positive or negative) was insignificant in the second sub-period. (This result carries over to nominal forward rates and yields.) In other words, it appears that the strong and statistically significant (average) response of forward rates to inflation news over the four-and-a-half year period of inflation targeting can be attributed to behaviour in the first half of the period. One interpretation of this is that when the new framework was set up, financial markets were initially uncertain as to the authorities' intentions. Despite the various measures introduced to increase the openness and transparency of the monetary framework,(2) better-than-expected RPI outturns also seem to have been needed to demonstrate the authorities' commitment to the inflation target. Our results suggest that, as more information became available on the operation of the framework and the confidence of financial markets in the authorities' commitment to low inflation increased, yields stopped responding to short-term inflation news. It is hard to reach a definitive conclusion, but these results are consistent with there having been some improvement in the credibility of the inflation-targeting framework during the period of its operation.

How do we explain the results for the earlier periods? As far as the ERM period is concerned, the lack of responsiveness of implied forward inflation rates is consistent with monetary policy being seen as credible, which to some extent would support the evidence on exchange rates. But the lack of any reaction of either real rates or nominal short rates during this period is something of a puzzle. Overall, the small sample size and fragility of the results makes it hard to draw strong conclusions.

The results for the earlier, pre-ERM period are also difficult to interpret. Real rate expectations appear to have risen at the longer five and ten-year maturities in the event of unexpected increases in inflation, but not to have fallen when inflation turned out lower than expected. At the same time, implied forward inflation rates at the five-year maturity appear to have risen in response to higher-than-expected inflation news, while at the ten-year maturity they appear, if anything, to have fallen (though the results where news is disaggregated are not statistically significant at 5%). One interpretation of these results would be that the market believed the authorities would not want to respond to higher inflation outcomes in the short term, but would be forced to react in the medium term, though not sufficiently to prevent inflation rising. Certainly, these results seem difficult to reconcile with policy being fully credible in this period, though we need to be cautious in drawing conclusions, given the small size and consequent illiquidity of the IG market in the early part of this period.(3) When the results are re-run excluding the earlier part of the sample up to March 1984, none of the implied forward inflation rates appears to respond significantly to inflation news, an outcome apparently consistent with monetary policy credibility. One perhaps more plausible explanation could simply be that inflation surprises carried less information on future inflation pre-1992, reflecting higher average inflation and inflation uncertainty, and the fact that the authorities had no explicit inflation target. During 1982–90, monthly inflation averaged around 0.5%, compared with 0.2% between 1992–97, and inflation was considerably more volatile. So it would have been quite consistent with rational behaviour for financial markets to have placed less weight on short-term inflation movements, and so for asset prices to have exhibited less sensitivity to RPI news.

Summary and conclusions

This article has examined the same-day reaction of a variety of asset prices to monthly RPI announcements for a sample beginning in the early 1980s and ending in April 1997, the month before the Bank of England was given operational independence for setting interest rates. Of the assets considered, gilts were found to be the most sensitive to the RPI announcements, particularly during the post-1992 period of inflation targeting. Consistent with market efficiency, it was found that gilt yield movements only occurred in response to the unexpected (news) component of RPI announcements.

These movements are interpreted in more detail by examining the Bank's estimated daily interest rate term structure, which allows us to decompose yield movements—subject to the caveats on risk premia discussed above—into shifts in implied inflation and in real interest rate expectations. During the period of inflation targeting, it is found that movements in forward nominal rates at the longer end of the yield curve reflect changes in implied forward inflation rates, consistent with an inflation expectations effect. But some evidence is also found of an asymmetric

(1) The shift in yields reflected a fall in inflation to its lowest level for 25 years. *The Financial Times* of 13 February reported that '[t]he inflation news, described by one seasoned market dealer as 'stunningly good', transformed the gilts market...'.
(2) Of these measures, the most important were probably the publication of the quarterly *Bank of England Inflation Report* (from February 1993) and the decision to publish the minutes of the monthly Chancellor-Governor meetings (from April 1994).
(3) In June 1982, for example, IGs represented only 4% of the outstanding stock of government bonds.

response to inflation news, with inflation expectations appearing to fall in response to favourable news on RPI, but not rising in the event of higher-than-expected inflation outturns. Moreover, the analysis suggests that the responsiveness of yields and implied forward inflation rates to news appears to relate solely to the first few years of operation of the inflation-targeting framework.

Although any conclusions must remain tentative, particularly given the small size of the sample, it is argued that these results are inconsistent with monetary policy being seen as fully credible, at least during the early part of the pre-independence inflation-targeting framework. Our preferred interpretation is that the authorities were still in the process of building credibility at that time, with the markets requiring evidence of lower-than-expected inflation to revise their longer-term inflation expectations down towards the explicit target. But the declining responsiveness of bond yields and implied forward inflation rates to inflation news over the period that the framework operated suggests that its credibility improved over time.

Annex A

Table 1
Asset price changes on RPI announcement days

μ = average response, σ = standard deviation

	Sample 1.82–9.90 N = 105		Sample 10.90–9.92 N = 24		Sample 10.92–4.97 N = 55		Sample 1.82–4.97 N = 184	
	μ	σ	μ	σ	μ	σ	μ	σ
FT-SE 500	1.17	7.38	-0.467	17.6	1.57	16.0	1.07	12.1
3-month Libor	0.014	0.158	-0.010	0.122	0.005	0.037	0.008	0.128
5-year yield (a)	0.0003	0.078	-0.011	0.153	-0.010	0.077	-0.005	0.091
10-year yield (a)	-0.001	0.079	-0.012	0.141	-0.010	0.085	-0.005	0.091
20-year yield (a)	0.0001	0.072	-0.010	0.113	-0.013	0.077	-0.006	0.080
£ effective	-0.019	0.369	0.037	0.367	0.025	0.328	0.001	0.356
DM/£	-0.0003	0.013	0.001	0.010	0.001	0.010	0.0002	0.012
$/£	0.0001	0.012	0.001	0.016	0.001	0.010	0.0004	0.012

Note: N = Number of observations.

(a) Sample starts January 1983.

Table 2
Implied forward interest rate changes on RPI announcement days

μ = average response, σ = standard deviation

	Sample 4.82–9.90 N = 102		Sample 10.90–9.92 N = 24		Sample 10.92–4.97 N = 55		Sample 4.82–4.97 N = 181	
	μ	σ	μ	σ	μ	σ	μ	σ
2-year nominal (a)	0.011	0.312	-0.013	0.193	-0.014	0.095	0.001	0.251
5-year nominal (a)	-0.023	0.246	-0.020	0.114	-0.009	0.108	-0.018	0.198
10-year nominal (a)	0.012	0.332	0.006	0.172	-0.017	0.108	0.003	0.264
2-year real	-0.011	0.105	0.007	0.104	0.001	0.062	-0.005	0.093
5-year real	-0.006	0.056	0.017	0.064	-0.001	0.041	-0.002	0.053
10-year real	-0.001	0.044	0.018	0.087	-0.001	0.033	0.002	0.049
2-year inflation	0.014	0.318	-0.020	0.240	-0.015	0.100	0.001	0.260
5-year inflation	-0.024	0.255	-0.037	0.110	-0.008	0.098	-0.021	0.202
10-year inflation	0.017	0.352	-0.013	0.172	-0.017	0.106	0.003	0.278

Note: N = Number of observations.

(a) Sample starts January 1982.

Annex B

Table 1
Asset price response to expected inflation and inflation news—equation (1)

$\Delta Y_t = a+\beta_1(\pi-\pi^e)+ \beta_2\pi^e+u_t$

	Sample 1.82–9.90 N = 105					Sample 10.90–9.92 N = 24					Sample 10.92–4.97 N = 55					Sample 1.82–4.97 N = 184				
	β_1	β_2	R^2	*DW*	*H* (a)	β_1	β_2	R^2	*DW*	*H* (a)	β_1	β_2	R^2	*DW*	*H* (a)	β_1	β_2	R^2	*DW*	*H* (a)
FT-SE 500	-2.64 *0.8*	0.78 *0.5*	0.01	1.7	2.3	12.08 *0.6*	-8.74 *0.9*	0.05	2.1	0.0	-6.06 *0.5*	-10.13 *1.7*	0.06	2.2	1.0	-1.61 *0.4*	-2.75 *1.3*	0.01	2.2	0.0
3-month Libor	-0.04 *0.5*	-0.04 *1.1*	0.02	1.9	0.8	-0.21 *1.4*	-0.01 *0.2*	0.09	2.0	0.4	-0.03 *1.0*	-0.03 *1.4*	0.05	2.2	3.8	-0.05 *1.0*	-0.03 *1.2*	0.01	1.9	0.0
5-year yield (a)	0.09(b) *2.3*	-0.01 *0.6*	0.05	2.3	1.1	-0.16 *0.8*	0.03 *0.4*	0.04	1.9	3.7	0.18(d) *3.5*	0.04 *1.6*	0.22	2.1	1.4	0.08(c) *2.4*	0.01 *0.5*	0.04	2.2	0.3
10-year yield (a)	0.06 *1.7*	0.01 *0.5*	0.04	2.1	0.8	-0.13 *0.8* [*0.6*]	0.03 *0.4* [*0.5*]	0.03	2.0	4.4(c)	0.22(d) *4.1*	0.04 *1.4*	0.27	2.4	0.9	0.09(c) *2.5*	0.02 *1.2*	0.05	2.2	0.2
20-year yield (a)	0.07(c) *2.0*	-0.02 *1.1*	0.05	2.3	0.0	-0.08 *0.5*	0.01 *0.2*	0.02	2.0	4.2	0.21(d) *4.2*	0.04 *1.6*	0.29	2.4	0.3	0.09(d) *3.1*	0.000 *0.0*	0.05	2.3	0.1
£ effective	0.16 *0.9*	-0.02 *0.2*	0.01	1.9	1.9	0.61 *1.4* [*0.9*]	-0.19 *1.0* [*1.3*]	0.12	1.8	12.9(d)	0.10 *0.4*	-0.04 *0.3*	0.01	1.1	0.1	0.18 *1.4*	-0.06 *0.9*	0.01	1.8	0.6
DM/£	0.004 *0.7*	-0.002 *0.6*	0.01	1.9	1.5	0.03(c) *2.6*	-0.004 *0.9*	0.25	1.6	0.4	-0.001 *0.2*	-0.000 *0.0*	0.00	1.2	0.6	0.01 *1.1*	-0.002 *0.9*	0.01	1.9	1.2
$/£	0.01 *1.5*	0.002 *0.8*	0.03	1.8	0.9	-0.000 *0.0*	-0.002 *0.2*	0.00	2.3	0.0	0.01 *1.1*	-0.002 *0.6*	0.03	1.8	0.0	0.01 *1.6*	0.000 *0.1*	0.01	1.9	0.1

Notes: N = Number of observations.
Conventional t-ratios are in italics.
T-ratios based on White heteroscedasticity-corrected standard errors are shown in square brackets where the H-test is significant at 5%.

(a) F-test for heteroscedasticity is from regressing the equation's squared errors on its squared fitted values.
(b) Sample starts January 1983.
(c) Significant at the 5% confidence level.
(d) Significant at the 1% confidence level.

Table 2
Asset price response to inflation news—equation (2)

$\Delta Y_t = \alpha+\beta(\pi-\pi^e)+ u_t$

	Sample 1.82–9.90 N = 105				Sample 10.90–9.92 N = 24				Sample 10.92–4.97 N = 55				Sample 1.82–4.97 N = 184			
	β	R^2	*DW*	*H* (a)	β	R^2	*DW*	*H* (a)	β	R^2	*DW*	*H* (a)	β	R^2	*DW*	*H* (a)
FT-SE 500	-2.45 *0.7*	0.01	1.7	1.4	10.48 *0.5*	0.01	2.3	0.1	-6.81 *0.6*	0.01	2.3	0.1	-2.30 *0.5*	0.00	2.2	0.0
3-month Libor	-0.05 *0.7*	0.00	1.9	0.2	-0.21 *1.5*	0.09	2.0	0.8	-0.03 *1.0*	0.02	2.1	2.6	-0.05 *1.1*	0.01	1.9	0.0
5-year yield (b)	0.08(c) *2.2*	0.05	2.3	1.6	-0.15 *0.8*	0.03	2.0	2.3	0.18(d) *3.5*	0.19	2.2	1.5	0.09(c) *2.5*	0.04	2.2	0.2
10-year yield (b)	0.07 *1.8*	0.03	2.1	0.4	-0.13 *0.7*	0.02	2.1	2.6	0.23(d) *4.1*	0.24	2.5	0.1	0.09(d) *2.7*	0.04	2.2	0.0
20-year yield (b)	0.06 *1.9*	0.04	2.3	0.7	-0.07 *0.5*	0.01	2.0	2.5	0.21(d) *4.3*	0.25	2.5	0.1	0.09(d) *3.1*	0.05	2.3	0.1
£ effective	0.16 *0.9*	0.01	1.9	2.0	0.58 *1.3* [*0.9*]	0.07	1.9	17.3(d)	0.10 *0.4*	0.00	1.1	0.1	0.17 *1.3*	0.01	1.8	0.9
DM/£	0.003 *0.6*	0.00	1.9	0.8	0.03(c) *2.5*	0.22	1.7	0.2	-0.001 *0.2*	0.00	1.2	0.6	0.004 *1.0*	0.01	1.9	0.6
$/£	0.01 *1.6*	0.02	1.8	0.8	0.001 *0.00*	0.00	2.3	1.4	0.01 *1.1*	0.02	1.8	0.0	0.01 *1.6*	0.01	1.9	0.1

Notes: N = Number of observations.
Conventional t-ratios are in italics.
T-ratios based on White heteroscedasticity-corrected standard errors are shown in square brackets where the H-test is significant at 5%.

(a) F-test for heteroscedasticity is from regressing the equation's squared errors on its squared fitted values.
(b) Sample starts January 1983.
(c) Significant at the 5% confidence level.
(d) Significant at the 1% confidence level.

Table 3
Asset price response to positive(+)/negative(-) inflation news—equation (3)

$\Delta Y_t = \alpha + \beta_+ D_+ (\pi - \pi^e) + \beta\_D\_ (\pi - \pi^e) + u_t$

	Sample 1.82–9.90 N = 105					Sample 10.90–9.92 N = 24					Sample 10.92–4.97 N = 55					Sample 1.82–4.97 N = 184				
	β_+	$\beta\_$	R^2	*DW*	*H* (a)	β_+	$\beta\_$	R^2	*DW*	*H* (a)	β_+	$\beta\_$	R^2	*DW*	*H* (a)	β_+	$\beta\_$	R^2	*DW*	*H* (a)
FT-SE 500	-6.17 *1.2*	4.53 *0.6*	0.01	1.7	0.7	58.19 *1.1*	-18.2 *0.5*	0.05	2.3	1.3	-3.68 *0.1*	-8.38 *0.4*	0.01	2.3	0.0	-2.40 *0.3*	-2.16 *0.3*	0.00	2.2	0.0
3-month Libor	0.05 *0.5*	-0.23 *1.4*	0.02	1.9	0.0	-0.58 *1.6*	0.01 *0.0*	0.14	1.8	1.6	0.12 *1.6*	-0.10 *2.4*	0.10	2.0	0.2	0.03 *0.4*	-0.15 *1.7*	0.02	1.9	0.1
5-year yield (b)	0.11(c) *2.0*	0.02 *0.2*	0.05	2.3	0.8	-0.56 *1.2*	0.10 *0.3*	0.07	1.9	3.1	0.19 *1.4*	0.17(c) *2.1*	0.19	2.2	1.4	0.08 *1.4*	0.10 *1.4*	0.04	2.2	0.2
10-year yield (b)	0.09 *1.7*	0.01 *0.1*	0.04	2.1	0.1	-0.62 *1.5*	0.17 *0.6*	0.09	1.9	3.8	0.14 *1.0*	0.27(d) *3.0*	0.25	2.4	0.9	0.05 *0.9*	0.14(c) *2.1*	0.05	2.2	0.1
20-year yield (b)	0.10(c) *2.1*	-0.03 *0.3*	0.05	2.4	0.1	-0.44 *1.3*	0.15 *0.6*	0.07	1.8	3.7	0.10 *0.8*	0.26(d) *3.3*	0.26	2.4	0.4	0.06 *1.3*	0.13(c) *2.2*	0.06	2.3	0.1
£ effective	0.13 *0.5*	0.20 *0.5*	0.01	1.9	2.0	2.13(c) *2.0* *[1.6]*	-0.35 *0.5* *[0.4]*	0.18	1.6	5.9(c)	-0.45 *0.7*	0.37 *0.9*	0.02	1.1	0.0	0.14 *0.6*	0.20 *0.8*	0.01	1.8	0.8
DM/£	0.002 *0.2*	0.01 *0.5*	0.00	1.9	0.5	0.05 *1.9*	0.01 *0.7*	0.26	1.6	0.0	-0.02 *0.8*	0.01 *0.5*	0.01	1.2	2.7	0.002 *0.3*	0.01 *0.8*	0.01	1.9	0.5
$/£	0.01 *0.7*	0.01 *1.2*	0.03	1.8	1.6	0.06 *1.1* *[0.7]*	-0.03 *1.0* *[0.9]*	0.07	2.0	8.7(d)	-0.01 *0.2*	0.01 *1.2*	0.03	1.8	0.0	0.01 *0.9*	0.01 *0.9*	0.01	1.9	0.1

Notes: N = Number of observations.
Conventional t-ratios are in italics.
T-ratios based on White heteroscedasticity-corrected standard errors are shown in square brackets where the H-test is significant at 5%.

(a) F-test for heteroscedasticity is from regressing the equation's squared errors on its squared fitted values.
(b) Sample starts January 1983.
(c) Significant at the 5% confidence level.
(d) Significant at the 1% confidence level.

Table 4
Response of implied forward rates to news—equation (2)

$\Delta Y_t = \alpha + \beta(\pi - \pi^e) + u_t$

	Sample 4.82–9.90 N = 102				Sample 10.90–9.92 N = 24				Sample 10.92–4.97 N = 55				Sample 4.82–4.97 N = 181			
	β	R^2	*DW*	*H* (a)	β	R^2	*DW*	*H* (a)	β	R^2	*DW*	*H* (a)	β	R^2	*DW*	*H* (a)
2-year nominal (b)	0.03 *0.2*	0.00	1.7	0.5	-0.17 *0.7*	0.02	1.8	2.4	0.07 *1.1*	0.02	1.8	2.4	0.03 *0.3*	0.00	1.7	0.0
5-year nominal (b)	0.38(d) *3.6*	0.11	1.9	0.1	-0.04 *0.3*	0.00	2.2	1.7	0.29(d) *4.1*	0.24	2.3	0.0	0.31(d) *4.5*	0.10	1.9	0.2
10-year nominal (b)	-0.27 *1.8*	0.03	1.6	0.0	-0.02 *0.1*	0.00	2.8	1.5	0.30(d) *4.5* *[2.5]*	0.27	2.3	44.5(d)	-0.09 *1.0*	0.01	1.7	0.1
2-year real	-0.01 *0.1*	0.00	1.9	2.2	0.04 *0.3*	0.01	1.4	0.0	0.06 *1.4*	0.03	1.9	0.0	0.01 *0.3*	0.00	1.9	3.1
5-year real	0.04 *1.6*	0.02	1.8	0.9	-0.01 *0.1*	0.00	1.4	0.1	0.06(c) *2.0*	0.07	2.5	0.4	0.04 *1.9*	0.02	2.0	0.5
10-year real	0.06(d) *2.8*	0.08	1.8	0.1	0.001 *0.0*	0.00	1.4	0.3	0.02 *0.9*	0.02	2.0	0.3	0.04(c) *2.2*	0.03	2.0	0.0
2-year inflation	0.05 *0.4*	0.00	1.9	0.2	-0.22 *0.8*	0.02	1.8	2.4	0.01 *0.1*	0.00	1.9	0.0	0.03 *0.3*	0.00	1.9	0.0
5-year inflation	0.38(d) *3.3*	0.10	2.0	0.1	-0.03 *0.3*	0.00	1.6	1.5	0.23(d) *3.5*	0.18	2.4	0.1	0.29(d) *4.0*	0.08	2.0	0.3
10-year inflation	-0.36(c) *2.3*	0.05	1.5	0.0	-0.02 *0.1*	0.00	2.0	1.7	0.28(d) *4.2* *[2.2]*	0.25	2.3	54.9(d)	-0.15 *1.5*	0.01	1.6	0.1

Notes: N = Number of observations.
Conventional t-ratios are in italics.
T-ratios based on White heteroscedasticity-corrected standard errors are shown in square brackets where the H-test is significant at 5%.

(a) F-test for heteroscedasticity is from regressing the equation's squared errors on its squared fitted values.
(b) Sample starts January 1982.
(c) Significant at the 5% confidence level.
(d) Significant at the 1% confidence level.

Table 5
Response of implied forward rates to positive(+)/negative(-) inflation news—equation (3)

$\Delta Y_t = \alpha + \beta_+ D_+ (\pi - \pi^e) + \beta_- D_- (\pi - \pi^e) + u_t$

	Sample 4.82–9.90 N = 102					Sample 10.90–9.92 N = 24					Sample 10.92–4.97 N = 55					Sample 4.82–4.97 N = 181				
	β_+	β_-	R^2	*DW*	*H* (a)	β_+	β_-	R^2	*DW*	*H* (a)	β_+	β_-	R^2	*DW*	*H* (a)	β_+	β_-	R^2	*DW*	*H* (a)
2-year nominal (b)	-0.19 *0.9*	0.45 *1.4*	0.02	1.7	0.3	-0.80 *1.4* *[1.0]*	0.21 *0.5* *[0.6]*	0.08	1.7	4.5(c)	0.09 *0.5*	0.07 *0.6*	0.02	1.8	2.6	-0.16 *1.0*	0.26 *1.5*	0.02	1.7	0.3
5-year nominal (b)	0.52(d) *3.3*	0.12 *0.5*	0.13	1.9	0.1	-0.26 *0.7*	0.09 *0.4*	0.03	2.1	3.3	0.25 *1.3*	0.30(d) *2.7*	0.24	2.3	0.1	0.45(d) *3.9*	0.14 *1.1*	0.11	1.9	0.0
10-year nominal (b)	-0.36 *1.6*	-0.10 *0.3*	0.03	1.6	0.0	-0.47 *0.9*	0.25 *0.7*	0.04	2.7	0.2	-0.14 *0.8* *[0.7]*	0.53(d) *5.1* *[2.9]*	0.36	2.2	20(d)	-0.37(c) *2.3*	0.24 *1.3*	0.03	1.6	0.1
2-year real	0.03 *0.4*	-0.07 *0.6*	0.00	1.9	0.6	0.38 *1.2*	-0.16 *0.7*	0.06	1.5	0.5	0.06 *0.5*	0.06 *0.8*	0.03	1.9	0.0	0.03 *0.5*	-0.01 *0.2*	0.00	1.9	0.0
5-year real	0.08(c) *2.2*	-0.04 *0.7*	0.05	1.9	0.0	-0.09 *0.4*	0.04 *0.3*	0.01	1.5	0.5	0.03 *0.4*	0.08 *1.6*	0.08	2.5	0.5	0.06 *1.8*	0.01 *0.3*	0.02	2.0	0.1
10-year real	0.08(c) *2.6*	0.02 *0.3*	0.08	1.9	0.1	-0.19 *0.7*	0.12 *0.6*	0.03	1.5	0.9	-0.000 *0.1*	0.04 *0.9*	0.02	1.9	0.2	0.05 *1.7*	0.02 *0.7*	0.03	2.0	0.0
2-year inflation	-0.20 *0.9*	0.57 *1.6*	0.03	1.9	0.3	-1.2 *1.7*	0.37 *0.8*	0.12	1.8	4.1	0.02 *0.1*	0.01 *0.0*	0.00	1.9	0.1	-0.17 *1.1*	0.27 *1.4*	0.01	1.9	0.3
5-year inflation	0.47(d) *2.8*	0.17 *0.6*	0.11	1.9	0.0	-0.17 *0.5*	0.05 *0.2*	0.01	1.5	1.7	0.22 *1.3*	0.23(c) *2.1*	0.18	2.4	0.1	0.42(d) *3.5*	0.13 *0.9*	0.09	2.0	0.0
10-year inflation	-0.44 *1.9*	-0.20 *0.5*	0.05	1.5	0.0	-0.28 *0.5*	0.13 *0.4*	0.01	1.9	0.0	-0.13 *0.8* *[0.7]*	0.49(d) *4.7* *[2.5]*	0.33	2.3	38(d)	-0.44(c) *2.6*	0.22 *1.1*	0.04	1.6	0.1

Notes: N = number of observations.
Conventional t-ratios are in italics.
T-ratios based on White heteroscedasticity-corrected standard errors are shown in square brackets where the H-test is significant at 5%.

(a) F-test for heteroscedasticity is from regressing the equation's squared errors on its squared fitted values.
(b) Sample starts January 1982.
(c) Significant at the 5% confidence level.
(d) Significant at the 1% confidence level.

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Monetary policy rules and inflation forecasts

By Nicoletta Batini of the Bank's Monetary Assessment and Strategy Division and Andrew Haldane of the Bank's International Finance Division.

This article compares the use of simple backward-looking interest rate rules for monetary policy with policy rules that respond to forecasts of future inflation, in line with monetary policy behaviour in the real world. It appears that these forecast-based rules can better control both current and future inflation, by accounting for the lags in the monetary transmission mechanism, and can ensure a suitable degree of output-smoothing. In addition, they ensure that policy is responsive to most available information. Their superior performance provides support for the practice of basing monetary policy on forecasts of inflation and output, as in the United Kingdom.

Introduction

There has been considerable interest in simple interest rate rules for monetary policy. These rules offer a hypothetical path for the policy instrument, short-term interest rates. This path typically depends on deviations of certain key macroeconomic variables from their target paths. The Taylor rule is a well known example of a monetary policy rule, with the path for the short-term interest rate depending on deviations of inflation from target and output from trend.(1)

There are various ways to interpret the instrument paths provided by these rules. One is that they provide a *descriptive* path for interest rates: the rules simply mimic passively, and inevitably somewhat crudely, the behaviour of monetary policy-makers in practice. For example, a Taylor-rule path for interest rates follows fairly closely the path of actual US official interest rates over recent years. Another, more ambitious interpretation is that policy rules are a useful *prescriptive* tool: the rules can be used actively to diagnose when monetary policy may be heading off-track, by comparing the actual and hypothetical paths of interest rates.

In either role, however, it seems likely that most simple monetary policy rules suggested in the literature may underplay one important aspect of monetary policy-making in the real world—its forward-looking perspective. For example, the Taylor rule sets an interest rate path on the basis of current or lagged values of output and inflation. By contrast, policy-makers in practice have recently tended to base policy decisions on expectations of future inflation and output, rather than their actual values, as shown by empirical evaluations of monetary policy behaviour in the G7 countries.(2)

This forward-looking dimension to policy-making behaviour is perhaps seen most clearly among inflation-targeting countries, which include the United Kingdom. In these countries, forecasts of future inflation and output are a key ingredient of the monetary policy decision-making process. For example, in the United Kingdom, the Bank of England's quarterly *Inflation Report* contains projections for both inflation and output growth up to two years ahead. These projections are central to the policy deliberations of the Bank's Monetary Policy Committee.

What benefits might this forward-looking dimension to monetary policy behaviour confer? One way to answer this question is to evaluate quantitatively hypothetical interest rate rules, which are similar in spirit to Taylor rules, but which respond to forecasts of future inflation and output rather than their current values. This article evaluates empirically forecast-based rules of this type, using model-based simulations. It also compares their performance with Taylor-type rules.(3)

A forecast can only be formed on the basis of information available in the current period, or in previous periods ('predetermined' variables). So the forecast future values of any variable, such as inflation, can always be expressed in terms of a set of known variables. In this sense, a forecast-based rule can be transformed into a backward-looking rule. At root, they are responding to the same set of variables. So there should in principle be little to choose between the performance of policy rules that respond to current values of macroeconomic variables and those that respond to forecast values of these same variables.

In practice, however, there are advantages to having the monetary policy instrument respond directly and explicitly

(1) See Taylor, J B (1993). For a broader discussion of simple rules, see Stuart, A (1996) 'Simple monetary policy rules', *Bank of England Quarterly Bulletin*, August, pages 281–87.
(2) See Clarida, Gali and Gertler (1998).
(3) Further details on these simulations are contained in Batini and Haldane (1999), *Bank of England Working Paper* No 91. This paper formed part of a National Bureau of Economic Research project on 'Monetary Policy Rules' organised by John Taylor.

to inflation forecasts. These advantages relate to three of the most difficult technical problems facing monetary policy-makers in practice:[1] first, how to deal with monetary transmission lags; second, how to ensure a proper treatment of output; and third, how best to use available information. We discuss below how forecast-based rules deal with each of these problems—lags, output and information. But we begin by discussing how to evaluate the performance of the various hypothetical policy rules.

Model and method

Four basic ingredients are needed to evaluate the performance of any monetary policy rule, backward or forward-looking. First, the monetary policy rule itself, describing how policy is to be implemented. Second, a model of the macroeconomy, describing interactions among the main macroeconomic variables, including the monetary policy instrument. Third, a set of shocks to the economy, describing unpredictable disturbances to the key macroeconomic variables in each period. And fourth, some criteria for judging the various possible policy outcomes.

Given these building-blocks, the performance of any given policy rule can be evaluated by placing the policy rule alongside the model of the economy and subjecting the resulting system—model plus policy rule—to the sequence of macroeconomic shocks. The best-performing policy rule is the one that can stabilise the effects of these disturbances, by minimising (squared) deviations of inflation from target and of output from potential—the evaluation criteria.

The forecast-based *monetary policy rule* evaluated here takes the following form:

$$i_t = \alpha (E_t \pi_{t+j} - \pi^*) + \beta x_t \qquad \textbf{(1)}$$

where i_t is the short-term nominal interest rate (the policy instrument); $E_t \pi_{t+j}$ denotes the expectation or forecast formed today (in period t, E_t) of inflation j periods in the future (π_{t+j}); π^* is the inflation target; and x_t is a set of other variables affecting the interest rate path.[2] The coefficients α and β are (positive) constants chosen by the policy-maker.

According to this forecast-based rule, the path for short-term interest rates depends on forecast values for inflation j periods in the future. Deviations of this inflation forecast from its target value elicit remedial policy responses. For example, if the inflation forecast j periods in the future is above target, the rule prescribes a tightening of monetary policy. Specifically, short-term interest rates are raised to offset a proportion, α, of the gap between expected inflation and the inflation target in each period.

It is useful to contrast the performance of the forecast-based policy rule in equation **(1)** with a more conventional backward-looking Taylor-type rule for interest rates:

$$i_t = \chi (\pi_t - \pi^*) + \delta (y_t - y^*) + \phi x_t \qquad \textbf{(2)}$$

where y_t is the level of output; y^* denotes potential output; and x_t again denotes a set of other variables.[3] Under this formulation, the path of short-term interest rates depends on realised values of the inflation and output gaps, with weights χ and δ respectively.[4]

The *model* used in the policy simulations is a small, rational expectations macroeconomic model. The model is described in detail in the Appendix, but some of its main features are outlined briefly here. First, the model is open-economy. In the model, the exchange rate serves as an important transmission mechanism for monetary policy, through its effect on net exports and hence output, and through its effect on import prices and hence price inflation.

Second, the model has several forward-looking features. The most important forward-looking variable is the exchange rate, which depends on the expected future path of short-term interest rates, domestically relative to overseas. As these interest rate expectations adjust, the exchange rate 'jumps' in response—as is observed among asset prices in the real world. In the model, all forecasts are formed rationally, in the sense that they are based on all useful information (including knowledge of the model and of the policy rule) and, on average, do not differ systematically from the eventual outcome.

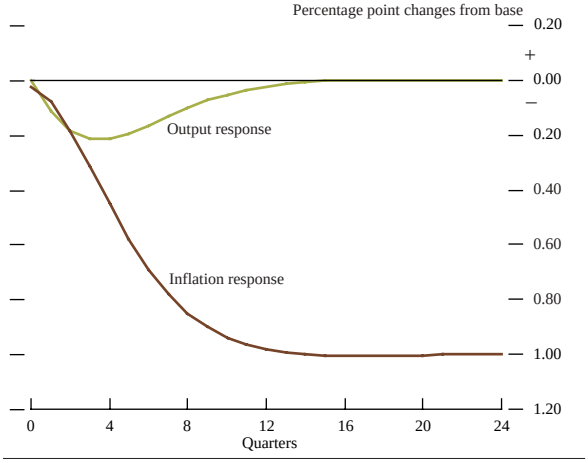
Third, consumer price inflation is also affected by expectations. This derives from forward-looking behaviour on the part of wage-bargainers when setting wages, as wages are a key component of consumer prices. Fourth, consumer price inflation also embodies a substantial degree of inertia or 'stickiness'. This is an important feature of the model. It ensures that the time-series behaviour of inflation mimics that in the real world—which is slow-moving and persistent. Price stickiness ensures that *nominal* monetary shocks have persistent effects on *real* magnitudes, such as output and employment. This is again in line with the real-world behaviour of the macroeconomy.

Finally, inflation inertia also ensures that there are transmission lags between implementing a change in monetary policy and its impact on output and inflation. These monetary transmission lags are a well recognised macroeconomic phenomenon. The model is calibrated in such a way that it matches the lagged and persistent response pattern of output and inflation following a monetary policy disturbance. Chart 1 illustrates the path of inflation and output resulting from a tightening of monetary policy, which aims to reduce inflation by 1 percentage point.

(1) There may be further, theoretical advantages to operating monetary policy according to an inflation forecast. For example, in some models, targeting an inflation forecast is equivalent to the fully-optimal rule (see Svensson (1996, 1997)). It may also help to improve monetary policy credibility by focusing inflation expectations.
(2) Such as lags of short-term interest rates and the expected inflation rate in the next period. The latter term allows us to think of equation **(1)** as defining a path for short-term *real* interest rates. Batini and Haldane (*op cit)* discusses these features.
(3) Which again includes lags of interest rates and the inflation rate expected next period.
(4) In the original Taylor rule, these weights are both equal to 0.5.

Inflation eventually ends up 1 percentage point lower. But the transmission mechanism is fairly slow and protracted. It takes up to two to three years for the new inflation equilibrium to be reached, one side-effect of which is a persisting contraction in output.

Chart 1
Inflation and output response



Turning finally to the *shocks*, these are calibrated using the Bank of England's core forecasting model (August 1997 version).(1) The exception is the exchange rate, where the shocks are the residuals from an uncovered interest parity condition, in turn derived using survey-based measures of exchange rate expectations.

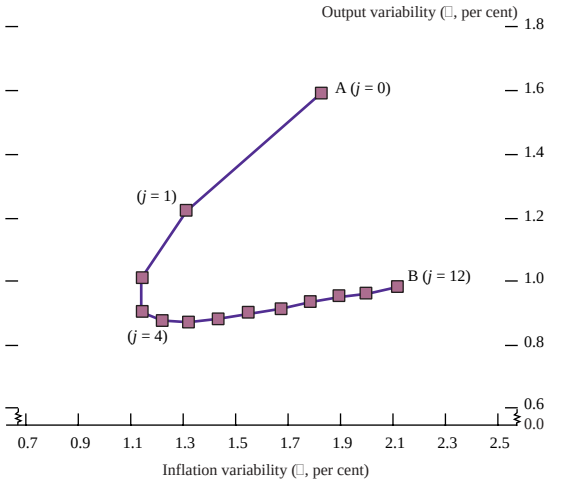
Lags

Lags in the transmission mechanism complicate the inflation control problem for monetary policy-makers. If policy-makers respond to deviations of *current* inflation from target, they will very probably be acting too late to offset effectively any build-up of inflationary pressures, because of these lags. Instead, they need to form and respond to expectations of *future* inflationary pressures, thereby allowing time for monetary policy to take its full effect. This then allows inflationary pressures to be headed off pre-emptively.

Forecast-based policy rules, such as those in equation **(1)**, have such a forward-looking dimension. In particular, they allow the policy-maker to align explicitly the horizon of the inflation forecast and the control lag for monetary policy. This is likely to improve inflation control, because the variable to which monetary policy is responding will also be the variable over which the authorities can exercise some degree of control.

This point can be illustrated using simulations from the macroeconomic model and the policy rule outlined above. Chart 2 shows the results of one particular set of simulations. The variability of inflation is plotted on the vertical axis, and the variability of output relative to trend (the output gap) on the horizontal axis.(2) So points moving to the south-west in Chart 2 signal an improvement in policy performance—lower output and inflation variability—and conversely, points to the north-east signal a worsening policy performance.

Chart 2
Output-inflation volatility frontier



Each point in the chart gives the inflation/output variability pair associated with a simulation of the model under one particular specification of the policy rule. The line AB joins these simulation points. Moving along the locus of points from A to B, the simulations use a policy rule with a progressively more distant inflation forecast horizon. So for example, point A shows the pair of inflation/output variability points associated with the policy rule in equation **(1)** when $j = 0$—that is, when the policy-maker responds only to the current-period inflation rate. The next point along, moving from A to B, is the pair of inflation/output variabilities associated with a policy rule that responds to expected inflation one period ahead ($j = 1$). Because periods in the model are quarters, this is equivalent to responding to the inflation rate expected in the next quarter. For $j = 4$, policy is responding to the inflation rate expected one year (four quarters) ahead, and so on. Point B gives the pair of inflation/output variabilities associated with a policy rule that responds to expected inflation three years ahead ($j = 12$ quarters).

Moving from point A to B, it is clear that lengthening the inflation forecast horizon initially helps to achieve a greater degree of both inflation and output-control; the locus moves to the south-west. The improvement in inflation control is marked, with inflation variability falling by almost 50%, comparing targeting current-period inflation with targeting an inflation forecast six quarters ahead. This is because of transmission lags, which mean that by responding to actual inflation, monetary policy is acting too late. Inflation control is disturbed. By having policy respond to what it is best able to control—

(1) The calibrated model outlined above does not have enough dynamic structure to ensure that its empirically estimated residuals are legitimate measures of original shocks. Using atheoretic time-series or VAR models to construct structural shocks is problematic because of the need to impose identification restrictions to unravel the structural shocks from the reduced-form VAR residuals. That is why shocks from the Bank's core forecasting model were used. The Appendix discusses this in more detail.
(2) Technically, variability is measured here by the square root of the average unconditional variance of each variable across 100 stochastic

future inflation—inflation control can be improved dramatically.

Too distant an inflation forecast horizon can also lead to a worsening of policy performance, however, as Chart 2 illustrates. At inflation forecast horizons much beyond six quarters, inflation variability begins to increase. Monetary policy is, in these situations, doing too little to smooth inflationary shocks. Just as too near a forecast horizon can damage inflation control, so can too distant a horizon. In the model, the optimal forecast horizon lies somewhere in between, at around four to six quarters. This is where monetary policy has its largest impact on inflation; it is the horizon at which the authorities' inflation control is, at the margin, greatest.

Because it is transmission lags that justify basing policy on inflation forecasts, the optimal forecast horizon will clearly depend on the length of these lags. The longer the monetary transmission lag, the further into the future is the optimal forecast horizon. Behavioural shocks that lead to a shortening of the transmission lag, such as a reduction in inflation inertia, ought also to be accompanied by a shortening of the policy horizon if inflation control is not to be upset.

Output

Monetary policy-makers in practice typically take account of output as well as inflation fluctuations in setting monetary policy. For example, the Bank of England Act 1998 states that the Bank's objectives shall be: '(a) to maintain price stability; and (b) subject to that, to support the economic policies of the government, including its objectives for growth and employment'. Similar provisions can be found in the statutes of the European Central Bank in the euro area, and of the Federal Reserve Board in the United States under the Humphrey-Hawkins Act.

On the face of it, an inflation forecast based policy rule, such as equation **(1)**, appears to take no explicit account of output objectives; it responds only to expectations of future inflation. As Chart 2 illustrates, however, this impression is misleading. By altering the horizon of the inflation forecast, policy rules such as equation **(1)** can influence the variability of output in the economy.

For example, according to Chart 2, lengthening the forecast horizon from zero (current-period inflation targeting) to four periods (one year ahead inflation-forecast targeting) causes output variability to roughly halve. The reason for this is that, at these more distant horizons, monetary policy has a more pronounced impact on inflation; the transmission lags have worked their way through. Because of its greater impact, monetary policy has to adjust less to offset a given inflationary shock. Touches on the brake and accelerator can afford to be lighter. This smaller adjustment in policy in turn minimises the extent to which output needs to be destabilised following an inflation shock.

It is interesting to ask whether inflation forecast based rules could be improved by responding explicitly to output, rather than implicitly through the inflation forecast. Simulations from the model suggest that the gains in output stability from doing this are very small. Policy rules that respond only to inflation forecasts appear capable of synthetically recreating a similar degree of output stability to rules with explicit output terms in them. Certainly, the absence of output terms from an inflation forecast based rule does not in any way suggest a greater degree of output variability or a greater disregard for output objectives on the part of the policy-maker.

Information

It is well known from optimal control theory that the optimal policy rule responds to all variables that offer useful information on the target variables of policy. To behave otherwise would be to restrict arbitrarily the information set of the policy-maker. Because they respond to only a subset of the available information, simple policy rules, such as the Taylor rule, are very likely to be inefficient by comparison with the fully optimal rule. Forecast-based rules are also likely to be inefficient for the same reason—they are simple and hence restrictive in their use of available information.(1)

But there are good reasons for believing that forecast-based policy rules, although simple, may not be as restrictive and inefficient as other types of simple rule, such as the Taylor rule. An inflation forecast is formed using all information that is useful for predicting future inflation. That is, for example, how the forecasts published in the Bank of England's *Inflation Report* are constructed. This means that even an apparently simple, forecast-based rule is implicitly responding to a wide and complex array of macroeconomic variables. The inflation forecast is simply serving as a summary statistic for this information. It is for this reason that forecast-based rules, though not as efficient in general as the fully optimal rule, may tend to be more efficient than other types of simple, backward-looking rule.

Table A illustrates these points quantitatively. The set of rules is listed in the first column. They include the fully optimal rule; a variety of forecast-based policy rules, as in equation **(1)**, for a range of values of the forecast horizon j, setting the feedback parameter $\alpha = 0.5$; and a variety of Taylor-type rules, as in equation **(2)**, for a range of values of χ and δ.(2) The second, third and fourth columns give the variability (standard deviation) of inflation, output and short-term interest rates associated with each of these rules. The final column gives an aggregate measure of the policy-makers' welfare, by weighting together (somewhat arbitrarily) the variabilities in the second, third and fourth columns.(3)

(1) Except when using a specific kind of inflation forecast targeting rules, discussed in Svensson (*op cit*).
(2) Omitting lags of short-term interest rates.
(3) Output and inflation variabilities are equally weighted, while short-term interest rate variability is given a weight of one fifth this amount. The qualitative conclusions are not particularly sensitive to this choice of weights.

Comparing optimal, inflation forecast based and Taylor rules

	Standard deviation of:			Welfare loss
	output	inflation	interest rate	
Optimal rule	0.78	1.10	1.03	41.83
Inflation forecast based rules				
{$j = 0$}	1.52	1.19	0.92	76.37
{$j = 3$}	1.07	1.17	0.61	52.61
{$j = 6$}	0.91	1.34	0.51	54.18
{$j = 9$}	0.94	1.57	0.40	68.04
Taylor-type rules				
{$\chi = 0.5, \delta = 0.5$}	1.05	1.38	0.55	61.96
{$\chi = 0.5, \delta = 1$}	0.92	1.46	0.72	61.97

By definition, the lowest welfare loss comes from the fully optimal rule. It delivers both lower output and inflation variability than virtually all of the other rules. It is also, however, by far the most complicated of the rules considered in the table, responding to all variables in the model. As a result, the fully optimal rule would probably be impractical. It would be very difficult for the general public to monitor or understand effectively.

All of the simple forecast-based rules perform somewhat worse than the optimal rule. Welfare losses are around 30% higher, even though certain rules are capable of matching the performance of the optimal rule on specific criteria—for example, in reducing inflation variability. However, these simple forecast-based rules perform favourably compared with simple Taylor rules. For example, the best-performing Taylor rule delivers a welfare loss around 50% greater than the fully optimal rule. This is evidence of the greater information-efficiency of simple forecast-based policy rules compared with simple backward-looking rules. By responding, albeit implicitly, to a wider range of information variables, a forecast-based rule is able to deliver a greater degree of both output and inflation stability.

Conclusion

Hypothetical interest rate rules for monetary policy have attracted considerable recent interest. But most such rules have tended to be based on current values of macroeconomic variables, such as output and inflation. So these hypothetical rules contrast somewhat with monetary policy behaviour in the real world, which tends to have a more forward-looking, forecast-based dimension.

Policy rules that respond to forecasts of future inflation seem to perform well in quantitative simulations. These rules encompass, and can hence better control for the effects of, monetary transmission lags. They can ensure a suitable degree of output-smoothing. And they ensure that policy is responsive to most available information. These features allow better inflation and output control. The performance of hypothetical forecast-based policy rules offers support for the policy practice of basing monetary policy on forecasts of inflation and output, as is currently the case in the United Kingdom.

Appendix

To assess the performance of rules **(1)** and **(2)** above, we used a small, dynamic open-economy linear rational expectations model. This Appendix offers a brief description of the model's structure, properties, and calibration.(1)

The model

The model comprises four behavioural equations. Removing the constants in each equation and normalising to zero potential output and foreign variables, so that all variables represent deviations from equilibrium, the model can be expressed as:

$$y_t = \delta_1 y_{t-1} + \delta_2[i_{t-1} - E_{t-1}\pi_t] + \delta_3 q_{t-1} + e_{ISt-1} \qquad \textbf{(1A)}$$

$$m_t - p_t = \beta_1 y_t + \beta_2 i_t + e_{LMt} \qquad \textbf{(2A)}$$

$$\pi_t = \varphi_0 E_t \pi_{t+1} + (1 - \varphi_0)\pi_{t-1} + \varphi_1[y_t + y_{t-1}] + \mu[(1 - \varphi_0)\Delta q_t - \varphi_0 E_t \Delta q_{t+1}] + e_{\pi t} \qquad \textbf{(3A)}$$

$$E_t \Delta q_{t+1} + E_t \pi_{t+1} = i_t + e_{UIPt} \qquad \textbf{(4A)}$$

where y_t is output, m_t is nominal money, q_t is the real exchange rate, π_t is inflation, i_t is the nominal interest rate, and where Δ is the first-difference operator (thus in equation **(3A)**, $\Delta q_t = q_t - q_{t-1}$). Note that in equations **(3A)** and **(4A)**, $E_t \pi_{t+1}$ denotes expected inflation where E_t is the rational expectations operator. e_{ISt-1}, e_{LMt} , $e_{\pi t}$, and e_{UIPt} are disturbance terms or 'shocks', whose properties are described below.

Equation **(1A)** is the *IS* equation. Output (y_t) responds to the previous period's values of the real interest rate and the real exchange rate. The real interest rate has a negative direct effect on output ($\delta_2 < 0$) as higher rates depress expenditure, and an appreciation of the real exchange rate (ie a decrease in q_t) produces a decline in output ($\delta_3 > 0$), by reducing net exports. Equation **(1A)** indicates that output also depends on its lagged value (with coefficient $1 > \delta_1 \geq 0$). So output is predetermined, and monetary policy cannot affect current output. e_{ISt} is a vector of demand shocks.

Equation **(2A)** is the model's LM curve. Its arguments are conventional: a nominal interest rate, capturing portfolio balance ($\beta_2 < 0$); and real output, capturing transactions demand ($\beta_1 > 0$). e_{LMt} is a vector of velocity shocks.

Equation **(3A)** is a supply curve. It is the open-economy analogue of Fuhrer and Moore's (1995) Phillips curve specification (see Blake and Westaway (1996)).(2) The inflation terms—a weighted backward and forward-looking average—are the same as in the closed-economy case. There is some degree of inflation persistence (with weight φ_0), and some degree of forward-looking behaviour (weight $1\text{-}\varphi_0$). The weights sum to unity, so that the Phillips curve is vertical in the long run. Prices also depend on the output gap, reflecting demand pressures. The inflation specification contains, in addition, (real) exchange rate terms, reflecting the price effects of exchange rate changes on imported goods in the consumption basket. Consequently, the monetary transmission mechanism that links the interest rate to inflation works through two channels in the model. There is a direct price channel—operating via the cost of imports, and an indirect real interest rate channel—affecting inflation via the output gap.

Equation **(4A)** is an uncovered interest parity condition.(3) We do not include any explicit foreign exchange risk premium. The shock vector e_{UIPt} comprises foreign interest rate shocks and other noise in the foreign exchange market, including shocks to the exchange risk premium.

Model **(1A)**–**(4A)** is forward-looking in two ways. First, the uncovered interest parity condition is forward-looking, capturing conventional forward-looking behaviour in asset markets. In addition, the inflation equation is also forward-looking, reflecting forward-looking wage-bargaining behaviour. The parameters δ_1 and φ_0 jointly govern the overall degree of forward-looking behaviour in the model.

Calibration

The model is calibrated on UK data. For the calibration, we set $\delta_2 = -0.5$ (the real interest rate elasticity), and ($\delta_3 = 0.2$) (the real exchange rate elasticity), in line with previous empirical estimates of *IS* curves. For the money demand equation, we set $\beta_1 = 1$ and $\beta_2 = -0.5$, so that money is unit income-elastic and has an interest semi-elasticity of minus a half, in line with empirical findings based on UK data in Thomas (1996).

On the supply side, φ_0 is set equal to 0.2, which makes inflation predominantly backward-looking. This assumption appears to be more plausible empirically than an equally weighted backward and forward-looking inflation formulation ($\varphi_0 = 0.5$), both in the United States

(1) See Batini and Haldane (1999) (*op cit)* for a more detailed description.
(2) This specification can be derived as the reduced form of a three-equation wage-price system. See Blake and Westaway (1996), Batini and Haldane (1999) *op cit*.
(3) With the foreign interest rate normalised to zero.

(Fuhrer (1997)) and the United Kingdom (Blake and Westaway (1996)). Finally, φ_1 (the output sensitivity of real wages) is set at 0.2, in line with previous studies.

Shocks

A necessary step in generating impulse response functions is specification of the structural relationship between the various shocks. We assume that the innovations to these shocks behave in a recursive manner, in the order $(e_{IS t\text{-}1} \rightarrow e_{UIP t} \rightarrow e_{\pi t})$.[1]

Simulation of the model requires values for the standard deviation of the equations' disturbances. We set the standard deviation of the *IS*, aggregate supply and money demand innovations, $e_{IS t\text{-}1}$ and $e_{\pi t}$, and $e_{LM t}$ equal to the estimated residual standard deviation from the output, earnings and money demand equations from the Bank of England's core forecasting model (for the sample period 1989 Q1–97 Q3). The standard deviation of the uncovered interest parity shocks is estimated by generating a $\{e_{UIP t}\}$ sequence from equation **(4A)**, using survey data on exchange rate expectations.

(1) Money demand shocks are unimportant because they are fully accommodated under an interest rate rule.

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The yen/dollar exchange rate in 1998: views from options markets

By Neil Cooper and James Talbot of the Bank's Monetary Instruments and Markets Division.(1)

1998 was a period of unprecedented volatility for the yen/dollar exchange rate. To help to assess market participants' views on exchange rate developments, the Bank of England uses a range of techniques that employ information from the over-the-counter (OTC) currency options markets. This article describes these techniques and shows how they can be used to assist our understanding of market perceptions of the yen/dollar exchange rate over this period.

Introduction

The exchange rate for the Japanese yen against the US dollar fluctuated widely during 1998, as shown in Chart 1. The yen depreciated from ¥131 on 1 January to ¥147 on 11 August, an eight-year low against the dollar.(2) But it then appreciated by 14% on 6–8 October, reaching ¥111. The yen/dollar rate ended the year at ¥114 intraday.

Chart 1
Yen vs dollar exchange rate during 1998

The appreciation of the Japanese yen on 6–8 October was its largest two-day move since it began to float in February 1973, as a result of the collapse of the Bretton Woods agreement. Prior to this appreciation, US interest rate expectations had been declining since the Federal Reserve's interest rate cut on 29 September: the March 1999 three-month eurodollar futures contract suggested that investors were expecting a further fall of 50 basis points before expiry. As the yen began to appreciate, the unwinding of large yen 'carry trades'(3) exacerbated its rise. Some market comment at the time suggested that the moves were not expected to persist. We describe below what we can infer from derivatives markets about these expectations.

There were also two major interventions by the monetary authorities to support the yen in 1998. On 9 April, the Japanese government announced the largest-ever fiscal package, comprising ¥12 trillion of spending and ¥4 trillion of tax cuts. This was followed by intervention by the Bank of Japan later in the day. On 10 April, a bank holiday for most Western markets, the Bank of Japan intervened again; the yen appreciated against the dollar from ¥132 to ¥128 during Tokyo trading, but fell back over the next few days to its pre-intervention level. The second major intervention to support the yen was conducted in conjunction with the US Federal Reserve on 17 June. The yen appreciated from ¥143 to ¥137 on the day, but by 25 June was back at ¥142.

This article describes the techniques used by the Bank of England to extract information from foreign exchange options traded on the over-the-counter (OTC) market. It also demonstrates how information from these options can be used to investigate market views, addressing a number of questions of interest to central banks and other policy-makers, including:

- did options markets predict the possibility of any of these dramatic movements in yen/dollar?
- following the large shifts in the exchange rate, was volatility expected to persist?
- did the correlation between movements in the dollar and the yen change substantially over the year?
- were the intervention episodes successful in changing market views about the short-run path of the yen/dollar exchange rate?

Extracting information from options prices

A wide range of financial instruments can be employed to infer market expectations of future levels of interest rates, exchange rates, inflation rates and commodity prices. But though assets, such as bonds and futures, can be used to extract point estimates for the expected future values of these variables, option prices can provide us with a

(1) Andy Bowen provided excellent programming assistance.
(2) The market convention for quoting the yen/dollar exchange rate is in terms of the number of yen per dollar. Thus an increase in the exchange rate represents a depreciation (appreciation) of the yen (dollar).
(3) A 'carry trade' is where an investor borrows money in yen at low Japanese interest rates and then invests this money in dollars at a higher interest rate; it is possible to make large profits if the yen does not appreciate.

fuller picture of how the market views their future evolution. The most common and straightforward use of option prices is the calculation of implied volatility via the classic Black-Scholes (1973) model. Implied volatility is a measure of the degree of uncertainty that the market attaches to the returns on an asset. It is also possible to estimate the complete probability distribution for the future price of an asset and, for exchange rates, to calculate implied correlations between currencies.(1) All three of these measures are now used regularly by the Bank of England to analyse currency movements.

Much of the Bank's work on extracting information from options has focused on price information from the exchange-traded markets, particularly from the London International Financial Futures and Options Exchange (LIFFE). For foreign exchange options, however, liquidity is highest on the interbank or OTC markets. According to the recent triennial survey of foreign exchange and derivatives markets conducted by the Bank for International Settlements,(2) the average daily turnover of currency options on the OTC market was $87 billion worldwide, compared with an average daily turnover on the exchanges throughout the second quarter of 1998 of only $1.9 billion.(3) The main advantage of using OTC market data is the greater liquidity of the market; it also provides quotes on a wider range of exchange rates. But the OTC market has different ways of quoting prices, which require different methods for extracting information such as implied distributions.

Deriving measures of uncertainty

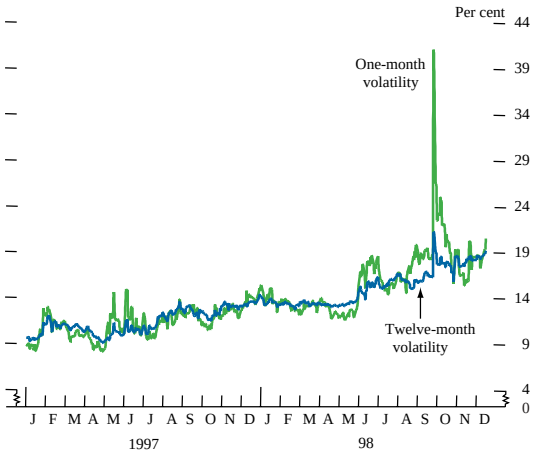
In the Black-Scholes model,(4) European-style(5) currency options prices are determined by:

- the current spot rate;
- domestic and foreign interest rates;
- the maturity of the option;
- the strike price of the option; and
- the volatility of the underlying exchange rate.

Except for the volatility of the exchange rate, all of these variables are directly observable. Hence, for any given option price, it is possible to calculate the volatility implied by the Black-Scholes formula. This concept of implied volatility is widely used within options markets, and corresponds to the standard deviation of annualised returns. In fact, within the OTC foreign exchange options market, dealers typically give a quote in terms of implied volatility. Both participants to a trade know that to calculate the cash price, they apply this volatility to the Black-Scholes formula. This enables options traders to compare prices offered by different market-makers at different points in time without having to worry about changes in the underlying spot exchange rate affecting the quote. These implied volatility quotes are readily available from market-makers' screens, on services such as *Bloomberg* and *Reuters*.(6)

Implied volatility is a measure of the uncertainty that the market attaches to future movements in the exchange rate over the remaining life of the option. By constructing a time series of implied volatility quotes, it is possible to track this uncertainty over time. Chart 2 shows one and twelve-month implied volatility for yen/dollar. Short-run uncertainty had been rising since the start of 1997, and increased further with the onset of the Asia crisis. But the unprecedented appreciation of the yen in early October triggered an even larger increase: one-month implied volatility reached 41%—more than double the previous high—following the move. Was this volatility anticipated in options markets? And was it expected to persist?

Chart 2
Yen/dollar implied volatility

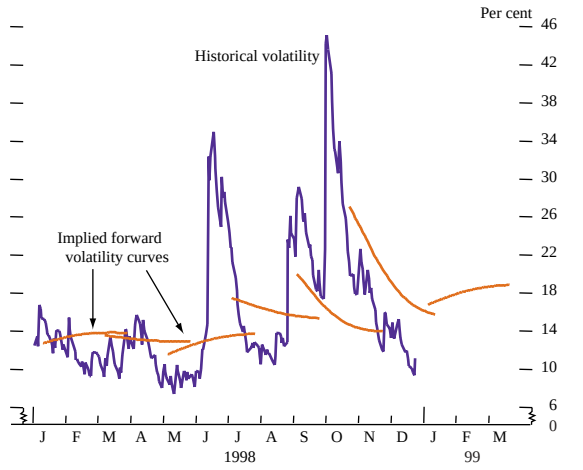


By examining the implied volatilities of options for a range of maturities, it is possible to calculate forward volatility curves. These indicate how the market expects short-term volatility to change over each period of time, and allow us to examine issues such as whether volatility is expected to persist following a particularly turbulent time in the markets.(7) Chart 3 shows a time series of historical

(1) For more details on how implied probability density functions and implied exchange rate correlations are used by monetary policy-makers, see Bahra, B 'Probability distributions of future asset prices implied by option prices' *Bank of England Quarterly Bulletin*, August 1996, pages 299–311, and Butler, C and Cooper, N 'Implied exchange rate correlations and market perceptions of European Monetary Union', *Bank of England Quarterly Bulletin*, November 1997, pages 413–23.
(2) Details of this survey can be found in Thom, J, Paterson, J and Boustani, L 'The foreign exchange and over-the-counter derivatives markets in the United Kingdom', *Bank of England Quarterly Bulletin*, November 1998, pages 347–60.
(3) See 'International Banking and Financial Market Developments', *BIS Quarterly Review*, November 1998, Table 19A.
(4) The actual model used is the Garman-Kohlhagen (1983) pricing model, which adapts the Black-Scholes model to price currency options.
(5) European-style options can only be exercised at their maturity. (American-style options, by contrast, can be exercised at any time until they expire.)
(6) In this article, we use daily data from the *Chase Manhattan FX Options* pages on Reuters for the analysis of movements in yen/dollar in 1998. For more distant time horizons, we use implied volatility data provided by Citibank and NatWest Markets.
(7) One criticism of using implied volatility quotes in this way is that the Black-Scholes model assumes constant volatility. Hence, it is inconsistent to use volatilities implied by this model to infer views about how volatility has changed and is expected to change. But this practice may be justified in a number of ways. First, Heynen, Kemna and Vorst (1994) showed that for a variety of alternative stochastic models that encompass changing volatility, the Black-Scholes implied volatility is an extremely accurate measure of the *average* expected volatility over the lifetime of the option. So although we know that the Black-Scholes model is misspecified, we also know that the volatilities calculated using it may still be regarded as a measure of the volatility expected on average over the remaining lifetime of the option. Second, the method we use to calculate market-derived 'forward' volatility forecasts, using Black-Scholes quotes, is explicitly based upon a model that incorporates stochastic volatility. Campa and Chang (1995) showed that these forward volatilities derived from the OTC FX options market were an unbiased estimate of future short-maturity implied volatilities.

volatility[1] for the yen/dollar exchange rate since the beginning of 1998. This measures the actual exchange rate volatility that occurred, rather than the volatility implied by options prices. The chart also incorporates a set of forward implied volatility curves generated at different points in time. These forward implied volatility curves indicate how short-term volatility is expected to evolve over the following three months. As can be seen from the chart, when volatility has been particularly high, it is expected to revert back to lower levels. This reversion of volatilities is also suggested by the fact that twelve-month implied volatility often lies below one-month implied volatility when the latter is particularly high, as in October 1998. But the forward curves use quotes across a wider range of maturities to infer a more detailed picture of how short-maturity volatility is expected to evolve.

Chart 3
Historical volatility and forward implied volatility curves for yen/dollar



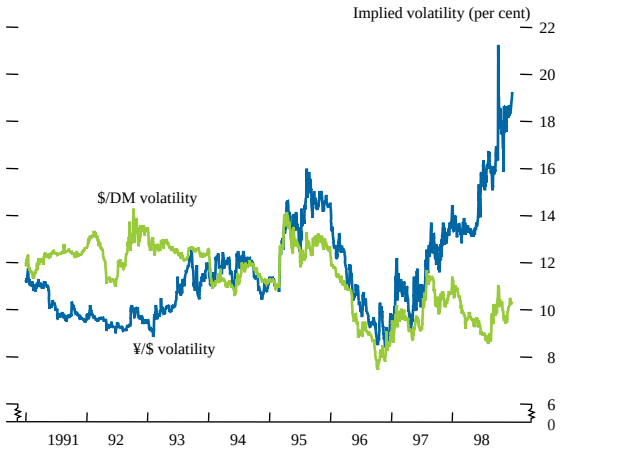
These forward volatility curves indicate that the market did not expect the increase in volatilities in October 1998. Although volatility had increased throughout the summer, the forward volatility curve suggested that it would fall back towards previous levels. After the dramatic events of 6–8 October, volatility was expected to drop rapidly, but to remain at historically high levels for some months to come. By the end of the year, the forward curves were flat, but were predicting much higher volatility in the first quarter of 1999 than for the same period of 1998.

Market expectations of the co-movement of currencies

A second source of information can be derived by exploiting the three-way relationship between the exchange rates of any three currencies to calculate implied correlations.[2] This indicates how the market expects any two currencies to move together against a third currency acting as a numeraire. One use of this technique in the Bank has been to measure the degree of convergence between European currencies in the run-up to the start of EMU. But it can also be used to examine expectations of large changes in the relationship between any two currencies such as the dollar and the yen, using a third currency as numeraire.

The two most actively traded currency pairs in the UK OTC options market in 1998 were yen/dollar and dollar/Deutsche Mark.[3] Chart 4 shows a time series of twelve-month implied volatility for both of these currency pairs from 1991–98. After the period between 1991 and mid 1993 when dollar/Deutsche Mark implied volatility was higher than yen/dollar, the two series tracked each other closely until mid 1997, when they began to diverge. During 1998, yen/dollar twelve-month implied volatility rose from 13.7% to 19.3%, whereas dollar/Deutsche Mark implied volatility fell slightly from 10.8% to 10.4%.

Chart 4
Yen/dollar and dollar/Deutsche Mark twelve-month implied volatility



It is difficult to assess whether an upward movement in the implied volatility associated with one currency pair is the result of special factors applying only to those economies, or is caused by a global increase in uncertainty. From Chart 4, it would appear that Japan-specific factors may have been driving the rise in volatility in the yen/dollar exchange rate since mid 1997. But the implied volatilities of all four major currency pairs in the UK OTC market[4] rose shortly after the announcement of the Russian debt moratorium on 17 August. If we want to infer what was driving the relationship between dollar and yen during this period, and what might happen in the future, we can remove the effect of a general rise in uncertainty by using implied correlation measures.[5] Chart 5 shows the implied correlation between the yen and the dollar using the Deutsche Mark as numeraire.

Until mid August, we observe an inverse relationship between the implied volatility of yen/dollar and the implied correlation of yen/Deutsche Mark and

(1) This is calculated as an exponentially weighted moving average (EWMA) of squared daily returns.
(2) How these implied correlations are derived and how they have been used at the Bank to analyse FX movements is described in Butler and Cooper (1997), *op cit.*
(3) See the Bank of England's 1998 survey of turnover in the UK foreign exchange and OTC derivatives markets, *op cit.*
(4) The Bank's 1998 survey lists these as DM/¥, $/DM, £/DM and £/$.
(5) If all implied volatilities rise by the same proportion, the implied correlation measure remains unchanged.

Chart 5
Twelve-month implied volatility of ¥/$ vs twelve-month implied correlation of DM/¥ and DM/$

Deutsche Mark/dollar: the implied correlation fell as yen/dollar volatility rose. To the extent that the expected volatility of a currency pair is related to economic fundamentals, this is consistent with market participants becoming more uncertain about prospects for the Japanese economy. The relationship broke down after that date: the subsequent rise in yen/dollar volatility could be attributed to the global rise in uncertainty following the announcement of the Russian debt-rescheduling programme. But after the dramatic appreciation of the yen in early October, the previous pattern was re-established. The rise in the implied volatility represented a fall in the degree of expected co-movement of the dollar and the yen. By the end of 1998, it would appear that options traders were expecting a weak link between the performance of the dollar and yen against the euro during 1999.

Deriving probability density functions

The techniques described above use information derived from at-the-money options, ie where the strike price(1) is equal to the current forward rate. By comparing options with different strikes under the assumption that investors are risk-neutral, it is possible to infer the probabilities that the market attaches to different levels of the future spot rate. The OTC market for foreign exchange options has developed ways of quoting prices that differ from exchange-traded options markets. On the exchanges, prices are quoted for a range of exercise prices, for both call and put options. By contrast, on the OTC market, prices are quoted using the terminology of the Black-Scholes model. Furthermore, instead of a wide range of strikes, we receive only three types of price quote for European-style options: 'at-the-money (ATM) implied volatility'; the 'risk reversal'; and the 'strangle'. The box on page 72 explains what these quotes represent and how they are interpreted. We describe below how it is possible to infer from these the risk-neutral probabilities that market participants attach to different outcomes for the future exchange rate.

As explained in the box, these three market quotes can give us some measure of the uncertainty attached to the future exchange rate, and the balance of risks of a large appreciation versus a large depreciation. But it would be useful to be able to see more directly the probabilities attached to different levels of the exchange rate implied by the option prices. This is the idea behind calculating an implied probability density function (PDF).

Breeden and Litzenberger (1978) derived the result that the underlying probabilities attached to different levels of the underlying asset price may be derived from option prices, if one assumes that investors are risk-neutral. In technical terms, Breeden and Litzenberger infer underlying probabilities from a set of option prices by calculating the second partial derivative of the call price function(2) with respect to the strike price. Because we have only a very limited number of option prices derived from the OTC market, we have to undertake extensive interpolation and extrapolation to derive enough prices to utilise this result. The Technical Appendix explains how we do this and gives an illustrative example.

But to see intuitively why we would expect the prices of options to reflect these probabilities, suppose that we observe a set of European-style call options prices with the same maturity but with different strike prices. A call option with a lower strike will always be worth more than a higher strike option. This reflects both the fact that the lower strike option will have a higher pay-off if exercised, and the additional probability that it will end up 'in the money' (ie with intrinsic value). This additional probability reflects the chances that the exchange rate will lie between these two strikes. If we have a wide range of strikes, it ought to be possible to infer what the probabilities lying between each of the strike prices are, by examining the relative prices of options with adjacent strikes.

Suppose that we have three options with adjacent strikes, and form a portfolio consisting of a long position in the first (lowest strike) and third (highest strike) options, and a short position in two of the middle strike options. This portfolio has a triangular-shaped pay-off, which will only be positive if the exchange rate ends up between the first and third strike prices. The value of this portfolio depends directly on the probability that the market attaches to the exchange rate being in the range covered by the first and third strikes at their maturity. If we could form a number of these portfolios, each made up of options with close exercise prices, then we could work out the probabilities attached to all the different possible future levels of the exchange rate. This is the underlying idea behind Breeden and Litzenberger's result.

Why is the assumption of risk-neutrality necessary? Because options are priced using a risk-neutral probability distribution, the distribution inferred from options prices

(1) The strike (or exercise) price is the price at which the buyer of the option has the right to buy (for a call option) or sell (for a put option) the underlying asset.
(2) The call price function relates the prices of options to their underlying parameters, such as maturity, underlying asset price and strike price.

How OTC market quotes can be used to infer information about expected future currency movement

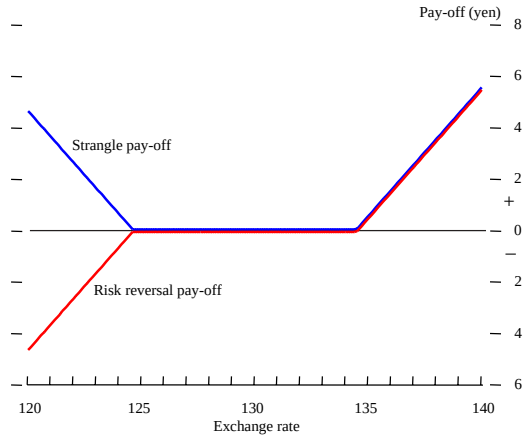
Although the Black-Scholes model is widely used within options markets, few market participants agree with its assumptions. The most contentious of these is that the future exchange rate is lognormally distributed. If this were true and the Black-Scholes model were a correct description of the world, then implied volatility would be the same for all options irrespective of their strike price. But when implied volatilities are calculated for options with the same maturity but with differing strike prices, it is invariably found that the implied volatility depends on the strike price. In practice, the market typically attaches higher probabilities to large movements, and may attach a higher probability to a large movement in a particular direction, than is assumed by the model. This is reflected in options prices and their implied volatilities. This relationship between the implied volatility and the strike price of options is termed the 'volatility smile', so-called because of its typical shape. In practice, traders merely use the Black-Scholes model as a convenient device for quoting prices in terms of implied volatilities, which they adjust according to the strike price and maturity of the option. How they do this yields insights into the probabilities that they attach to alternative future levels of the spot exchange rate.

Much of the trading in OTC currency options consists of trading in at-the-money (ATM) options where the strike price equals the forward rate. Quotes are also available for two types of combinations of out-of-the-money (OTM) options: the 25-delta 'risk reversal' and the 25-delta 'strangle'. The 'delta' of an option is the rate of change of its price with respect to changes in the underlying spot exchange rate. Instead of quoting exercise prices directly, the convention in the foreign exchange options market is to quote prices for options with particular deltas. Like the practice of quoting implied volatilities, the rationale for this is to allow comparison of quotes without needing to take into account changes in the underlying exchange rate. The more OTM that an option is, the lower the delta. When referring to the delta of options, market participants also drop the sign and the decimal point of the delta. So for example, an OTM put option with a Black-Scholes delta of -0.25 is referred to as a 25-delta put.

The 25-delta risk reversal quote is a combination of a long position in a 25-delta call option and a short position in a 25-delta put option. Its pay-off is shown in Chart A. It is usually quoted as the difference in the implied volatilities of the two options. For example, if the 25-delta call option was quoted at 11% and the 25-delta put option was quoted at 9%, the risk reversal would be quoted at 2%. When, as in this example, the risk reversal is positive, it means that an OTM call is more expensive than an equally OTM put (compared with what would be predicted by the Black-Scholes model).

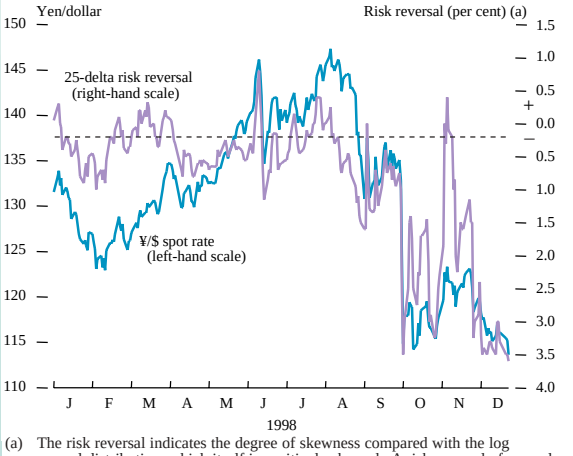
The risk reversal can be used to assess how the market sees the balance of risks between a large appreciation and a large depreciation in the exchange rate. When the risk reversal is large and positive, it suggests that higher probabilities are attached to large appreciations (of the dollar in this case), and when it is large and negative, it indicates expectations skewed in favour of a large depreciation. Chart B below gives a time series of the one-month 25-delta risk reversal against movements in the spot rate. But it is difficult to infer from the risk reversal exactly how much expectations of the future exchange rate are skewed in favour of large movements in any particular direction.

Chart A
The pay-offs to 25-delta risk reversals and strangles



The strangle is also a combination of 25-delta options. But this time, it is a long position in both an OTM call and a put. It is quoted as the average of the two OTM options' volatilities minus the ATM volatility. So for example, suppose that the volatilities of the OTM call and put are 11% and 9% respectively, but the ATM volatility quote is 9.5%. The strangle quote will be equal to 0.5%. When the strangle is positive, this indicates that the OTM options are more expensive than the Black-Scholes benchmark model would suggest. This implies that there are higher probabilities attached to large movements of the exchange rate in either direction than dictated by the log normal distribution underlying the Black-Scholes model. This is indicative of a 'fat-tailed' distribution for the expected future exchange rate, or what is termed 'excess kurtosis'.

Chart B
¥/$ spot rate and one-month 25-delta risk reversal



(a) The risk reversal indicates the degree of skewness compared with the log normal distribution, which itself is positively skewed. A risk reversal of around -0.2 (represented by the horizontal line) is consistent with a symmetric distribution.

must also be risk-neutral. This distribution is the set of probabilities that economic agents would attach to the future exchange rate in a world in which they were risk-neutral. If they are risk-averse, any exchange rate risk premia will drive a wedge between the probabilities inferred from options and the true probabilities that agents attach to alternative future exchange rates. In particular, the mean of the risk-neutral distribution (the forward rate) will not equal the expected spot rate. Though we recognise that this bias may exist, we assume in the rest of this article that the qualitative shape of the risk-neutral distribution matches that of the true distribution held by market participants.

Using implied distributions to assess market reaction to developments in yen/dollar throughout 1998

Chart 6 shows how the one-month PDF for the yen/dollar exchange rate moved during 1998. The vertical lines show the expected value of the spot rate one month forward.(1) Variance increased, but the most noticeable difference is in the skewness measure.(2) At the beginning of the year, the yen/dollar PDF exhibited a slight positive skew,(3) suggesting that the markets attached more weight to a sharp upward movement (yen depreciation) than to a sharp downward movement (yen appreciation). By the end of the year, the distribution was negatively skewed, reflecting a shift in the perception of the balance of upside and downside risks. Not surprisingly, three-month PDFs have higher variance: as we look further ahead, agents become more uncertain about the expected future path of the spot exchange rate. The three-month distribution on 2 January was positively skewed. The yen had been depreciating continuously for six months, and agents were probably expecting this trend to continue. But by the end of the year, the three-month PDF exhibited a mild negative skew. This is consistent with the recovery of the yen during 1998 Q4.

To what extent did movements in PDFs anticipate or reflect the extreme movements in the spot rate? Here we consider three episodes during 1998: the sharp appreciation of the yen from 6–8 October, and the two major interventions in support of the yen on 10 April and 17 June. Analysis of PDFs for 6 and 9 October (see Chart 7) shows that on 6 October, agents were not expecting a sharp appreciation of the yen. The one-month PDF was almost symmetric; less than 5% probability was attached to a forward rate of below ¥120, although two days later, the spot rate had fallen to ¥114. The probability on 6 October of the three-month forward rate lying below ¥120 was higher, at l5%. But this reflected the higher variance: the PDF was actually positively skewed, suggesting a relatively higher probability of future outcomes in the upper tail of the distribution—a large yen depreciation—than in the lower tail.

The one-month PDF for 9 October was much wider than for 6 October, reflecting greater uncertainty about the future level of the exchange rate. The mean shifted from ¥132 to

Chart 6
One-month PDFs for yen/dollar on 2 January 1998 and 31 December 1998

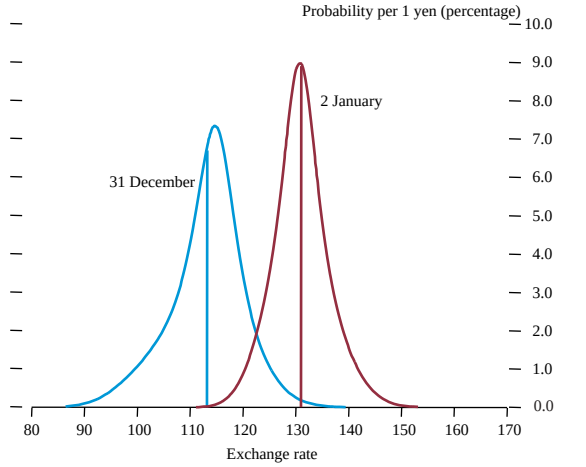
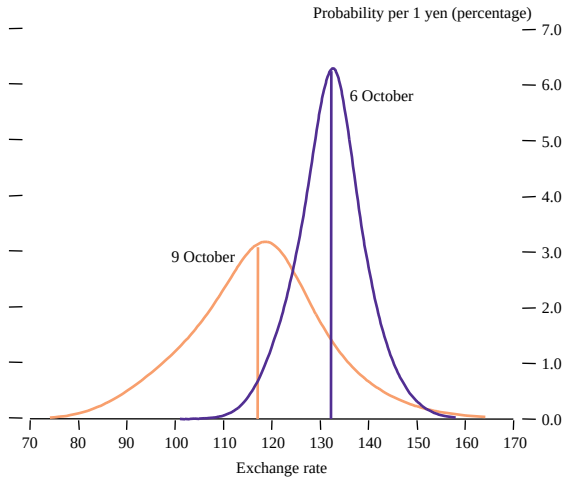


Chart 7
One-month PDFs for yen/dollar on 6 October 1998 and 9 October 1998



¥117, a similar magnitude to the fall in the spot rate. The distribution changed from having a slight positive skew to a negative skew. This is consistent with one view that after such a sharp depreciation of the dollar, further large downward moves in the yen/dollar rate, rather than a large appreciation, were to be expected in the short term. A similar pattern was observed for three-month PDFs on the same days, but here the change in skewness was even more pronounced.

An event study can also tell us something about the impact of foreign exchange intervention on short-run market expectations, particularly if the intervention is taken as a signal of a shift in future government policy. This should be picked up by the options that we study here. Interestingly, the qualitative shape of the PDFs does not change much on either date. Chart 8 shows the three-month PDF before and after the first intervention on 9–10 April. When the Bank of Japan intervened, the forward rate fell by a similar

(1) This is very similar to the means of three-month PDFs calculated on the same days.
(2) Here we use a variant of the Pearson skewness measure, where skewness = (mean - median)/standard deviation.
(3) Foreign exchange PDFs are usually fairly symmetric. Other PDFs used by the Bank for short interest rates or equity indices often exhibit dramatic positive or negative skewness, or even bi-modality.

Chart 8
Three-month PDFs for ¥/$ on 9 April 1998 and 14 April 1998

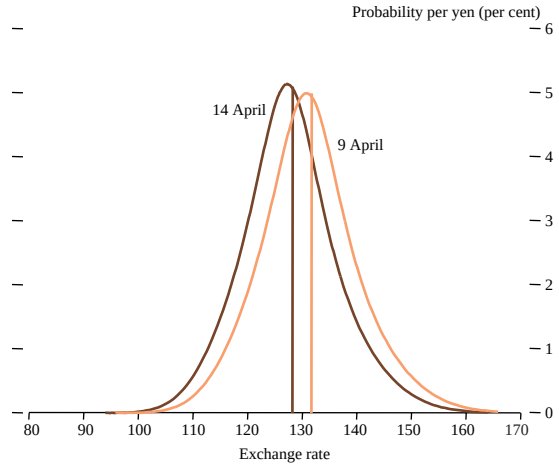
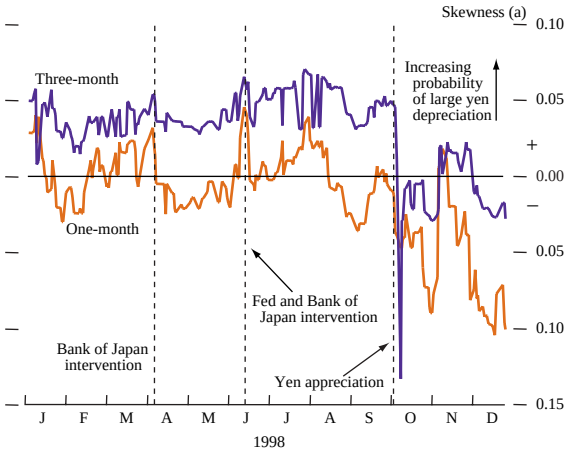


Chart 9
Time series of the skewness of ¥/$ PDFs



(a) Skewness is measured as (mean - median)/standard deviation.

magnitude to the spot rate, and uncertainty increased slightly at both the one and three-month horizons. Skewness hardly changed at the three-month horizon, but fell slightly at one month. The balance of risks remained in favour of a large dollar appreciation rather than a large dollar depreciation, although the central case was for a somewhat stronger yen following the intervention. In fact, the next three months did correspond to a period of dollar strength. PDFs for the June intervention tell a similar story. Chart 9 shows the time series of skewness for one and three-month horizons, during 1998. By the end of the year, the balance of risks had shifted towards further yen appreciation, particularly in the short run.

Summary and conclusions

In this paper, we describe techniques used by the Bank of England to extract information from foreign exchange options markets. We apply these techniques to analyse movements in the yen/dollar exchange rate during 1998. Standard quotes from market-makers allow us to infer the degree of uncertainty attached to the future path of an exchange rate. In addition, we also construct probability density functions that enable us to describe a more complete distribution of agents' views. These PDFs tell us that agents were not anticipating a large rise in the yen in October 1998; in fact, many were buying options to hedge against a further depreciation. Information from option prices can also tell us something about market views on the efficacy of central bank intervention in the foreign exchange market. Both interventions in the yen/dollar market resulted in a short-run appreciation of the yen. But options traders did not believe that the unilateral intervention by the Bank of Japan in April, or the co-ordinated intervention in June, would change the balance of probabilities over the short term of a further sharp depreciation in the yen versus a sharp appreciation. By the end of 1998, however, traders were attaching a higher probability to a large yen appreciation than to a large yen depreciation.

Technical Appendix
Constructing implied probability density functions from OTC options quotes

A range of techniques have been devised for deriving risk-neutral probability density functions (PDFs) from option prices.(1) The technique used by the Bank, with the European-style exchange-traded options on LIFFE, fits a mixture of two log normal distributions directly to the observed call and put option prices. Unfortunately, the OTC market provides us with too few option quotes across strike prices to be able to employ this approach. Instead, we use an approach developed at the Federal Reserve Bank of New York by Malz (1997).(2) Rather than fitting a distribution directly to option prices, this approach uses a result discovered by Breeden and Litzenberger (1978)—that the implicit distribution contained within option prices can be recovered by calculating the second partial derivative of the call price function with respect to the strike price. This theoretical result requires a continuum of option prices with differing strikes. Of course, in reality, we have a much more limited set of prices and so some degree of interpolation and extrapolation between prices is required. What distinguishes this method is the approach that it uses for interpolation across the quite limited set of prices provided by OTC market-makers.

An obvious approach to this would be to interpolate directly across the option prices. But in practice, it is difficult to fit a curve directly to prices, particularly for short times to maturity.(3) Instead, both researchers and market participants have found it easier to interpolate across implied volatilities—that is, they generate a continuous volatility smile—and then calculate the continuous pricing curve from that produced by using the Black-Scholes formula. Note that this does not imply a belief that the Black-Scholes model assumptions hold. The model is simply used as a convenient device for making the transformation from implied volatilities to prices.

Malz (1997) followed common practice by using a quadratic function to interpolate across the volatility smile, but using the Black-Scholes delta to represent exercise prices. The delta represents the rate of change of the option price with respect to the underlying exchange rate, and can be thought of as a measure of the 'money-ness' of an option. The interpolated curve is chosen in such a way that it passes exactly through the points on the volatility smile given by the observed quotes. The functional form used is given by:

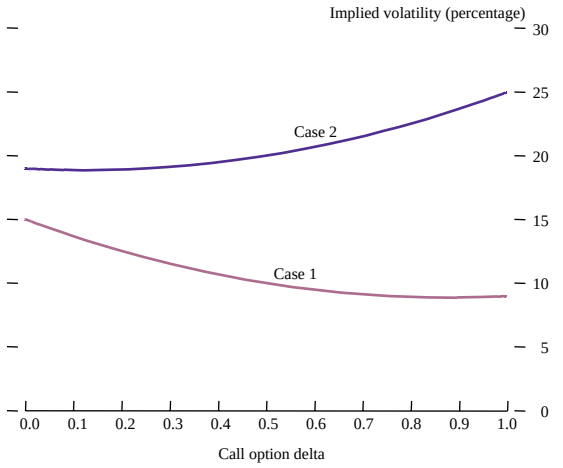
$$\sigma(\delta) = atm - 2\ rr(\delta - 0.5) + 16\ str\ (\delta - 0.5)^2 \qquad \textbf{(1)}$$

Quotes for ATM volatility (*atm*), risk reversals (*rr*) and strangles (*str*) are inserted into this formula to obtain the interpolated volatility smile: $\sigma(\delta)$. From this volatility smile, it is possible to calculate a near-continuous call-pricing function by inserting the volatilities into the Black-Scholes formula. To derive the implied PDF, we exploit the Breeden and Litzenberger result, by calculating the second partial derivative of this call-pricing function with respect to the strike price.

As an example, we construct two PDFs using stylised data to demonstrate how the technique is implemented and how changes in the underlying data cause changes in the calculated implied probability distributions. For both PDFs, we use a yen/dollar spot rate of ¥130 and hypothetical Japanese and US interest rates of 0.5% and 5.5% respectively. In the first case, the implied volatility is set at 10% and the risk reversal at 3%. In the second case, implied volatility is increased to 20% and the risk reversal is reduced to -3%. In both cases, the strangle price is 0.5%. The stylised prices have been set to historically realistic levels, although the risk reversals used are set to their historic extremes (for yen/dollar) to indicate how skewed the implied PDFs have been at times in the past.

Inserting these prices into the functional form above gives the volatility smiles using delta as a proxy for the strike portrayed in Chart A1. Solving for the strike prices corresponding to these deltas and volatilities using the

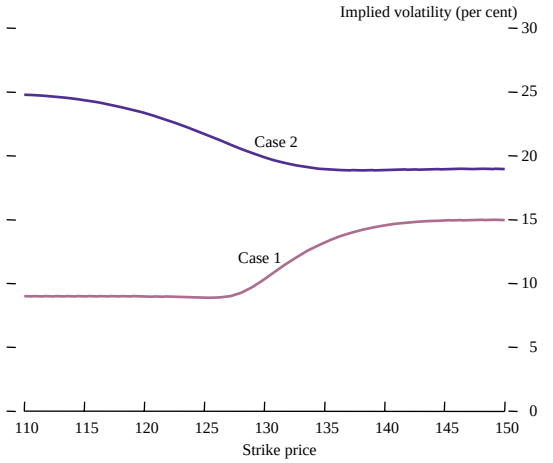
Chart A1
Interpolated volatility smiles in delta-space



(1) Many of these techniques were reviewed in Bahra, B (1997) 'Implied risk-neutral probability density functions from option prices: theory and application', *Bank of England Working Paper* No 66.
(2) See Malz, A 'Estimating the Probability Distribution of Future Exchange Rates From Option Prices', *Journal of Derivatives*, Winter 1997.
(3) Because it is based on the second partial derivative of the call pricing function, the estimated PDF is extremely sensitive to any errors in the interpolated call price function. At the same time, the shape of the call price as a function of strike is difficult to interpolate accurately at short times to maturity, because it has a shape that is mostly almost piecewise-linear but becomes highly convex over a small range of strikes. Small errors in fitting the call price function lead to large errors in the convexity of the curve and hence the estimated PDF. By contrast, the shape of the implied volatility smile is much easier to approximate, and small fitting errors result in only very small errors in the call price function and its convexity. Interpolating this way consequently results in much more stable PDF estimates.

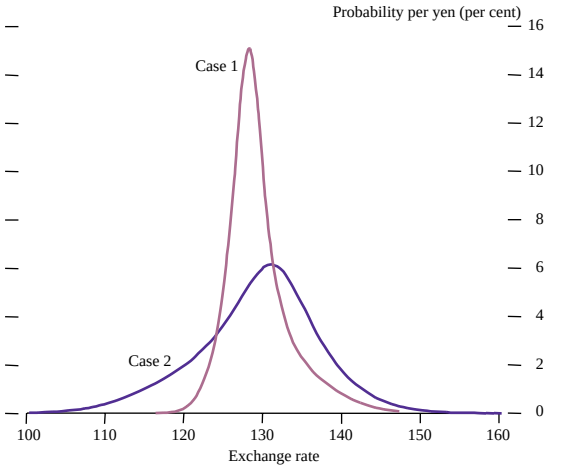
Black-Scholes formula, we get the conventional volatility smiles set out in Chart A2.

Chart A2
Interpolated volatility smiles in strike-space



From Chart A2, it is possible to see that the height of the strike-space volatility smile depends on the ATM implied volatility price, and that its slope depends on the sign and size of the risk reversal. When the risk reversal is negative, the volatility smile slopes downwards on average. When it is positive, the slope is, on average, positive.

Chart A3
Implied PDFs using hypothetical data



Given this volatility smile, the final stage is to calculate the corresponding call pricing function and calculate numerically its second partial derivative with respect to the strike price. The resulting implied PDFs are shown in Chart A3. The implied PDF for Case 1, with low implied volatility and positive risk reversal, has a low variance and a positive skew. By contrast, the second PDF, associated with higher implied volatility and a negative risk reversal, has an increased variance and negative skew.

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Risk, cost and liquidity in alternative payment systems

For its academic workshops and projects, the Bank of England's Centre for Central Banking Studies (CCBS) invites central bankers from as wide a range of countries as possible to analyse and compare their experiences of relevant issues, in a process of learning from diversity. Each workshop is followed by a three-month project, for which three to six foreign central bankers are invited to collaborate with Bank of England staff on research related to the workshop material.

In this article, Maxwell Fry, director of the CCBS, summarises one aspect of the research conducted at the CCBS as part of its first academic workshop and project.(1) *This started with a one-week academic workshop on payment and settlement issues in January 1998, attended by participants from 22 central banks as well as international experts in the subject. After the workshop, six participants—three foreign central bankers and three Bank of England staff—assembled to plan a research programme for the ensuing ten weeks. The research built on the ideas presented at the academic workshop, as well as the specific interests of the team members. The results of the project research were first presented at a conference in March, which was co-hosted by the CCBS and the ESRC-supported Money, Macro and Finance Research Group. The project output also formed the basis for a report prepared for the Bank's 1998 Central Bank Governors' Symposium in June. Routledge will publish the final project output in April 1999.*(2)

Central bank involvement in payment systems

Central and commercial bankers now generally recognise that payment and settlement arrangements cannot simply be left for the 'back office' to sort out. In their role as the 'plumbing' of the financial and banking system, the efficiency and safety of these arrangements have become issues with wider strategic and policy implications for central banks.(3) By way of illustration, the Bank of England's mission statement specifically recognises the promotion of sound and efficient payment and settlement arrangements as an important element of the Bank's core purposes. Gerry Corrigan, former President of the Federal Reserve Bank of New York, also recognised this important role—he referred to the 'trilogy' of central banking functions and responsibilities: monetary policy, banking supervision and payment systems.

Central banks' objectives for payment systems, under both the monetary and financial stability headings, may be summarised as reducing risk and promoting efficiency in payment systems. Risk reduction is paramount, but promoting efficiency is a complementary goal. Efficiency has many dimensions, which can broadly be grouped under cost, speed and robustness. Robustness encompasses both the reliability of the service and the certainty of its effects, which may depend on the clarity of the rules or the precision of the relevant legal framework. It is perhaps obvious that efficiency is a desirable objective in its own right but, in addition, it may well be necessary to achieve the risk-reduction objective. Typically, users have a choice about whether or not they use particular systems. There is no point in developing a very safe system if nobody is prepared to use it. So the risk-reduction and efficiency objectives have to be pursued in parallel, but recognising that, while market participants may have an equal interest in the promotion of efficiency, they may not have as strong an interest in risk reduction if the private and social costs of risk differ. As a result, it is sometimes left to the central bank to highlight the risk-reduction questions.

Central banks have tended to play a more active role in payment systems since the late 1970s than in earlier years. This is largely because of rapid technological changes, dramatic growth of financial activity and the consequent enormous growth in both volumes and values of payment transactions, and the integration or globalisation of financial markets. As a result, liquidity and credit risks for central banks, commercial banks and other participants involved in payment systems have increased dramatically. Furthermore, payment systems have become a serious potential source of domestic and cross-border financial crises.

In this new environment, promoting stability and efficiency of payment systems, developing measures to reduce risk, and ensuring that payment system arrangements and

(1) The author thanks Robert Heath, Joanna Place and David Sheppard for comments and assistance on earlier drafts.
(2) Maxwell J Fry, Isaack Kilato, Sandra Roger, Krzysztof Senderowicz, David Sheppard, Francisco Solis, John Trundle, *Payment Systems in Global Perspective* (London: Routledge, 1999).
(3) Andrew Crockett (1998, page 4) points out that the Bank for International Settlements' (BIS) Committee on Payment and Settlement Systems was transformed into a senior-level body in 1990 after the growing realisation that 'payment systems were not only a technical matter, but also went to the very heart of central bank policy concerns'.

changes in such arrangements do not jeopardise monetary management have become crucial central bank objectives. The efficiency of a country's payment system is one determinant of its rate of economic growth. Here, the speed and certainty of fund transfers from the payer's account to the payee's account are the main elements.

Central banks can promote such efficiency in two primary ways—by operational involvement or via oversight. The degree to which central banks are involved in operational activities differs across countries. Nevertheless, there is a tendency for central banks to play a more active role in developing and running large-value than small-value transfer systems. Quite apart from operational involvement, however, all central banks perform some degree of payment system oversight. In some countries, this amounts to a formal regulatory role for the central bank, often involving responsibility for developing the rules for the operation of the payment system(s). In others, central bank influences are less formal, with day-to-day management of the payment system undertaken by the commercial banks. Where commercial banks have existed for centuries, central banks tend to play a more passive role than in countries that until recently possessed a 'monobanking' system.

Payment systems in industrial, transitional and developing countries

Information on payments arrangements in transitional and developing countries is scarce, and not generally available in a form suitable for comparative analysis.(1) So in January 1998, the Bank of England asked central banks in a sample of countries, hereafter referred to as the BoE group, to complete a questionnaire both to supplement published information and to supply comparative data for analytical purposes. The 70 respondent countries are listed in Table A.

These 70 countries were chosen because members of their central banks attended conferences on payment systems at the Bank for International Settlements in December 1997 or at the Bank of England in January 1998, or were invited to the Bank of England's Central Bank Governors' Symposium in June 1998.

Payment systems range from simple cash-dominated systems, as in the Seychelles, to systems involving a range of non-cash payment instruments. The key feature of each payment system is how payments are effected. In a currency-based payment system, payments are concluded by the transfer of currency notes from payer to payee; settlement takes place at the same time as the transaction, because currency represents final payment (currency constitutes 'good funds', ie legal tender or central bank money), so no clearing function is needed. Because all other payment instruments involve at least one third party, the payment process is necessarily more complicated.

Table A
The Bank of England group

Industrial	Transitional	Developing
Australia	Armenia	Bahrain
Austria	Belarus	Barbados
Belgium	Bulgaria	Bermuda
Canada	China	Botswana
Finland	Czech Republic	Brazil
France	Hungary	Colombia
Germany	Latvia	Cyprus
Greece	Poland	Eastern Caribbean
Hong Kong	Russia	Egypt
Iceland	Slovak Republic	Fiji
Italy	Slovenia	Guyana
Netherlands	Tanzania	Jordan
New Zealand	Vietnam	Kenya
Norway		Korea
Portugal		Kuwait
Singapore		Lebanon
Spain		Malawi
Sweden		Malaysia
Switzerland		Malta
United Kingdom		Mauritius
United States		Mexico
		Morocco
		Mozambique
		Namibia
		Nigeria
		Pakistan
		Peru
		Saudi Arabia
		South Africa
		Swaziland
		Tonga
		Turkey
		Uganda
		United Arab Emirates
		Zambia
		Zimbabwe

Processing of cheques, for example, involves some means of clearing; settlement takes place through correspondent balances or by transferring balances of 'good funds' in accounts held at the central bank. The same is true for all non-cash payment instruments.

An important influence on the choice of payment system is the value of the transaction. The most efficient payment system in terms of the cost/risk trade-off for transactions of $100 may not be the same as for transactions of $1,000,000. So discussion of alternative payment systems often distinguishes between a large-value transfer system (LVTS) and a small-value transfer system (SVTS). Virtually all LVTSs settle through accounts held at the central bank. For this reason and because LVTSs play such a crucial role in economic affairs, central banks are invariably involved directly or indirectly in their operation. This article concentrates on LVTSs rather than SVTSs.

A major design choice when developing payment systems in general, and LVTSs in particular, concerns the means by which the interbank obligations arising from the transfer of payment instructions are settled. A key distinction is that between real-time gross settlement (RTGS) and deferred net settlement (DNS). Under RTGS, payment instructions are settled individually as they are processed, across the banks' settlement accounts at the central bank. Under DNS, the process of transferring and exchanging payment instructions is separate from, and precedes, the process of settlement. Banks will periodically (often at the end-of-day) calculate their net pay/receive obligations resulting from the

(1) The BIS publishes detailed information about payment systems in the eleven G10 countries (Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States), eg Bank for International Settlements (annual) and Bank for International Settlements (1993). Recently, the BIS (1998) has published case studies on payment system issues in 19 transitional and developing countries. The International Monetary Fund (IMF) has also published some useful material on payment systems in transitional and developing countries, eg Johnson *et al* (1998) and Summers (1994).

instructions exchanged during the period in question, and then settle these net amounts across their accounts at the central bank. DNS systems often operate through payment clearing houses.

Since 1980, the majority of industrial countries have adopted RTGS systems as the preferred system for large-value transfers. FedWire, introduced in 1918, was the first RTGS system; its modern version was developed in 1970. In the 1980s, the Netherlands (1985), Sweden (1986), Switzerland (1987), Germany (1987), Japan (1988) and Italy (1989) introduced RTGS systems. Since 1990, many industrial, transitional and developing countries have adopted RTGS systems. All EU countries developed euro RTGS systems linked to the EU-wide RTGS system (TARGET) before it started operations on 4 January 1999.

The BoE group uses a variety of payment systems. Four main groupings can be identified: countries with only RTGS systems; countries with only DNS systems; countries with both RTGS and DNS systems; and countries with other types of payment systems. In countries with both RTGS and DNS systems, three subcategories appear: RTGS for high-value transactions and DNS systems for retail arrangements; RTGS and DNS systems for both wholesale and retail payments; and an arrangement with two RTGS systems, where one is restricted and the other is open, operating alongside net settlement systems. In the group that has other types, the most common is gross systems with deferred batched settlements usually at the end of the day or next day, although occasionally at set times during the day. However, most respondent countries indicated that they are examining the possibility of adopting an RTGS system, mainly for large-value interbank settlement transactions. Net settlement, together with other types of settlement systems, is increasingly used for retail transactions.(1)

Table B shows that within the BoE group, 86% of the industrial countries, 46% of transitional countries and 25% of developing economies use RTGS systems.(2) The high adoption rate of RTGS systems in transitional economies reflects a number of factors: it is a logical development from the deferred gross systems that transitional economies typically possessed in the 1980s; telecommunication and computing costs have fallen worldwide; and the advantages of electronic over paper-based payment instruments are relatively greater for large countries such as China and Russia than for small countries. Preference for RTGS also partly reflects the legal complexity of netting arrangements.

Table B
Payment systems in the Bank of England group

Percentage of countries in each group

Type	Industrial	Transitional	Developing
RTGS	86	46	25
DNS	86	62	83
Other	5	38	22

All G10 countries possess at least one LVTS providing same-day final settlement. Canada uses a DNS system for this; in all other G10 countries, it is provided through RTGS systems, though in some (the United States, France and Spain), it is also provided through DNS systems or, in Germany's case, through a hybrid batched settlement system.

An analytical framework

Given the diversity of payment instruments and systems around the world, is there any analytical framework that can be applied to all countries and to all payment systems? Perhaps two universal characteristics of payment systems can be detected. To do this, one might start with some simple history:

1 Payment preceded money: barter.
2 Credit preceded money: credit barter.

In a small, static, traditional society, such as Europe in the Middle Ages or a Pacific Island before the arrival of Captain Cook, there would be no demand for a means of payment. All transactions could easily be arranged by barter exchanges or credit barter. In such a world of virtual certainty, everyone would know where to send his or her products, and when and where to collect the goods and services provided in exchange.

Following Charles Goodhart (1989, Chapter 2), uncertainty and transaction costs constitute the two prerequisites for a demand for money as a means of payment:

- uncertainty produces a preference for immediate rather than postponed payment; and
- transaction costs produce a preference for payment in something that is generally acceptable as a means of payment. A chain of exchanges is more costly.

Uncertainty or risk, on the one hand, and transaction costs, on the other, are still the two main considerations for payment system analysis today. This is recognised in the analytical framework presented by Allen Berger, Diana Hancock and Jeffrey Marquardt (1996). This framework adapts the standard risk-return analysis used in finance by substituting cost for return: on the efficiency frontier, lower risk in a payment system can be obtained only at a higher cost. Chart 1 shows the efficiency frontier *FF*, plotting combinations of risk and cost attached to the most efficient payment systems.(3) Efficiency is measured from a social welfare viewpoint, incorporating all costs of payers and payees, as well as externalities. In other words, efficient

(1) Large international banks have established card networks in the Czech Republic, Hungary, Korea and Saudi Arabia that service retail transactions in a variety of settlement schemes.
(2) Unfortunately, it was impossible to distinguish between LVTSs and SVTSs for this table. Most DNS systems in the industrial countries are SVTSs.
(3) An alternative but less intuitive representation would place a bundle of payment attributes on the horizontal axis, replacing return in the standard risk-return trade-off diagram. Of course, a bundle of 'goods', in contrast with the 'bad' cost attribute used here, would tilt both the efficiency frontier and the indifference curve clockwise by 90°.

Chart 1
Risk-cost trade-off along the efficiency frontier

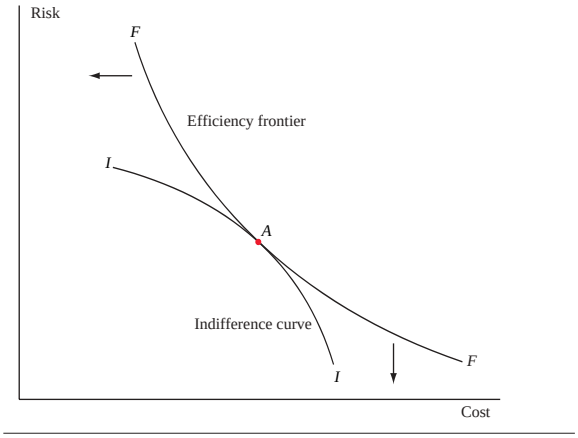
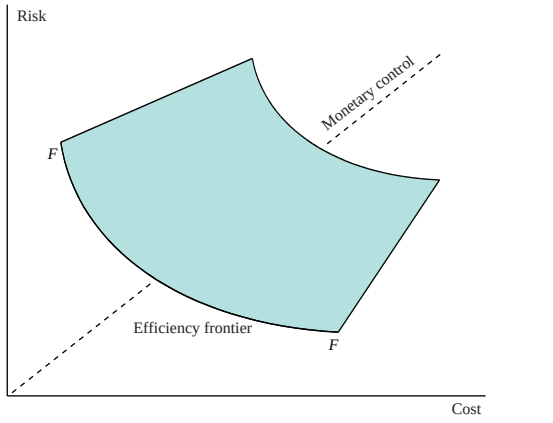


Chart 2
Risk, cost and monetary control trade-off along the efficiency frontier



payment systems cannot reduce risk without raising cost, or reduce cost without increasing risk. Many factors (including technological, institutional and legal) determine the position and movement of the efficiency frontier. Over time, innovations in these factors may shift the efficiency frontier towards the origin, so enabling reductions in both cost and risk.

To determine the optimal payment system, Chart 1 must incorporate a social indifference curve. Society would prefer less cost and less risk, but would be indifferent between various combinations involving lower risk and higher cost. The curve *II* connects points of indifference, ie there is no preference to being located at any particular point on the curve. This curve is the social indifference curve, implying that society as a whole holds a view on its preference or trade-off between risk and cost.

When risk is high, society may be prepared to pay more per unit of risk reduction than when risk is low. In this case, the social indifference curve *II* will be convex to the origin; at relatively high risks, society is prepared to incur a relatively large cost for risk reduction, so the slope of the curve is relatively flat. But where risk is already low (towards the bottom right-hand side of Chart 1), society is prepared to incur only a small cost for further risk reduction. Indifference curves nearer the origin offer greater social welfare than indifference curves further away from the origin. So welfare is maximised at the point of tangency between an indifference curve and the efficiency frontier: it is not possible to move from point *A* to a higher indifference curve.

As with any two-dimensional representation of a complex system, Chart 1 omits several crucial factors that determine the position of the efficiency frontier in risk-cost space. For example, monetary policy techniques may affect the position of the efficiency frontier. Chart 2 depicts this in a three-dimensional diagram as a rising plane, such that greater monetary control can be obtained only at the expense of a less favourable risk-cost trade-off in the payment system. Indifference must now also be represented as a plane, in which society trades off risk, cost, and monetary control or price stability.

In reality, risk takes a variety of forms, with economic, legal, operational and security risks constituting the main categories. Efficiency also combines speed, reliability and cost. Evidently, therefore, the choice of payment system and design is multifaceted, with trade-offs possible along a number of axes.

Deferred net settlement versus real-time gross settlement

In the 1970s, payment systems in most industrial countries could be characterised as unprotected DNS systems. At that time, the United States was the only country to possess an RTGS system. Both DNS and RTGS systems were unprotected, in that payment risks, ie the various risks that payments would fail to be made, were ignored. In the DNS system, banks provided unlimited (and often unknown) implicit and unsecured credit, from receipt of payment until net settlement after clearing at the end of day or beginning of the next day. In the United States, the Federal Reserve System provided unlimited, free and unsecured intraday credit to all users of FedWire. So in theory, payment risk is borne by the commercial banks in a DNS system, but by the central bank in an unprotected RTGS system. In practice, however, failure in a DNS system may be so severe that the central bank is obliged to bail out banks viewed as too big to fail. In this case, the central bank absorbs part of the risk and, if such action is anticipated, creates a moral hazard in so doing.

Using Robert Lindley's (1998) analysis, a simple but unsatisfactory net settlement system involves:

- end-of-day clearing (or next morning for convenience);
- settlement of net balances through deposits at the central bank (ie with good funds);
- no limits or caps on transfers;
- no collateral or loss-sharing rules;

- weak or non-existent legal basis for netting (creating a potential 'unwind' problem);[1] and
- poor visibility of risk exposures.

In such a simple system, commercial banks provide implicit credit, which is unlimited and unsecured.

A simple RTGS system involves:

- continuous settlement across accounts at the central bank;
- unlimited unsecured intraday liquidity from the central bank; and
- finality.

An RTGS system is a prerequisite for genuine delivery versus payment (DVP) for securities market transactions and payment versus payment (PVP) in foreign exchange transactions. But RTGS systems require more liquidity to settle continuous streams of gross payments. To encourage their adoption, central banks may provide this extra liquidity at what appears to be a subsidised price.

There is a perception that the central bank has a preference for a safe but expensive system, whereas commercial banks prefer a cheaper but riskier system. In terms of the risk-cost trade-off diagram used earlier (see Chart 1), these preferences are illustrated in Chart 3, where I_c is the indifference curve between cost and risk for commercial banks and I_b is the indifference curve for the central bank. In this case, commercial banks prefer point *C*, with greater risk and lower cost, to position *B*, preferred by the central bank. In some countries, the central bank may impose its preference by dictating a maximum acceptable degree of risk.

Chart 3
Different central and commercial bank preferences in terms of risk-cost trade-offs

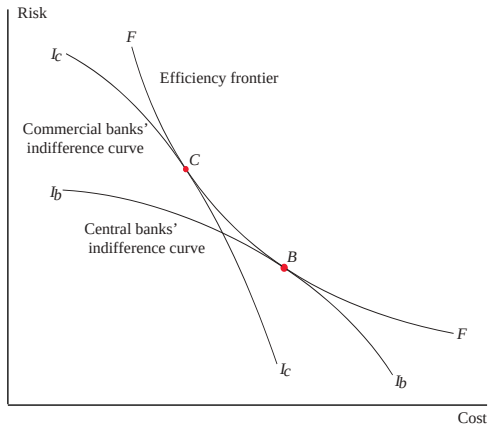
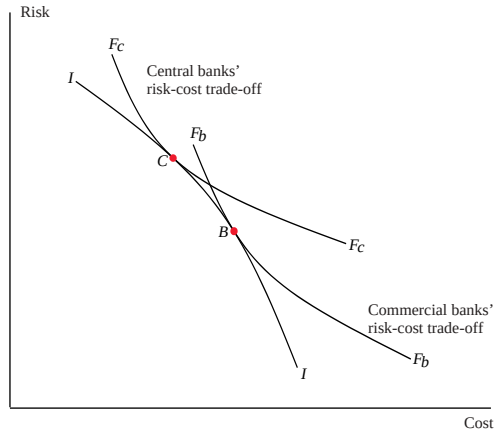


Chart 4 illustrates an alternative explanation for different choices of commercial and central banks. In this case, commercial and central banks have the same indifference curve, but commercial banks face a different risk-cost trade-off F_c from that of the central bank, F_b. In other words, private and social costs differ in Chart 4. Commercial banks still prefer point *C* to *B*, the point preferred by the central bank, but the reason lies not in innate preference towards risk but in some form of price distortion.

Chart 4
Preferences in terms of different central and commercial bank risk-cost trade-offs



Lindley (1998) questions whether the crucial difference between DNS and RTGS lies in a trade-off between 'safe but expensive' and 'cheaper but riskier'. He argues that the key choice lies in the type of RTGS system adopted, basing his case on the observation that liquidity needs in net and gross systems are identical. Table C illustrates a sequence of payments during the day between bank *A* and bank *B*. By the fourth payment, bank *A*'s payments to bank *B* have exceeded bank *B*'s payments to bank *A* by 6. This sequence can occur in either DNS or RTGS systems. The type but not the amount of intraday liquidity differs. If this sequence occurred in a DNS system, bank *B* would provide liquidity to bank *A* in the form of implicit and free credit. In a protected DNS system, liquidity is provided free but some collateral must be posted. If it is provided at all in an RTGS system, liquidity is invariably provided explicitly by the central bank. The cost of such liquidity depends on reserve requirements, interest on reserve balances, collateral requirements and any interest charged on intraday credit facilities.

Table C
Daily payment sequence between bank *A* and bank *B*

Sequence	*A* to *B*	*B* to *A*	*A*'s balance	*B*'s balance
1	3		-3	+3
2	2		-5	+5
3		1	-4	+4
4	2		-6	+6
5		2	-4	+4
6		4	0	0

Maximum overdraft: 6; average overdraft: 3.8.

Risk is generally harder to control with implicit credit than explicit credit arrangements. Indeed, the provision of implicit credit may be unrecognised, or at least unknown.

(1) An unwind involves a recalculation of the net settlement figures, eliminating any payment orders sent or received by a participant that has failed—thereby producing a brand-new set of net settlement positions for the surviving participant.

In a paper-based debit transfer system, for example, the net amount of intraday credit provided between banks cannot be known: though bank *A* may know how much it is owed by bank *B*, it cannot know until clearing how much it owes to bank *B*. So the provision of free implicit credit is an inevitable component of such a netting system. But if commercial banks are willing to provide intraday free credit in a DNS system, why are they unwilling to do so when operating in an RTGS system, if the central bank declines to provide it?

The Swiss National Bank does not provide any intraday liquidity for its RTGS system—Swiss Interbank Clearing (SIC). The commercial banks are unwilling to provide intraday liquidity, so the lack of liquidity produces payment queues. Payment instructions submitted to SIC are executed only if the bank has sufficient funds. Otherwise, the payment instruction is queued and can be delayed for several hours. Such delays inevitably introduce settlement risk for some party to the transaction, so destroying one of the main virtues of RTGS. At the end of each day, remaining payment instructions incur a penalty and are cancelled. The alternative is for the commercial banks to obtain overnight credit from the Swiss National Bank at 2% above the market rate.

One solution to this liquidity shortage problem lies in payment management. With payments that require only a specific date (value date) but not a specific time for the settlement, Table D shows that payment prioritisation/queue management can reduce liquidity needs. In this case, which uses the same set of payments as in Table B, bank *A* needs a balance of 3 rather than the balance of 6 that was required in the previous example, where there was no queue management.

Table D
Daily payment sequence between bank *A* and bank *B* with queue management

Sequence	*A* to *B*	*B* to *A*	*A*'s balance	*B*'s balance
2	2		-2	+2
5		2	0	0
1	3		-3	+3
6		4	+1	-1
4	2		-1	+1
3		1	0	0

Maximum overdraft: 3; average overdraft: 1.2.

Another apparently obvious solution is for bank *B* to provide intraday credit to bank *A*. It does so implicity in the DNS system, so why is it so unwilling to do so explicity in the RTGS system? Why is the preferred solution to delay payments in RTGS systems without central bank liquidity, eg in SIC? One answer may lie in the open access to most RTGS systems, as opposed to the closed access in many high-value DNS systems. For example, there are more than 10,000 participants in FedWire and more than 5,000 in Germany's ELS system, but there are only 16 direct settlement banks in both New York's Clearing House Interbank Payments System (CHIPS) and London's Clearing House Automated Payment System (CHAPS).[1]

So monitoring of each counterparty's creditworthiness is impossible in the American and German RTGS systems, but feasible in both CHAPS and CHIPS. While restrictive membership criteria facilitate risk management, if all settlement members are too big to fail, the DNS system acquires the ultimate risk protection of the central bank. So one argument in favour of an RTGS system is that it reduces moral hazard and so improves incentives to monitor counterparty risk. An RTGS system can enhance credibility of the central bank's claim that no bank is too big to fail: failure of even the biggest bank in an RTGS system has no direct implications in terms of credit risk for any other participant.

According to Lindley (1998), RTGS is superior to DNS because:

- it keeps the payment system simple;
- it separates the payment process from liquidity provision; and
- the form of liquidity provided (central bank balances, central bank credit, explicit interbank credit) depends on central bank and market preferences.

Schoenmaker (1995) reaches the opposite conclusion, because he assumes that the social costs of liquidity are positive and substantial. However, if a central bank satiates the payment system with liquid assets that banks have to hold for prudential purposes (as in the United Kingdom), this cost evaporates. In this case, the central bank ensures that eligible liquid assets produce the same risk-adjusted yield as all other assets.

Liquidity is economised in a DNS system through the substitution of credit for immediate settlement. A typical large-value net payment system accomplishes $100 in payments for a deferred settlement in 'good funds' of $1. Immediate settlement incurs the opportunity cost of holding larger reserve balances (Goodfriend 1990, page 10). So one way of counteracting commercial banks' reluctance to use a liquidity-intensive RTGS system is for the central bank to subsidise liquidity. As Mark Flannery (1996, page 807) points out, subsidising transaction costs reduces social welfare.

Flannery's (1996) case against subsidising transaction costs because it reduces social welfare does not hold if private costs of transactions exceed their social costs. Scott Freeman (1996) shows that welfare is maximised when liquidity constraints in a payment system are eliminated through central bank provision of an elastic currency:

'the monetary authority must temporarily supply enough currency to clear all debts at par [a condition that would not

(1) CHAPS evolved from a DNS to an RTGS system in April 1996.

occur under liquidity constraints]. This temporary injection of fiat money may take the form of a discount window offering central-bank loans equal to the nominal amount of debt presented to it. Once all debts are cleared, the optimal rediscounting policy requires that the central-bank loans be repaid with fiat money, which is then removed from circulation in order to return the fiat-money stock to its initial level, thereby maintaining a constant price level' (Freeman 1996, page 1,127).

'Fiat money is needed both to purchase goods and to repay debt. As a result, the real stock of currency, determined by the demand for money to purchase goods, may be insufficient to permit the unconstrained clearing of credit markets. The selling of debt at a discount indicates a nonoptimal equilibrium. The model of this paper therefore suggests that the optimal central-bank policy includes the elastic provision of a stock of fiat money. Central-bank loans that temporarily increase the stock of central-bank money permit the clearing of debt at par (or at its risk-adjusted price), thus restoring economic efficiency. Therefore, the two roles of money require two distinct central-bank policies: the central bank must not only choose the end-of-period fiat money stock but must also provide within-period central-bank loans sufficient for the clearing of debt unconstrained by a need for liquidity'. (Freeman 1996, pages 1,137–38.)

This finding resembles Milton Friedman's (1969) optimum quantity of money. His basic argument is that, because the marginal cost of increasing the real quantity of money is virtually zero, welfare is maximised when real money balances are provided up to the point of satiety. The optimum real quantity of money is that which makes the marginal benefit equal to the zero marginal cost. From the social welfare viewpoint, too much is consumed if private costs fall below social costs, and too little if private costs exceed social costs. The optimum quantity of money, ie the quantity at which private and social costs are equated at zero, can be achieved by engineering a continuous decrease in the price level. This deflation should reduce the nominal interest rate to zero. Alternatively, the central bank could pay the risk-adjusted nominal interest rate on money balances (Howitt 1992, pages 81–3). In the case of intraday liquidity, the optimal arrangement from the social welfare perspective is to eliminate liquidity constraints through central bank provision of an elastic supply of liquidity. Then banks will satiate their desire for liquidity for payment purposes, because the opportunity cost of holding such liquidity is zero.(1)

For protection against payment risk, the prudential requirements in terms of liquid asset ratios are similar for both RTGS and DNS systems; payment risks are certainly no greater in an RTGS system than in a DNS system. An RTGS system spreads risk more evenly over the day than a DNS system, which bunches risk at the end of the day.

The form in which liquid assets are held against payment risk is irrelevant, ie they serve the same purpose whether they are held as Treasury bills or balances in accounts at the central bank. Since the introduction of the United Kingdom's RTGS system in April 1996, the Bank of England has used repurchase agreements (repos) to convert banks' liquid assets into payment balances every morning. The Bank sells the assets back to the commercial banks at the same price at the end of the day. In other words, the Bank's intraday interest rate is zero. Because banks must hold these liquid assets for prudential purposes under any alternative payment system arrangements, these intraday balances acquired through intraday repos with the Bank of England incur no additional opportunity costs to satisfy the higher liquidity demands of the RTGS system. In fact, they are well in excess of any likely liquidity needs. Though holding liquid assets for prudential purposes is not costless, what is costless is the extra liquidity requirement of the RTGS environment. So the United Kingdom follows the theoretical precepts of Friedman and Freeman in terms of providing costless liquidity for intraday payment purposes.

An alternative way to deal with this central bank payment risk exposure is to substitute an insurance premium for a liquid asset ratio requirement. Private and social costs of liquidity can still be equated at zero through a zero intraday interest rate. Then a risk premium can be charged appropriately for the risk incurred by the central bank in its provision of intraday liquidity. In effect, this is the Federal Reserve's approach in charging a small fixed interest rate for intraday overdrafts. This interest rate can be considered the risk premium over a zero rate for risk-free intraday liquidity.

No discussion of intraday liquidity provision is complete without some mention of the possibility of a spillover of intraday payment system credit into overnight credit, and the potential effect of such an event on overall monetary conditions. Among central bankers, it is generally accepted that (a) explicit provision of secured intraday credit to RTGS systems is a 'good thing' on payment system efficiency grounds, and (b) despite the potential for spillover, central banks can introduce safeguards such that, on the rare occasions when it does occur, the effect is negligible. In other words, intraday and overnight/interday markets can be effectively segmented by, for example, imposing an early cut-off time for customer payments (so that banks can use the last period before the payment system closes to square their positions) and a penal regime for any 'spillover' lending. So monetary policy can still operate effectively in the context of end-of-day balances and overnight (or longer) interest rates (Dale and Rossi 1996).

The spillover issue has featured prominently in discussions about the terms on which the United Kingdom and the other 'out' countries not adopting the euro from 4 January 1999

(1) See also Bengt Holmström and Jean Tirole (1998).

can connect to the Trans-European Automated Real-time Gross settlement Express Transfer system (TARGET) euro payment system. The TARGET system has been designed with the twin objectives of supporting the single monetary policy in the euro area and of providing a sound and efficient same-day payment mechanism across the whole European Union. It is essentially made up of interlinked national RTGS systems, and so its efficiency relies on the provision of sufficient intraday credit. Despite the conclusions reached in the previous paragraph, however, there was a reluctance on the part of a number of the 'in' countries to extend intraday euro credit to 'out' countries such as the United Kingdom, because of a perceived risk of such credit spilling over into overnight credit and so affecting monetary conditions in the European Monetary Union (EMU) area. Fortunately, a practical solution to this issue was reached that both supported the TARGET system's need for adequate intraday credit and avoided the perceived risks to the EMU area's monetary policy stance.

Conclusion

Because the existence of money depends on the existence of uncertainty and transaction costs, a useful framework for analysing payment systems is a variant of the risk-return paradigm used in finance. With cost substituting for return, an efficient payment system can only reduce risk at an increased cost. Where private and social costs diverge, as they do in the case of costly liquidity, central banks can improve social welfare by reducing the cost of liquidity to zero.

Once costs of risk and costs of liquidity are distinguished, the socially optimum strategy appears to be one of providing unlimited intraday liquidity at zero cost, but charging a risk premium assessed on each borrower based on standard actuarial principles. This can be achieved either by prudential ratio requirements set on the basis of the payment risk created by each bank, or by assessing an insurance premium on users of the payment system.

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Monetary policy and the international economic environment

In this speech,[1] *the* **Governor** *discusses the new monetary policy arrangements in the United Kingdom and in the euro zone, and the differing economic environments in the United Kingdom, Europe and the rest of the world. Against this background, he stresses the monetary policy objective shared by both the United Kingdom and the euro zone of achieving and maintaining price stability, keeping aggregate demand in line with economies' supply capacity.*

It would be a masterly understatement to describe the past two years, since the last CIB Scotland Dinner, as eventful. Here in Scotland, following the referendum and last year's legislation, you are now actively preparing for the elections to the Scottish parliament in May. In my own neck of the woods, we have seen responsibility for the implementation of monetary policy devolved upon the Bank's new Monetary Policy Committee. And elsewhere in Europe, eleven countries have merged their separate currencies into the single euro, thereby passing responsibility for monetary policy from national authorities to the new European Central Bank. These are truly historic events.

I have no wish to become embroiled in the matters of Scottish politics this evening—I am more than happy to leave that to the Secretary of State. I simply wish you all well, and look forward to developing a constructive dialogue with the new parliament as we have with the Scottish banking and business communities. But let me say a few words about the new monetary policy arrangements here in the United Kingdom and in the euro zone.

The real significance of these arrangements—in both cases—is that in introducing them, the respective governments confirmed their common commitment to achieving and maintaining effective price stability in their respective currency areas. That role for monetary policy is not simply an end in itself, in some abstract, doctrinaire way. On the contrary, it recognises that consistently and reliably low inflation, into the medium and longer term, is a necessary means to the end of sustainable growth of output and employment, which are, of course, the truly good things of economic life that we are all seeking to achieve.

Our own new legislation defines the MPC's objective as to maintain price stability and, subject to that, to support the Government's economic policy, including its objectives for growth and employment. The Maastricht Treaty defines the primary objective of the European Central Bank as to maintain price stability and, without prejudice to that objective, to support the general economic policies of the European Union.

There are significant differences between the two statutory frameworks. In our case, for example, the precise definition of the stability objective is determined by the Government, and there are much more rigorous requirements for transparency of the MPC process and public accountability for MPC decisions. I am convinced that our arrangements are wholly appropriate to our particular circumstances. But the essence of what we and the ECB Governing Council are mandated to do is very much the same.

In effect, it involves aiming to keep overall aggregate demand in the economy (as a whole) more or less continuously in line with the underlying overall capacity of the economy (as a whole) to meet that demand. Effective price stability is essentially a measure of our success in achieving economic stability in that much broader sense.

It is a limited role. Neither we nor the ECB can do very much directly to affect the underlying supply side of the economy, which depends upon its structural characteristics, and above all, in today's world, on the efficiency and flexibility of goods, capital and labour markets. Monetary policy cannot substitute for supply-side reform, but by maintaining price stability we can, indirectly, help markets to function more effectively.

Nor can either the MPC or the ECB do much directly to influence the pressures on particular firms or particular sectors or regions of the economy—we and they can only influence the monetary situation in the economy of our respective currency areas as a whole. We have essentially one instrument—the short-term interest rate. But again, if we are successful in achieving overall stability, that will also contribute over time to a more rather than less favourable operating environment for the different component parts of the economy. But that is the most that either we in the MPC or the Governing Council of the ECB can hope to do.

The fact that we both have essentially the same objective (and are subject to the same limitations) does not, of course, mean that we can adopt the same policy stance—the same level of short-term interest rates, as some commentators have recently—and over-simplistically—suggested. We start

(1) Given at the Chartered Institute of Bankers in Scotland on 18 January 1999.

from different positions, and our respective economies are subject to many different, as well as many of the same, influences. That was an important economic reason why the Government decided, rightly in my view, not to participate in the first wave of Monetary Union—despite the attraction, in the right circumstances, of nominal exchange rate certainty across Europe. It was, I know, a matter of regret to many of our European partners; but there was also a sense of relief, because many of them recognised that our different economic situation would have complicated European monetary management had we joined from the outset, as it would have complicated monetary management in this country.

In our case, the UK economy has grown at an average annual rate of around 3% now for the past 6½ years (to the third quarter of last year). That is well above any plausible estimate of the underlying rate of growth of capacity in the economy as a whole, which is typically estimated at some 2%–2½%. So what we were in fact doing over this period was steadily reabsorbing the economic slack created by the recession of the early 1990s. In the labour market, this was reflected in a rise in employment of some 1.65 million, to an all-time high on the latest figures (for the three months to last November) of 26.6 million. It was reflected, too, in a fall in the rate of unemployment from a peak of 10.6% (on LFS figures) to the current rate of 6.1%, which is the lowest rate for almost 20 years. As far as the regional impact is concerned, I would note that over this period, unemployment in Scotland, though still higher than in the United Kingdom as a whole, has also declined—to 7.6% on the latest LFS data, compared with a peak of 10.8%; and on a claimant-count basis it, too, is currently lower than for the past 22 years.

These developments in the labour market produced only a fairly gradual pick-up in pay settlements and earnings growth compared with past periods of labour market tightening—though we have, of course, been unsighted on what has happened to earnings growth more recently. And underlying retail price inflation on the Government's inflation target measure (RPIX) averaged some 2¾% a year through the expansion, and is currently exactly on target at 2½%.

By the time of your previous dinner, it was already becoming clear that overall output growth needed to moderate if we were not to run into overall capacity constraints and a pick-up in inflation. The exaggeratedly strong exchange rate against the core European currencies—reflecting, *inter alia*, market misperceptions about the prospective strength, or rather weakness, of the euro—was itself moderating external demand, especially for manufacturing output, while at the same time exerting a restraining price effect on domestic inflation. But domestic demand growth, including demand for services, continued to accelerate through 1997, and that was the background to the tightening of monetary policy in 1997. We could not avoid that tightening, despite the uncomfortable sectoral imbalance within the economy. To have done so would, as I have said elsewhere, have put the whole of the economy, including the internationally exposed sectors we would have been trying to shelter, at risk of accelerating inflation, so it would not have helped even those sectors in anything other than the short term.

Meanwhile, in the euro zone, things were very different. Demand and output growth in the major continental economies remained generally fairly sluggish for much of the period, only really starting to pick up towards the end, helped by relatively weak exchange rates. Unemployment, which is much the most urgent and important issue confronting Europe, actually increased; and, despite some improvement over the past year or so, it remains at or close to double-digit rates in all the largest euro-zone countries. Inflation against this background remained low, tending lower, as did interest rates. The position is complicated in the euro zone by a reviving political debate about just how much of the unemployment reflects supply-side weaknesses requiring structural reforms, and how much it reflects inadequate overall demand. The outcome of that debate will be crucial to the future evolution of the euro zone. But in the immediate situation, there was no reason to suppose that continued growth of demand and output was inconsistent with effective price stability in the zone as a whole.

So much for our different starting-points. But over the past year, the world—and I *mean* the world—has changed quite dramatically for both of us, in that we have both been affected by the international economic slowdown. This started, in fact, with the financial disturbances in Asia in the latter half of 1997, but even as late as the beginning of last summer, it seemed as if it might have only limited impact on the overall world economy. The IMF, for example, was then still projecting 3%–3¾% world growth in 1998 and 1999 respectively, which was certainly a setback compared with their forecast of more than 4% just six months before, but it was hardly catastrophic.

Since last summer, it has become increasingly clear that things are likely to be significantly worse than that. The financial collapse in Russia, deepening recession in Japan, the long battle—then sudden defeat last week—in Brazil's attempt to hold its exchange rate, and fluctuating fears of possible knock-on effects on the major countries' financial markets all contributed to an increased sense of financial fragility, which has not been easy to contain. We can, I believe, still avert a more general international financial upheaval (and the financial markets' response to the latest developments in Brazil, as well as the beginnings of a recovery in capital flows to some countries in Asia, are reasonably encouraging in this respect). But we are nevertheless bound to see a pronounced slowdown of world economic activity. The IMF has cut its latest (December) forecast for world growth to less than 2¼% in 1998/99. And the risks almost certainly remain on the downside. That is still not global slump or recession. But large parts of the world economy are in fact in recession, and the prospect for the world as a whole turns very much on what happens in the major industrial countries.

In essence, what we are seeing is a sharp cutback in capital flows to much of the emerging world and to some of the transition economies, enforcing on those countries a corresponding cutback in domestic demand, and creating the need for an urgent improvement in their current accounts. The counterpart is a sharp decline in net external demand in the industrial countries, which, if it is not offset by action to stimulate domestic demand in those countries, could lead to weakening global activity and price deflation.

In fact, to varying degrees (reflecting differing assessments of how far their particular currency area is expected to be affected by the slowdown in external demand, and different starting-points, relating to their assessment both of trends in domestic demand, and how close they were initially to full capacity, in their respective overall economies), both the United Kingdom and the euro zone, as well as the United States, have acted fairly aggressively to reduce interest rates since the autumn; and Japan has moved to more active fiscal stimulus. And if the global economic prospect and net external demand in the industrial countries were to deteriorate further, then it would be right to contemplate further moves in the same direction, consistent with our aim of effective price stability. What we are trying to do, as I said earlier, is to keep aggregate demand in line with the supply capacity of our economies. We have no interest in the creation of unnecessary spare capacity in our economies as a whole, or in a fall in the underlying general price level.

But what this will inevitably mean is a worsening of the balance of payments on current accounts of the industrial countries, individually and collectively, reflecting the imbalance between external and domestic demand growth in our economies. That imbalance clearly will need to be reversed at some point as the flow of international capital is restored to a more sustainable level. The pressures can in the meantime be mitigated by official international financing, but private flows may take a while to settle down. For the time being, though, the directly and indirectly internationally exposed sectors, not just of the UK economy but throughout the industrial world, will continue to operate in a highly competitive environment.

All in all, this is an uncertain and difficult prospect. It will be an exceptionally challenging period for both international and domestic monetary policy management in both the United Kingdom and the euro zone, as well as in the rest of the industrial world. And it will, I know, be a challenging period for many of you, even though the excessive strength of the exchange rate has now started to ease. But our economy as a whole starts from a position of relative strength compared with the past, and our own financial underpinnings, including both corporate and personal sector balance sheets, are relatively robust. We are currently seeing an overall slowdown, as we needed to do. That slowdown could go further. But I would frankly be surprised if it developed into a steep or protracted recession—that certainly is not the most probable outcome; it is not a necessary outcome; and it is one that the MPC will certainly seek to avoid, always consistently with achieving our inflation target.

Mr President, I can promise you that the next two years will be eventful. The only other certainty is that we shall be confronted by the Millennium. But I would hope that by the time we meet at this Dinner again, the situation will be both clearer and calmer. In the meantime, I thank you once again for your excellent hospitality, and I ask you all to rise and to join me in a toast to the health and prosperity of the CIB in Scotland.

Monetary policy and the labour market

In this speech,[1] *Mervyn King, Deputy Governor of the Bank, discusses the link between unemployment and inflation in the transmission mechanism of monetary policy, how the Monetary Policy Committee uses empirical information about the UK labour market when deciding on interest rates, and the way in which unemployment enters the objectives of monetary policy. Mr King asks whether, with an explicit inflation target, it is true that the MPC neither cares about unemployment nor takes it into consideration.*

It is both an honour and a challenge to deliver the fourth EPI lecture. It is an honour to follow in such distinguished footsteps, and it is a challenge to tackle the subject of the link between monetary policy and the labour market. Few subjects are as emotive. Wages, jobs and unemployment feature as frequently in the popular press as they do in academic articles. The Bank of England must learn from one in order to convey our message in the other. And we are fortunate in that labour economics is a field in which British economists have been—and continue to be—at the forefront of research. That I can say objectively because I am not myself a labour economist. So tonight I shall be exploring lessons from the labour market for the Monetary Policy Committee (MPC). The Employment Policy Institute has played an important role in bringing together those undertaking research on labour markets and those involved with policy decisions. In particular, its Employment Audit provides a valuable commentary on current developments.

The labour market is unlike any other market. Indeed, for many people the very language of economists—equilibrium unemployment, market-clearing wages—seems incompatible with the human dimension of unemployment and deprivation. Are the 16 million unemployed people in the European Union merely an equilibrium, on the one hand, and a statistic, on the other? But for most people the labour market *is* the market where—for better or worse, in sickness or in health—they sell their time and their skills at a market price. That price determines, in large part, their opportunities and economic welfare. Wage rates have a much greater significance in influencing the distribution of real incomes than do the prices of almost anything else. As a result, the labour market cannot be divorced from broader social and political considerations.

If their terminology and language are sometimes insensitive, what do economists have to offer by way of ideas about unemployment? The prize for the most important idea and most insensitive terminology surely goes to Milton Friedman for the concept of the natural rate of unemployment. I shall discuss shortly the significance of this idea for monetary policy. But for a more elegant advocacy of a similar position it is necessary to delve further back in history.

This month sees the 75th anniversary of the publication of what Milton Friedman described as John Maynard Keynes' best book: *A Tract on Monetary Reform*. It is, undoubtedly, one of the most persuasive polemics ever written on the subject of monetary policy. To coincide with publication in December 1923, Keynes gave a lecture to the National Liberal Club in which he talked about 'the triple evils of modern society'. From the notes Keynes used for that lecture—printed in his Collected Writings—we can see that Keynes regarded the evils as, first, the 'vast enrichment of individuals out of proportion to any services rendered'; second, the 'disappointment of expectations and difficulty of laying plans ahead'; and third, 'unemployment'. Fat cats, short-termism, and the jobless society: Keynes was ahead of his time. All these Keynes argued were 'mainly due to instability of the standard of value'. Over the past twenty years, Britain faced the same three problems. The income distribution widened and the rewards for those with special talents, and even for some with no apparent talent, increased significantly more than earnings for the unskilled. Both inflation and expectations of inflation were high and unstable, making it more difficult for firms to plan for the long term. And the unemployment rate rose to double-digit levels.

Keynes argued that the way to prevent those triple evils from undermining society was price stability. Central bankers should be as vigilant in countering deflation as in preventing inflation. The link between unemployment and inflation has been a central theme in macroeconomics for the remainder of the century.

Following the publication of *A Tract on Monetary Reform*, Keynes received a letter from none other than the Deputy Governor of the Bank of England. 'Dear Keynes,' he wrote, 'I write to you in this familiar fashion because we are both old Kings' Scholars, though not of the same election'. So far, so good. Regrettably, however, the then Deputy Governor's only comment on the book appeared to be that he was grateful to Keynes for writing in a style

(1) The Employment Policy Institute's fourth annual lecture, given on 1 December. I am grateful to Spencer Dale and Martin Brooke for help in the preparation of this lecture, and to Mark Cornelius, Philip Evans, Nigel Jenkinson, Mike Joyce, Richard Thornton, John Vickers and Peter Westaway for additional comments and suggestions.

which an educated man could read with pleasure, and for having the book printed in a particular attractive style.

This Deputy Governor has learned a great deal from Keynes' book. I refer to it in almost every lecture I give. In this lecture I shall discuss *three* aspects of the significance of the labour market for monetary policy. The first of these concerns the link between unemployment and inflation in the transmission mechanism of monetary policy.

The second issue is how the MPC uses the available empirical information about the UK labour market when deciding on interest rates. How do unemployment figures and earnings data enter the MPC's decisions?

The third issue is the way in which unemployment enters the objectives of monetary policy. With an explicit inflation target, is it true that the MPC neither cares about unemployment nor takes it into consideration when setting interest rates?

The labour market and the monetary transmission mechanism

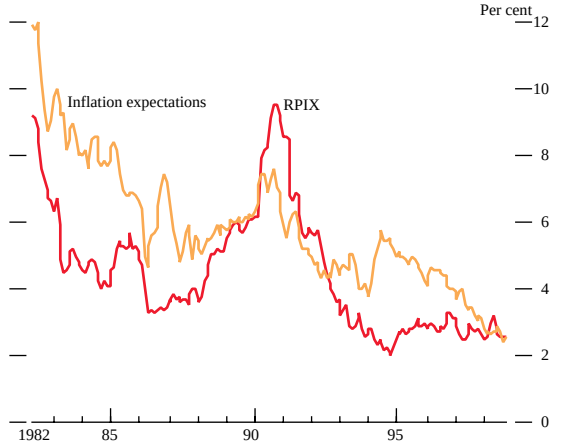
The theory of unemployment has spawned more concepts, and—without doubt—more acronyms, than almost any other field of economics (apart, perhaps, from measures of price inflation). I shall return to the language of unemployment later. But I want first to discuss the two concepts which are at the heart of any discussion of monetary policy and the labour market. They are the natural rate of unemployment and the rate of unemployment consistent with stable inflation, usually known as the NAIRU.

The concept of the natural rate of unemployment, introduced by Milton Friedman and Edmund Phelps thirty years ago, is the level of unemployment that—as Friedman famously described—would be 'ground out by the Walrasian system of general equilibrium equations' reflecting the structural characteristics of the labour and product markets. Friedman was the first to recognise that this natural rate of unemployment was neither constant over time nor immune to policy influences.

The natural rate hypothesis implies a vertical long-run Phillips curve. In other words, if the monetary authorities attempted to 'peg' the level of unemployment below the natural rate, then this in time would cause the inflation rate to rise indefinitely. The work of Friedman and Phelps soon proved highly relevant. The futility of using monetary policy to choose between different combinations of unemployment and inflation became only too apparent in the 1970s. Monetary shocks can—and in the early 1980s and 1990s, did—cause unemployment to deviate from its natural rate, but only for a period. As inflation expectations catch up with the consequences of the monetary shock, unemployment returns to the natural rate.

But the responses of unemployment and inflation expectations to monetary shocks are far from immediate. Indeed, Friedman speculated that the full adjustment to an unexpected change in inflation might take up to 'a couple of decades'. Such long lags in the dynamics of the labour market mean that there is unlikely to be a simple relationship between deviations of unemployment from its natural rate and changes in the inflation rate. Chart 1 shows that it did indeed take almost twenty years to bring inflation and inflation expectations (implied by financial market returns on indexed and conventional gilts) down from double-digit levels to the current target of $2^{1}/_{2}$%, accompanied by a large rise and subsequent fall in unemployment.

Chart 1
RPIX inflation and inflation expectations[(a)]



(a) Derived from five-year implied forward inflation rate.

The idea of the NAIRU can be thought of as a conceptual response to inertia in the system which means that the response of the economy to shocks will be protracted. In 1975 Franco Modigliani and Lucas Papademos introduced the concept of the non-inflation rate of unemployment—the NIRU—defined as 'a rate such that, as long as unemployment is above it, inflation can be expected to decline'. Note in passing that more appropriate terminology would be the non-increasing inflation rate of unemployment (NIIRU). Modigliani and Papademos recognised that the NIRU would be affected by macroeconomic shocks. They argued that there was evidence to suggest that 'over the last two decades the NIRU [in the United States] was held down by a favourable trend in the terms of trade between the private non-farm sectors on the one hand and imported goods and farm products on the other. A termination or reversal of this trend would tend to raise the NIRU, at least temporarily'.

It is ironic that two of the most prominent economists (one a future Nobel prize winner and the other a future central bank governor) of countries synonymous with art and beauty—Italy and Greece—should have given birth to an unattractive acronym that has spawned so many even more unappealing cousins. The first, and most feted, offspring—the NAIRU—was introduced by James Tobin five years later. NIRU, NIIRU, NAIRU—tongue-twisters for the *Financial Times* Christmas quiz, or measures of the Inflationary Trigger Point? Take your choice. For the sake of simplicity I shall adopt the conventional term, NAIRU, to represent the entire family.

So what is the relationship between the natural rate of unemployment and the NAIRU? The natural rate of unemployment and the NAIRU are quite different concepts. The former describes a real equilibrium determined by the structural characteristics of the labour and product markets—the grinding out of Friedman's Walrasian general equilibrium system (modified, if necessary, by non-Walrasian features of labour markets such as imperfect competition, search behaviour and efficiency wages). It exists independently of the inflation rate. In contrast, the latter, as well as being affected by these structural characteristics, is also affected by the gradual adjustment of the economy to past economic shocks that determine the path of inflation. Because it is defined as the unemployment rate at which there is no immediate pressure for a change in the inflation rate, it is a reduced-form—not a structural—variable.

This difference is reflected in the methods used to generate empirical estimates of the two concepts. The natural rate of unemployment can be estimated only by reference to a structural model of the labour market which has explicit microeconomic underpinnings and which can be used to identify the characteristics determining the natural rate. Empirical estimates of the natural rate would typically be related to inflation only in the long run, when the effects of shocks average out. In contrast, the NAIRU is estimated using a system of time-series equations relating inflation to past and present economic shocks. The sole criterion for judging the success of estimates of the NAIRU is their short-term correlation with inflation. Indeed, the NAIRU as defined here—and in recent work by Estrella and Mishkin (1998)—is the level of unemployment such that the difference between it and the current rate of unemployment is all that is necessary to describe short-run inflationary pressure.

Although the NAIRU will tend towards the natural rate of unemployment in the long run, there is no reason to expect there to be a close relationship between the two measures in the short run. The natural rate is likely to move only relatively slowly over time in response to changes in its structural determinants. In contrast, the NAIRU will vary both with changes in the natural rate and in response to macroeconomic shocks. So those who argue that estimates of the NAIRU are too time-varying to be plausible are, I think, in danger of missing the point.

The NAIRU can be used as an *ex post* device to describe the level of unemployment at which inflation did (or would have) started to increase. But the usefulness of these estimates as an *ex ante* predictor of future inflationary pressure depends critically upon the economic environment. In particular, for estimates of the NAIRU to be a good predictor of future inflation, the natural rate would need to be relatively stable, and the magnitude of likely shocks would need to be small. This perhaps goes some way to explaining why estimates of the NAIRU in the recent past have appeared to contain more *ex ante* information about future inflation in the United States than they have in Europe.

More fundamentally, the distinction between the natural rate and the NAIRU illustrates the difficulty of using those concepts for the month-to-month implementation of monetary policy. The natural rate, although clearly relevant to the dynamics of inflation, is not sufficient to explain changes in the inflation rate. The NAIRU, which is defined to be a measure related to short-run inflationary pressures, requires knowledge of the reduced form of the transmission mechanism and the history of shocks to the economy. But that knowledge is required also for a forecast for inflation, and so the NAIRU itself provides no additional information over that contained in the forecast. Indeed, estimates of the NAIRU could be described as a by-product of the process of forecasting inflation.

As an example, consider the impact of the appreciation of sterling from mid 1996 until late 1997. Retail price inflation can be thought of as a weighted average of domestic and imported inflation. The substantial real appreciation of sterling since mid 1996 has for a while reduced the imported component of UK inflation and so, in turn, retail price inflation, below the level that it would otherwise have reached. In essence, the NAIRU fell relative to the natural rate. That restraining effect on inflation will gradually wear off and begin to be reversed if sterling continues to fall. The issue of whether the domestic inflation component would fall to a level consistent with the inflation target by the time this temporarily depressing effect wore off was central to the monetary policy debate during the summer.

The example of sterling's appreciation shows how a macroeconomic shock, entirely independent of the labour market, can affect the relationship between the rate of unemployment and the rate of inflation. The rise in sterling is likely to have reduced the NAIRU via two separate channels. First, in the short run, the relationship between domestically generated inflation—of which wage inflation is a substantial element—and retail price inflation shifts because of lower imported inflation. Second, the temporary improvement in the terms of trade that followed the rise in sterling in 1996 reduced the wedge between the real consumption wage—which is of relevance to workers and which reflects a mix of both domestic and imported inflation components—and the real product wage—which is of relevance to employers and which reflects the prices only of domestically produced goods. That reduction in the wedge is likely to have reduced the pressure on nominal wage growth for any given level of unemployment.

So it is quite possible to believe that the NAIRU has fallen even if the natural rate has not. But this is likely to be temporary. As the impact of sterling's appreciation on wages and prices wears off, the NAIRU will, other things being equal, rise tending towards the natural rate. But other more lasting changes may reduce the natural rate (and hence the NAIRU). For example, a range of government policies, including changes to the Jobseeker's Allowance, the New Deal and the new Working Families Tax Credit, have increased incentives to work. The National Minimum Wage works in the opposite direction. Assessing the impact of these structural factors on the natural rate is no easier than

calculating the effect of macroeconomic shocks on the NAIRU. But it is useful to distinguish the two concepts, not least because they can move quite differently in the short run.

Enough of this theory, some of which may appear largely semantic. None of it is, of course, either new or original. But understanding the language of unemployment matters. Richard Rogerson, in the *Journal of Economic Perspectives* last year, posed the question 'Have the language and concepts developed by economists in their study of unemployment served their role of fostering clear communication of findings and allowing issues to be sharply defined?' Professor Rogerson's conclusion, you will perhaps not be surprised to hear, was a resounding no. Neither the natural rate nor the NAIRU are terms well chosen to win friends and influence people. After all, there is nothing natural about the natural rate.

Whatever we call them, it is crucial to recognise that there is considerable uncertainty about the location of both the natural rate of unemployment and the NAIRU. Even in the United States, where there appears to be no obvious trend in the natural rate, estimates of the 95% confidence interval for the NAIRU are typically from 5% to 7.5%. In the United Kingdom, where both structural reforms and macroeconomic shocks have had a larger impact than in the United States, the range of uncertainty is even greater. Perhaps the most honest answer to the question of what is the natural rate was that given by Milton Friedman to the *Wall Street Journal* in January 1995, 'I don't know what the natural rate is, neither do you, and neither does anyone else'.

The labour market and monetary policy in practice

How do these concepts affect monetary policy in practice? And what role does analysis of the labour market play in the MPC's decisions on interest rates?

Using the language of unemployment developed earlier, the MPC has to assess whether the current level of unemployment differs significantly from the NAIRU, and, as importantly, whether it is likely to remain so in the future. It may do that explicitly by taking a view on the level of the NAIRU, or it may do it implicitly by producing a forecast for inflation. In practice, we focus directly on an inflation forecast.

But the need for policy-makers to focus on the level of unemployment and the level of output each time they assess the stance of monetary policy is unavoidable. Alan Greenspan has to do it. MPC members have to do it. Knowing that the growth rate of GDP is (or is likely to be) above or below its trend rate of increase is of little value unless one also knows where the level of output is relative to potential. This is a basic, but fundamental, point. If, for whatever reason, the level of unemployment is below the natural rate, a rise in unemployment is unavoidable. That may be undesirable. But any attempt to avoid it will simply result in a longer, or more pronounced, correction at a future date. In order to hit the inflation target, the MPC needs to minimise deviations in the level of output from potential, not in the growth rate of output from its trend.

The need to focus attention on the *level* of economic activity is of course well understood by the academic community. It is now standard practice in the literature on monetary policy to assume that the authorities seek to minimise a social loss function, defined in terms of the deviation of the level of output or unemployment from their equilibrium values, and in terms of the deviation of inflation from its desired value. But if this is so obvious, why, in discussions of the economic conjuncture and economic policy is so much attention placed on growth rates rather than on levels? Why are commentators and pundits so concerned with whether economic growth is going to be above or below its trend rate, or even whether it is likely to be above or below zero? That is not what matters for economic policy nor, more importantly, for social welfare.

An excessive focus on growth rates of output and employment, rather than on their levels, may reflect a rather natural, but dangerous, optimism about the degree of spare capacity in the economy. After all, is not the belief that we could always achieve lower unemployment without an increase in inflation the mark of a kinder, gentler, altogether more civilised approach to economic policy? Or is it simply wishful thinking? As Greg Mankiw put it:

'Wishful thinking is one reason that monetary policy has historically been excessively inflationary…To my mind, wishful thinking is as worrisome a problem for monetary policy as time inconsistency'.

Genuine concern for the unemployed means a recognition that sustainable reductions in unemployment require a combination of monetary stability on the demand side and microeconomic reforms such as the New Deal on the supply side. As Alan Blinder has reminded us, we need soft hearts and hard heads, not the other way round.

Despite suggestions to the contrary, the MPC does have soft hearts and hard heads, and does not base its assessment of the labour market—never mind its decisions on interest rates—solely on estimates of the growth of average earnings. An assessment of the overall tightness of the labour market requires all the available data—both quantity and prices—to be analysed. The wealth and diversity of published labour statistics means it is rare for them all to point in the same direction. The MPC's analysis of the labour market is like the construction of a jigsaw puzzle. The pieces of data are assessed alongside each other in order to build up as clear a picture as possible. No single piece of data is interpreted in isolation. And no single piece of data is, in itself, decisive.

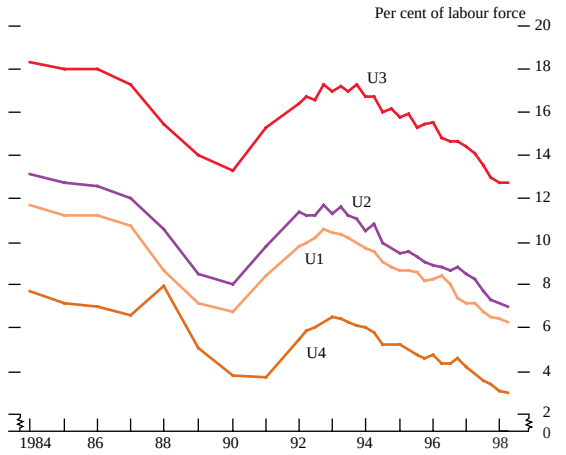
The growth of wages and salaries is an important indicator of domestically generated inflation. But this does not imply that there is some magical threshold defining 'acceptable' and 'unacceptable' rates of earnings growth. In the short

run, the link between earnings growth and inflation is complicated by a whole host of factors, including exchange rate movements, cyclical variations in productivity and profit margins, irregular bonus payments, and one-off adjustments to tax rates and other 'wedge' effects. It is true that, given the United Kingdom's historical levels of productivity growth of around 2% and the inflation target of 2½%, it would be a cause for concern to the MPC if average earnings increased by much more—or much less—than 4.5% over a *prolonged* period without there being a corresponding change in trend productivity growth. That is not because the Committee has a view about the appropriate level of pay awards. It is not our job to second-guess what businesses should or should not pay their employees. Nor is it because we think earnings growth *causes* inflation—inflation is a monetary phenomenon. Rather it is because sustained earnings growth much above or below these rates may *indicate* that the level of utilisation in the labour market has reached a level inconsistent with the inflation target.

The June meeting of the MPC drew particular attention to the rise in headline earnings growth as measured by the Average Earnings Index. But that should be viewed against a background of increasing concern about the tightness of the labour market. In its meeting in April, the Monetary Policy Committee noted that 'labour market data on quantities were signalling a tighter position than the price [earnings] data'. At that time, the Labour Force Survey and claimant-count measures of unemployment had fallen below their previous troughs recorded in the spring of 1990, and were still declining. This position was evident across all categories of unemployment, as can be seen from Chart 2, which shows the various measures of joblessness reported in the EPI's Employment Audit. In addition, employment and total hours worked were rising quite strongly; recruitment intentions were at their highest level for nine years, with the level of vacancies at job centres, and the average duration of these vacancies, both well above their 1988/89 peaks; and survey measures of recruitment difficulties were also at high levels.

The underlying rise of the Average Earnings Index had increased to 4½% by the beginning of 1997, but was little changed by the end of the year. If I had been asked to deliver the third Annual EPI lecture, rather than the fourth, the main question you might have expected me to grapple with was why earnings growth had not at that point risen by more, given the 1.0 million fall in unemployment and the 1.4 million rise in employment since the end of 1992. As a Committee, we discussed at some length during the spring of this year why the changes in the quantity measures had not fed through to higher earnings growth. We discussed whether the natural rate of unemployment (and NAIRU) might have declined due to an increase in trend productivity or improvement in the functioning of the labour market. We also considered whether there had been independent influences on the NAIRU stemming from falls in inflation expectations or the effects of sterling's appreciation.

Chart 2
EPI measures of unemployment



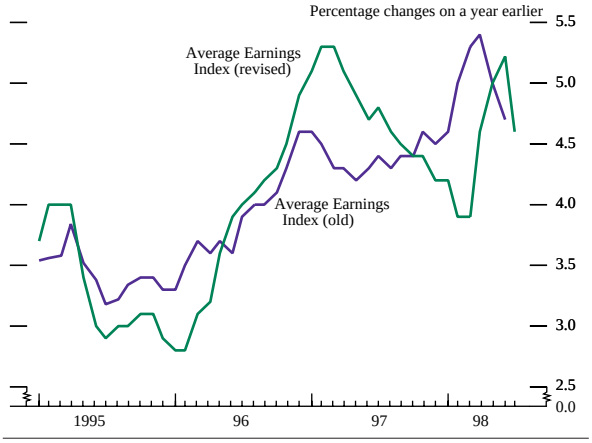
U1 = ILO unemployment.
U2 = U1 plus discouraged workers and people seeking work but unable to start in next two weeks.
U3 = U2 plus all others who want jobs.
U4 = ILO unemployed more than six months' duration.

It is against this background that the MPC's decision to raise rates in June should be judged. The increase in headline earnings growth to 4.9% in February, from an upwardly revised 4.6% the previous month, appeared consistent with other labour market indicators. But we were fully aware of the evidence suggesting that the rise in earnings growth had been, and for a couple of months would continue to be, affected by unusually large bonus payments. If this was true, earnings growth might well have fallen back once the bonus effect dropped out. Given the uncertainties in this area, the Committee concluded that it should not place too much weight on the latest numbers. Instead, it stepped back and examined the underlying trend in the labour market over the previous two years. We noted that private sector earnings growth had been rising throughout this period and that reported wage settlements displayed a similar profile. Given this longer-term perspective, the MPC concluded that capacity constraints in the labour market were threatening the attainment of the Government's inflation target.

Of course, since then, the earnings data have been successively revised, rebased and suspended—a piece of the jigsaw has temporarily gone missing. As you can see from Chart 3, the growth profile of the old series showed a steady rise from around 3¼% in mid 1995 to nearly 5½% or so by the spring of this year. In sharp contrast, the revised and rebased data (before they were suspended) followed roughly the shape of a slightly squashed capital 'N'. From a trough of 3% at the end of 1995, earnings growth was estimated to have risen to a peak of over 5¼% in February and March 1997 before falling back below 4% in early 1998 and then bouncing back above 5% again by May.

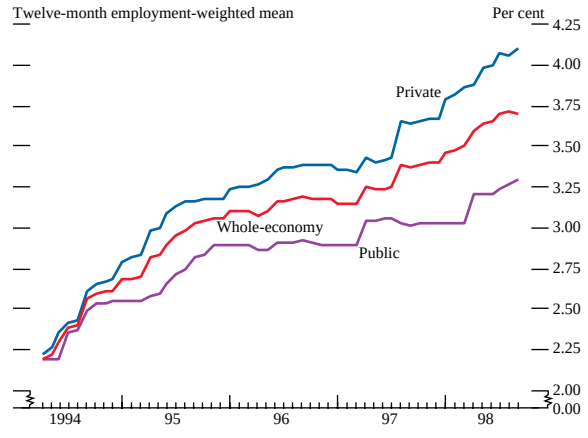
How would the MPC's analysis of the labour market have changed if the revised (but now suspended) data had been available six months earlier? That question is not easy to answer. The quantity data would still have suggested that the labour market was both tightening and, by historical

Chart 3
Headline average earnings growth: pre and post revisions



standards, tight. The MPC would therefore have had the unenviable task of trying to understand why the steady tightening in the quantity measures had produced a zigzag path for measured earnings growth. We would also have had to try to understand why the zigzag profile of the new Average Earnings Index was not visible in other measures—shown in Chart 4—of nominal earnings growth, such as wage settlements and private surveys. As I have said elsewhere, trying to reconcile the new earnings series with other labour market data is far from easy.

Chart 4
Wage settlements by sector



The Chancellor wrote to Giles Radice, the Chairman of the Treasury Select Committee, on 23 October announcing that he had asked Sir Andrew Turnbull and myself to conduct a review of the revisions to the average earnings figures. The review, which is considering both methodological and managerial issues, is being carried out by Martin Weale of the National Institute, supported by Peter Sedgwick of the Treasury. Martin and Peter have made an enormous effort over the last month or so to finish the review as quickly as possible. However, exactly when the report will be finished and what it will conclude, are, I am afraid, still not known. As a result, the ONS has yet to decide when to resume publication of the average earnings series. All I can say today is watch this space.

The labour market and the objectives of monetary policy

In the final part of my talk, I want to turn to the question of what this analysis of the labour market implies for monetary policy. One—perhaps the most—important economic and social problem facing Europe is the high level of unemployment—16 million unemployed people throughout the European Union, a rate of over 10%, with young people under 25 accounting for almost a quarter of this total. That represents a major failure of economic policy. But is it a failure of monetary policy? To go one step further, should the objectives of monetary policy—whether enshrined in the Maastricht Treaty or in the Chancellor's remit for the MPC—be altered to include an explicit reference to unemployment? Many think so. For example, in Europe the new German Finance Minister, Oskar Lafontaine, has said that, his aim was a 'European monetary policy that supported growth and employment as well as price stability'. Nearer to home, the TUC has called for the MPC to be given a wider remit to include employment as well as inflation. And several newspaper editorials have argued for a broader remit for the MPC.

The fact that the proposition appeared in a newspaper does not of course mean that it is necessarily compelling. As my newsagent told me the other day: 'don't believe everything you read in the newspapers—they are all in the hands of the media'.

The argument for including employment explicitly in the formal remit of the MPC is often bolstered by reference to the objectives of the Federal Reserve in the United States, which is charged by statute with promoting 'the goals of maximum employment, stable prices, and moderate long-term interest rates'. At first sight, this appears to contrast with the remit of the MPC, which is to: '(a) maintain price stability and (b) subject to that to support the economic policy of Her Majesty's Government, including its objectives for growth and employment'. But what matters most is the intellectual framework underlying the behaviour of the central bank. The Federal Reserve's remit does not make clear whether or not there is a long-term trade-off between employment and inflation which it is the responsibility of the FOMC to exploit. But the practice is clear. Under Alan Greenspan's leadership, the FOMC has firmly rejected the notion that by accepting a somewhat higher rate of inflation it is possible to achieve a *permanently* higher level of employment.

It is conventional to express the implications of a vertical long-term Phillips curve in terms of the statement that unemployment can be held below the natural rate only by accepting accelerating inflation—or, to be more precise, an inflation rate higher than anticipated by wage-bargainers. Equally, however, the statement can be turned the other way round. If the central bank is successful in pursuing, over a number of years, a constant rate of inflation, then unemployment cannot remain above the natural rate indefinitely. Not only can central banks not bring

unemployment down below the natural rate for long, neither can they be held responsible for unemployment persistently above the natural rate. Monetary policy cannot influence levels of employment in the long run. There should be no surprise about this. A central bank can use its chosen instrument—interest rates—to hit a nominal target—such as an inflation target, or a target for the exchange rate, or even the growth of nominal GDP—but it cannot use a nominal instrument to target some desired level of a real variable, such as the growth rate of output or the level of unemployment.

None of the above means that monetary policy has no impact on unemployment. On the contrary, monetary policy does affect the movements of employment and unemployment over the business cycle. And the remit of the MPC makes clear how we should take this consideration into account—as I explained a year ago in a lecture at the LSE. By aiming consistently and symmetrically to hit the inflation target, the MPC should ensure that inflation is, on average over a number of years, close to the target of 2½%. Shocks of various kinds will mean that inflation will often deviate from the target and the MPC is required to take action to bring inflation back to the target. But it will do so gradually, if to do otherwise would have damaging consequences for employment or output. By looking ahead and aiming to bring inflation back on track over a horizon of two years or so, the MPC should be able to avoid undesirable volatility of employment and output. That is part of our remit.

Conclusions

Let me briefly draw two conclusions from my analysis tonight. First, the concept of a natural rate of unemployment, and the existence of a vertical long-run Phillips curve, are crucial to the framework of monetary policy. They help us to focus on levels of output and employment rather than simply their growth rates. They also mean that there may be times when, although a rise in unemployment is undesirable, it is unavoidable. But the natural rate is of much less help in operational decisions on interest rates made month by month. This is because the natural rate is determined by microeconomic structural factors that are not easy to observe, and which are likely to change over time, and may not bear any close relationship to inflationary pressures in the short run.

More easily observable in terms of its relationship to inflation and unemployment is the concept of the NAIRU. This differs from the natural rate when macroeconomic shocks affect the rate of inflation corresponding to any degree of excess demand in the labour market. Since the NAIRU represents the current reduced-form relationship between inflation and unemployment, it is possible to calculate the prospects for inflation without any need to refer to such a variable as the NAIRU. It is a convenient shorthand concept for purposes of exposition, but not a necessary tool for operational decisions on interest rates.

Second, the contribution of monetary policy to employment objectives is to promote economic stability in its broadest sense. I referred at the outset to Keynes' view that the 'triple evils' of an unequal distribution of income, instability of expectations, and unemployment, were all related to an unstable and unpredictable monetary standard. The solution, Keynes argued, was to set monetary policy to hit a target for prices, or a low and stable inflation rate. He argued 75 years ago that monetary policy should be devoted to regulating the supply of money so that 'the index number of prices will never move far from a fixed point'. Keynes went on to say that,

'The Bank of England since the war has always done exactly the opposite of what the latest science recommends. I conclude from this that their opposition comes, not from mere obstinacy or conservatism, but from their not yet understanding the point. I am, therefore, optimistic about the future'.

It took the Bank of England almost seventy years to get to that point and introduce an inflation target. The objective of stability is best achieved by an inflation target because it stresses both what monetary policy cannot do—reduce unemployment in the long run—and what it can do—react to shocks in order to minimise undesirable volatility in output and employment. To that end, the pursuit of an explicit and symmetric inflation target is the relevant objective of monetary policy. With an inflation target, and, more recently, the new MPC, both unemployment and inflation have fallen significantly. I hope and believe that, with these new institutional arrangements, although we shall certainly make mistakes in the setting of monetary policy, we should be able to avoid the instabilities of the past thirty years which did so much to damage Britain's economic standing.

We should never forget that—as Milton Friedman pointed out in his 1968 Presidential Address (quoting in turn John Stuart Mill)—monetary policy becomes important for society only when it goes badly wrong. That is the basis for my proposition that a successful monetary policy should be boring, and that successful central bankers should be seen neither as heroes nor villains, but simply as competent referees, allowing the game to flow and staying out of the limelight. In the end, a central bank is doing its job when no one notices that it is there. So if, over the past forty minutes, I have been sufficiently boring then I promise to carry on in that vein. If not, then I promise to mend my ways.

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EMU: a view from next door

In this speech,[1] John Vickers, Executive Director and Chief Economist at the Bank of England, discusses some of the criteria for, and determinants of, the success of Economic and Monetary Union (EMU). He notes the importance of the ability of a common currency to deal with economic shocks that have asymmetric effects in different countries, and the role (and limitations) of convergence. He concludes with some remarks on EMU work at the Bank.

Introduction

One hundred and fifty years ago, John Stuart Mill was absolutely clear on the single currency question:

'So much of barbarism, however, still remains in the transactions of most civilised nations, that almost all independent countries choose to assert their nationality by having, to their own inconvenience and that of their neighbours, a peculiar currency of their own'.[2]

Mill was an internationalist ahead of his time. Though England had been on the gold standard, with interruption, since Isaac Newton had defined the conversion rate between gold and the pound sterling three centuries ago, it was only in 1844 that the basis for a single banknote system was established within England. But as the nineteenth century progressed, European currencies increasingly became manifestations of, or at least normally convertible into, gold—the underlying international common currency of the day—just as eleven of them will very soon enter the stage in which they are manifestations of the euro.

It goes without saying that it is in the interests of everyone that EMU is a success—for 'ins', for those who may be regarded effectively as 'pre-ins', and for 'outs' such as Japan and the United States. But what are the criteria for success, and what will success depend on? That is the first question that I want to address today. The second is convergence. What kinds of convergence are important for a pre-in country, and how can they be achieved? Finally, I would like to mention some developments in EMU work at the Bank of England.

What is success?

From an economic viewpoint, the success of EMU is closely tied to that of the European Single Market. A single money is not necessary for a single market, but it surely helps. The Single Market, like all markets, exists to facilitate mutually beneficial transactions. Mill's precursor David Ricardo saw how trade brought gains from diversity. According to his principle of comparative advantage, countries should, and under free trade would, concentrate on what they were best at in relative terms. So England would export cloth to Portugal (at least in those days), Portugal would export wine to England, and both would gain.

Moreover, the Single Market can bring gains from specialisation through the achievement of an efficient scale of operation in a number of industries, at the same time as yielding greater choice and variety for consumers. And the enhanced competition that comes with the Single Market should further spur productivity. In short, openness is good for growth.

What have monetary arrangements got to do with this? At the most basic level, money has the same core purpose as markets—to facilitate mutually beneficial transactions. Not only simple deals like those between the sellers of cloth and sellers of wine, but also more complex arrangements such as those between borrowers and lenders (whom I shall return to later), and between buyers and sellers of insurance.

A common currency has the advantage of minimising the inconvenience (including that of the neighbours) of international transactions—though of course there are costs of moving over to a common currency—and of eliminating uncertainties about nominal exchange rates between participating currencies. A single currency should also enhance international price comparability, and hence promote competition in the Single Market and the benefits it promises.

But for these gains to be fully achieved, the value of money in terms of goods and services must be stable and expected to remain so—at least stable enough to pass the Greenspan test that economic decisions are not unduly troubled by concerns about inflation or disinflation. Thus the first criterion for the success of EMU is price stability for the euro.

This, of course, is the paramount goal of monetary policy laid down by the Maastricht Treaty, and there is every reason to believe that it will be achieved. That being so, EMU might have the further advantage of bringing

(1) Given at the RIIA conference on EMU in London on 27 November 1998.
(2) Mill, J S, *The Principles of Political Economy*, 1848 (1894 edition, Vol 2, page 176), quoted in Mundell (see footnote 1 on page 99).

price stability to member countries that have not always enjoyed it.

But what about countries such as the United Kingdom that have the elements in place for—and, dare I say it, a developing record of—credible home-made price stability? In John Stuart Mill's words, is the assertion of nationality the only reason for such countries to have currencies of their own? No.

Of the many challenges for currency union to address, of particular importance is the possibility of undesirable fluctuations in output and employment caused by the inevitable but unpredictable stream of large-scale economic events—the so-called 'shocks'—that all economies face. How well the euro-area economies cope with these shocks, especially asymmetric shocks that affect individual countries differently, will be key to EMU's success.

The essence of the problem was set out in the classic paper on currency areas by Robert Mundell.(1) Suppose that there are two countries A and B. They start with full employment and balanced trade. Then there is an asymmetric shock: consumer preferences alter so that demand shifts in favour of A's products relative to B's. This is good news for producers in economy A, whose real incomes will rise, but bad news for producers in B, whose real incomes must fall if balance is to be restored.

So long as producers in economy B resist the necessary fall in their *real* incomes, output and employment in B will decline, but monetary and exchange rate policies can do little to help solve this problem. But suppose, not unrealistically, that the resistance, or at least part of it, is to falling *money* prices and incomes. In other words, there is nominal rigidity.

With a common currency there is a dilemma. Easing monetary policy to boost demand in economy B has the consequence of increasing inflationary pressure in fully employed economy A, and hence in the union of A and B. Indeed, since by assumption prices in B cannot fall, inflation (in the price of domestically produced products) in A is needed to reduce real incomes in B, and to restore the balance of trade. 'One-size-fits-all' monetary policy cannot do two jobs at once.

Within bounds, fiscal policy can still come in different sizes. But in the context of EMU, there is little scope for international transfers from A to B, and scope for inter-temporal transfers to current citizens from future generations in country B may also be limited, depending on countries' fiscal positions in relation to the Stability and Growth Pact.

Separate currencies provide a degree of freedom—depreciation of B's currency relative to A's. Monetary tightening in A to restrain inflation, and easing in B to restore output and employment, can both happen at once. Real incomes adjust and balance is restored.

Since the economic value of exchange rate flexibility depends on kinds of market rigidity—relative immobility of workers, and inflexible wages and prices—a key determinant of the success of EMU will be public policies to promote and sustain flexibility of the supply side of the European economy, upon which economic potential ultimately depends in any event. The more freely and flexibly the Single Market can work, the weaker will become the economic case for separate currencies.

Convergence of what?

As well as developing market-based shock-absorbers, it is important also to scrutinise the sources of asymmetric shock. Tackling particular kinds of asymmetry is of course the point of the Maastricht convergence criteria, and of the Chancellor's economic tests for UK membership.

Asymmetries can result from shocks that affect countries differently—for example, oil shocks affect continental Europe and the United Kingdom differently—and from asymmetric responses to common shocks—for example, because of differences in the transmission mechanisms of monetary policy. There are many questions about asymmetric shocks. Let me focus on two. Is the transmission mechanism in the United Kingdom unlike that in the rest of Europe? If so, should attempts be made to promote convergence of monetary transmission mechanisms—for example, as has been suggested, by encouraging migration from floating-rate mortgages, which have been typical in the United Kingdom, to fixed-rate mortgages, which are typical in continental Europe?

The first of these questions is hard to answer. The available evidence is mixed, with some but not all studies finding greater-than-average interest rate sensitivity in the United Kingdom. But the way that interest rate changes affect the United Kingdom would alter if it joined EMU, not least because there would then be no effects via the exchange rate between sterling and euro-area currencies.

A recent paper that reviews the evidence, and adds more, is by Dornbusch, Favero and Giavazzi.(2) They estimate for six countries the elasticities of output with respect to a common change in interest rates, while holding exchange rates fixed. They find that the impact effect (ie within eight to twelve months) in the United Kingdom is similar to that in France and Germany, somewhat larger than in Spain, but significantly smaller than in Italy and Sweden. The effect after two years is smaller in the United Kingdom than elsewhere, which the authors attribute partly to the fact that UK activity is less strongly related to the European business cycle. However, UK activity is correspondingly more open

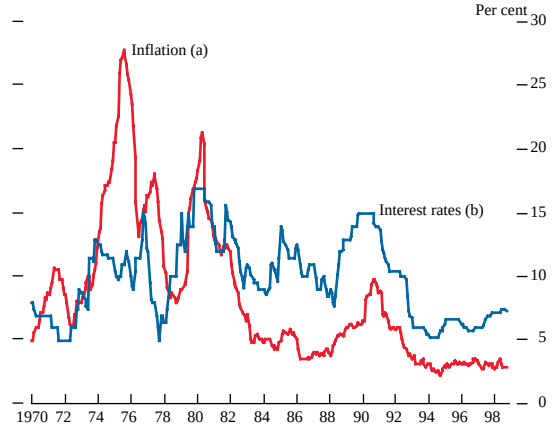
(1) Mundell, R, 'A Theory of Optimum Currency Areas', *American Economic Review*, 1961, Vol 71, pages 657–64.
(2) Dornbusch, R, Favero, C and Giavazzi, F, 'Immediate Challenges for the European Central Bank', *Economic Policy*, 1998, Vol 26, pages 17–52.

to transatlantic influences, and this may be a source of asymmetric shocks.

On the second question—the possibly unusual sensitivity to interest rates arising from the extent of floating-rate mortgages in the United Kingdom—it must be remembered first that for every borrower there is a lender. Ultimately, via financial intermediaries, lenders are also households. Thus while the UK personal sector has substantial liabilities with floating interest rates, it also has substantial assets of that kind. Of course, this is not to say that changes in short-term interest rates have little net effect on households. There will be important substitution effects on demand, and substantial income effects if borrowers and lenders on average have different marginal propensities to consume out of income. Still, it is important to keep in mind both sides of the household balance sheet.

It is also important to ask the underlying question: why have UK mortgage borrowers and lenders tended in the past to favour floating-rate debt over fixed (nominal) rate debt? No doubt there are numerous reasons, but a major one is surely the volatility and associated unpredictability of UK inflation—especially in the 1970–92 period (see the chart).

UK inflation and interest rates



(a) Annual percentage change of retail prices, based on RPI for 1960–75 and RPIX since 1975.
(b) Official interest rates.

Volatility of short-term interest rates is associated with volatile inflation. This is the *cashflow uncertainty* drawback of a floating-rate mortgage. But this seems likely to be a much lesser evil than large *real wealth uncertainty* associated with fixed (nominal) rate mortgages in an economy that lacks price stability. In a world of unpredictable inflation, real wealth uncertainty is diminished, but of course not eliminated, by floating rates insofar as those rates tend to move with inflation.

Of course, a much better way to contain that uncertainty is credibly to establish price stability, which should also make interest rate variability lower than in an inflationary environment. Price stability therefore has the double benefit of diminishing both cashflow uncertainty and real wealth uncertainty.

In the past six years, the United Kingdom has begun to enjoy a greater degree of price stability, and price stability is now the paramount monetary policy objective of the operationally independent Bank of England. Over those six years, short-term interest rates have also been rather stable—in a range between 5.25% and 7.5%. It so happens that the recent period has also seen a substantial shift in the balance between fixed and floating-rate mortgages. Data from the Council of Mortgage Lenders(1) suggest that around 60% of new mortgages taken out in the first half of this year were fixed-rate, compared with only about 20% of the stock of outstanding mortgages.

It would obviously be fallacious to infer that the establishment of a regime for price stability was necessarily the prime cause of that shift in borrowing behaviour. The recent period has also been one in which the yield curve has been inverted, so fixed-rate mortgage payments have been below floating-rate mortgage payments in the short run. But the inversion of the yield curve—in particular the fall in longer-term interest rates over the past year or so—is itself related to prospects for price stability. Therefore, considerations of price stability could well have been a factor in the recent shift towards fixed-rate mortgages, and might favour a further shift in the future.

A common thread in this discussion is that a country's transmission mechanism is not set in stone. The UK economy would respond differently to interest rates from how it does now if the United Kingdom joined EMU, for example because effects via European exchange rates would be suppressed. Allowing for this, it is not obvious that the UK economy is unusually sensitive to interest rates. But it may be, for example because of the atypical structure of housing finance. If so, it is noteworthy that there has been a recent spontaneous shift towards fixed-rate mortgages, perhaps partly because of a much better prospect that price stability will be achieved in the United Kingdom—in or out of EMU.

EMU and the Bank

Before concluding, let me say a word about EMU work at the Bank. The Bank's work helping the City of London prepare for the advent of the euro is nearly done, and the Bank will of course monitor closely the progress of the euro wholesale markets. Through London's international financial markets, the United Kingdom can make a major contribution to the development of the euro.

From 1 January 1999, the Bank will have a Director for Europe, John Townend, who will be responsible for co-ordinating all the Bank's European-related activities. And within the Bank's Monetary Analysis Division, which I head, we are setting up a new division for International Economic Analysis, to be run by Andrew Bailey. This will cover not only the Bank's existing and growing work on macroeconomic developments in the major industrialised

(1) Council of Mortgage Lenders, *UK and the Euro: Housing and Mortgage Market Perspectives*, October 1998.

economies and in the world economy as a whole, but also the economic analysis of EMU, including the possibility of UK membership. The Bank, like the rest of the City of London, is ready for the euro.

Conclusions

The main economic argument for independent currencies is that the shock-absorber of exchange rate adjustment is retained. A central element of the case for a common currency is therefore the ability to deal with shocks that have asymmetric effects other than by exchange rate adjustment.

To that end, some kinds of asymmetry between countries can be reduced by promoting convergence. This makes sense in dimensions such as monetary and fiscal stability, and economic conjunctures at the point of membership. But it must be remembered that many of the fundamental benefits of market openness—which EMU should enhance within Europe—stem from diversity and specialisation, not similarity.

The key complementary approach is further supply-side reform to promote market-based shock-absorbers, so that a free and flexible Single Market underpins the success of EMU. John Stuart Mill would surely be in favour of that.

Central bankers and uncertainty

In this speech,[1] *Professor Charles Goodhart, member of the Bank's Monetary Policy Committee, discusses how central banks do, and how they should, change short-term interest rates in response to economic developments.*

For the majority of my professional life, I have had the good fortune to be simultaneously involved both as a participant in, and as an academic observer of, central banks. Today, and as is suitable for this occasion and audience, I shall be primarily emphasising my academic observations. Nevertheless, my study of central bank behaviour is inevitably informed and coloured by my previous years as a Bank official, and current position as an external member of the Monetary Policy Committee (MPC), but my comments today are unauthorised, not necessarily representative of any of my colleagues or of other central bankers, independent and, I trust, reasonably objective—and where they are mistaken I have no one to blame but myself, except of course for the econometrics, where I have had help from the Bank staff.

Let me plunge into the central policy issue. The key decision that the monetary authorities take each month is whether, and by how much, to change the short-term interest rate. There was a time when a vocal segment of the academic community advocated a notably different operating mechanism, of monetary base control, but that debate has faded.

The question has, instead, become how central banks actually do, and how they should, vary interest rates in response to economic developments. The suggestion has now been made by a number of academics, notably by John Taylor, that most central bank reaction functions (except for those pegging their exchange rates and hence their interest rates to some other country) can in practice be reasonably well described by a relatively simple function, often now termed the Taylor rule; and that this rule approximates quite closely to the social welfare optimum, when examined in the context of a variety of models established for a variety of countries (Taylor, 1998a, b and c, and papers at the June 1998 Stockholm Conference). Under such a Taylor reaction function, the nominal level of the interest rate is determined by the current level of two variables, the rate of inflation and an (inherently somewhat uncertain) measure of the output gap, the deviation of actual output from potential, so:

$$i_t = a + b_1\pi_t + b_2\,(y_t - y^*)$$

where a is the equilibrium real interest rate (usually about 2% or 3%).[2]

My first point is that virtually all attempts to estimate the Taylor rule empirically require the addition of a lagged dependent variable, ie the interest rate in the previous period, in order to fit well. Moreover, with monthly, or quarterly data, the coefficient on the lagged dependent variable is usually close to, and in some estimated cases greater than, unity. This means that central banks have historically changed rates by only a small fraction of their ultimate cumulative reaction in response to an inflationary shock or to a deviation of output from potential. Thus, the equation actually fitted becomes:

$$i_t = a + (1 - \rho)\,b_1\pi_t + (1 - \rho)\,b_2\,(y_t - y^*) + \rho i_{t-1}$$

My main theme today is to enquire further into this phenomenon whereby virtually all central banks change interest rates, in response to shocks, by a series of small steps in the same direction, rather than attempting more aggressively to offset that shock quickly in order to return the economy to equilibrium.

Some academics studying this subject deal with this issue by positing that changes in interest rates enter the authorities' loss function. But why should that be so? One can easily understand the social loss arising from inflation and deviations of output from potential, but what exactly is the social loss arising from changes in interest rates themselves? We shall attempt to pursue this question further soon, but in the interim I want to raise a few points about the use of such a reaction function and its application to the United Kingdom.

First, the generally quite good fit of an estimated Taylor rule is not to say that in some countries, over some time periods, one cannot improve the fit by adding other variables. In small open economies, especially those pegging their exchange rate, the interest rate in the home country will also respond significantly to interest rates in its larger neighbour (Peersman and Smets, 1998). Nor, of course, are the coefficients closely similar for all countries (and over all time periods) in such estimated reaction functions.

(1) The annual Keynes lecture, given at the British Academy on 29 October 1998. The author would like to thank the British Academy, which holds the copyright of this speech and discussion and will be publishing them in its *Proceedings*, for permission to publish them here.
(2) Indeed, in some cases, notably Germany, evidence has been presented that such a reaction function fits the observed data better than the explanations given by the central bank of its own behaviour. Thus, Clarida and Gertler (1997) show that the addition of monetary variables to a Taylor-rule reaction function for Germany adds nothing to the explanatory power of that equation.

One of the curious lacunae in this literature has been the failure so far to integrate the Taylor reaction function literature with the literature on central bank independence.[1] I would expect the measure of independence to be positively associated with the size, and perhaps the speed, of the authorities' reaction to inflation shocks.[2] There is some partial and preliminary evidence that this conjecture is correct. For example, Stephen Wright at Cambridge (1997) tested such reaction functions for Germany, the United States and the United Kingdom over the time period 1961 Q1–94 Q4, and found that over this time period the estimated cumulative response of the monetary authorities in the United Kingdom to an inflationary shock, ie the size of the coefficient b_1, at 0.8, was both considerably less than that of the Federal Reserve and of the Bundesbank, and also below the value of unity required to guarantee price stability. But when I asked Stephen to re-run his equation over the last decade, he obtained the much higher value of 1.6 for the b_1 coefficient in the United Kingdom, as large as that in Germany, and slightly larger than the standard value of 1.5 incorporated in the normative versions of the Taylor rule.

Similarly, a preliminary study of a number of separate, and quite short, monetary regimes in the United Kingdom, undertaken in the Bank by Ed Nelson (1998), has found the coefficients in the Taylor reaction function, especially the b_1 (inflation response) coefficient, to be strongly time-varying, as shown below:

Table A
Taylor reaction function coefficients; United Kingdom, 1972–97

	b_1	b_2	ρ	
1972/76	0.00	0.69 (a)	0.70 (a)	Quarterly
1976/79	0.44 (b)	0.58	0.70 (a)	Monthly
1979/87	0.46 (a)(b)	0.08	0.75 (a)	Monthly
1987/90	-ve	0.25 (a)	0.66 (a)	Monthly
1992/97	1.32 (a)(b)	0.24	0.40 (a)	Quarterly

(a) Significant, t > 2.
(b) Forward-looking; using instrumental variables.

One of the most visible and widely remarked aspects of current central banking mores is that they, especially when independent, are supposed to give absolute primacy to the achievement of price stability. The level of output is not supposed to enter, for example, the objective function of the ECB or of the Bank of England. Yet, as described, the revealed preference of all monetary authorities appears to be to respond both to current inflation and to the current output gap. Actually, this seeming conundrum is very simply resolved. There are two ways to answer this question. The first is that these two variables, ie current inflation and the current output gap, are the critical variables needed to forecast future inflation. A regression of current inflation for the United Kingdom on the levels of inflation and a measure of the output gap one year previously, a measure that is as always somewhat arbitrary and uncertain, gives the following result:

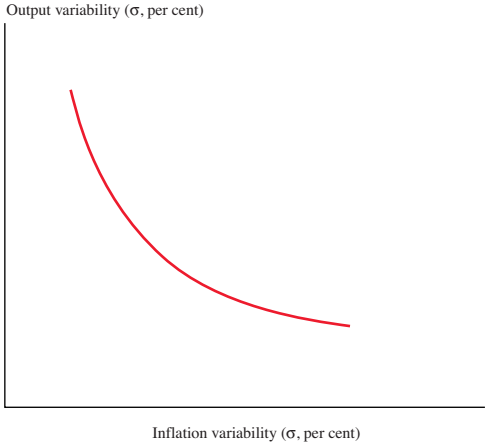
$$\pi_t = \underset{(0.011)}{0.010} + \underset{(0.113)}{0.840}\,\pi_{t-1} + \underset{(0.199)}{0.527}\,(y - y^*)_{t-1}$$

$R^2 = 0.739$, SEE = 0.029 (1974–97 annual data).

This is not to say that the vast efforts put in by the Bank staff and others to construct the inflation forecast do not add value to our estimates of future inflation, but it does suggest that knowledge of current inflation and where the country stands on the output gap, or equivalently using Okun's Law with respect to the natural rate of unemployment, can take one most of the way there. Given that lags in the transmission mechanism mean that the authorities can only reasonably target an inflation forecast (Svensson, 1997, a and b, and Svensson and Rudebusch, 1998), appearing to respond to current inflation and to the current output gap may well appear superficially much the same as targeting a pure inflation forecast.

The second leg of the answer, which was discussed in greater depth by Mervyn King in his 1997 Financial Markets Group lecture, is that even if we knew exactly how our economies worked, subject only to additive, stochastic shocks with mean zero, such shocks would still, from time to time, drive us away from our longer-term objectives of holding output close to productive potential with low, or zero, inflation. As is well known, the problem is particularly acute with supply shocks. That gives rise to the well understood complication that if one tries to restore inflation back very rapidly to its equilibrium, the lagged effects of monetary policy can lead both to large-scale, 'excessive' variations in output (around productive potential), and in many cases also to instrument instability (when the changes in interest rates needed to offset last time's disequilibrium become explosively greater over time). On the other hand, enormous concern to prevent any large deviation of output from its equilibrium can lead to continuing and excessive deviations of inflation from target. This leads to a trade-off between output-variability and inflation-variability of the general form shown in Chart 1.

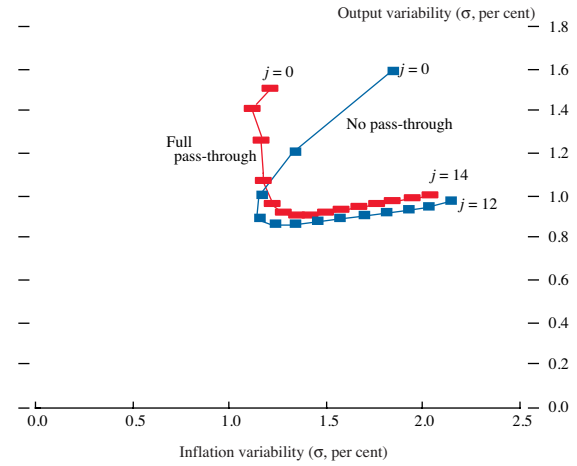
Chart 1
Output/inflation variability trade-off



(1) This void is being rapidly filled now; see, for example, Murchison and Siklos (1998).
(2) Though there is evidence that the Bundesbank, and perhaps other more independent central banks, react as or more slowly than those that have been more subservient (see Goodhart (1997) and Fischer, A M (1996)).

Fortunately for the MPC, the empirical evidence for the United Kingdom currently indicates that this is not a serious problem. The work of Haldane, Batini and Whitley at the Bank of England (1997) suggests that if one chooses an appropriate horizon for returning inflation to its target, one will achieve about as good an outcome for both inflation and output variability together as is practicably possible. Thus, in Chart 2, the choice of lag length (*j* in the chart) for returning inflation to its target simultaneously more or less minimises both inflation deviations and output variability following a shock.

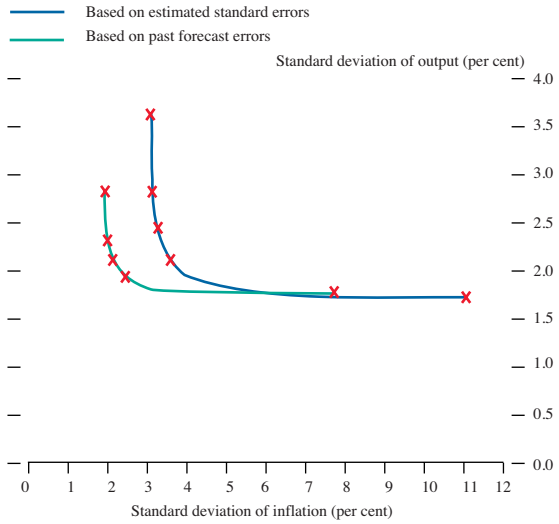
Chart 2
***j*-loci: full and no pass-through cases**(a)



(a) Chart 2 plots the locus of output/inflation variability as the horizon of the inflation forecast (*j*) is varied, one assuming full and immediate import-price pass-through (a shorter transmission lag), and the other, no immediate pass-through (a longer transmission lag).

In another independent exercise, my discussant, Charlie Bean (1998), estimated such a policy frontier between the standard deviations of inflation and output (see Chart 3).

Chart 3
Policy frontiers



He then wrote: 'The most striking thing about these frontiers are how sharply curved they are—indeed they are almost rectangular—and how close together are the optimal points for relative weights in the range 1:3 to 3:1. This rectangular quality is also found in the work of Haldane and Batini (1998),..., suggesting that it is not simply an artefact of the rather simple model structure employed here. This rectangularity has an important implication: a wide range of possible weights on output *vis-à-vis* inflation lead to the selection of rather similar points on the policy frontier. Hence little is lost by the government being able to write only an incomplete contract with the central bank, which does not explicitly prescribe the relative weight the central bank is supposed to place on output volatility versus inflation volatility; the central bank only needs to know that preferences are not extreme. Furthermore such an incomplete contract is likely to lead to a better outcome than a more completely specified contract that encourages the central bank to select a policy that is at the upper end of the policy frontier. One interpretation of the UK inflation remit is that it is precisely such an incomplete contract'.

So the evidence suggests that the short-term trade-off between the variance of inflation and output, over which so much blood has been spilt, is, in the United Kingdom at least, in practice not such a difficult and troublesome issue. The key point is that the MPC should choose an appropriate future horizon at which to aim to return to the inflation target set by the Chancellor. By doing so, they should be able to minimise the variance of both output and inflation. Given that horizon, how then should the monetary authorities operate, according to the principles that flow from our models of the economy, always remembering, and I really want to emphasise this, that in most of these models the only uncertainty in the system is additive and stochastic?

The answer to that conditional question is fairly clear. We should each month alter interest rates so that the expected value of our target, the forecast rate of inflation at the appropriate horizon about 18 months to two years hence, should exactly equal the desired rate of 2½%. Lars Svensson has written several papers on the optimality of such a procedure. If we start from an initial position in which the predicted forecast value of inflation is already close to the objective, then as a first approximation we should expect interest rates to respond to the unanticipated element in the incoming news. Since this is by definition a martingale series, often somewhat loosely termed a 'random walk', then, on these assumptions, an optimally conducted interest rate path also ought to be nearly random walk, as should also, of course, be the voting pattern of individual members of the MPC. This is, broadly, what the generality of our economic models imply.

I shall shortly demonstrate how, and why, no central bank actually does behave in such a random walk fashion. But before I do so, I want to contrast the normative theory inherent in our basic models with the public perception that such random walk behaviour is not optimal in practice. Thus, in *The Times* on Thursday, 11 June, under the headline 'Anger grows at Bank's U-turn' (page 29), Janet Bush and Anne Ashworth state that,

'Critics of the increase described the Bank's apparent shift in policy as 'almost laughable'. One said: 'It is like a drunk staggering from side to side down the street''.

You will appreciate that this latter is an almost perfect description of a random walk path. Similarly, the *Sunday Business* main leader of 7 June was entitled 'The fickleness of hawks today and doves tomorrow'; the unnamed writer commented,

'Where the committee lost credibility last week is in its inconsistency.... What is the outside world meant to make of members who can change their view so readily? It suggests a fickle committee, influenced by the latest anecdotal or statistical evidence, swaying its opinions one way or the other and back again'.

One of the arguments used by Wim Duisenberg, the President of the ECB, in rejecting the publication not only of individual voting records but also of minutes for some long duration is apparently, and this passage is in direct quotes in Robert Chote's *Financial Times* article on 1 June (page 10), that:

'Publication of the minutes soon after decisions have been taken or meetings have taken place will—and this is only human—make it more difficult for individual participants in the discussion to change their minds and be convinced of the arguments of others'.

Now this struck a particular chord with me; for example, yet another commentator, Jonathan Loynes, writing in *Greenwell Gilt Weekly* on 18 May, wrote,

'Of course, this does not mean that Professor Goodhart cannot switch *back* to the Hawks. If his change of heart was driven by recent softer earnings numbers then the latest pick-up could cause him to think again. But an immediate about-turn is most unlikely, if only for reasons of credibility'.

Wim Duisenberg presumably now doubts my humanity, Jonathan Loynes my credibility. Yet let me reprise once again. If policy is roughly on course to deliver the desired objective, then policy should be finely balanced, and should react to incoming unanticipated news in an approximately random walk fashion. A committee, or an individual within that, who consistently votes the same way for month after month either has got the balance of policy seriously wrong, or individually must think that that balance is seriously wrong.

I previously qualified the term 'random walk behaviour' with the adverb 'approximately'. The first point to make is that the dynamic structure of the economy involves strong serial correlation and long lags in monetary policy effects. If we seek to optimise monetary policy in a model with such inherent lags, even if we still use a certainty-equivalent model only involving additive stochastic uncertainty, then we could expect to find some degree of serial correlation in the path of interest rates. The dynamic structure of the economy itself can account for part of the observed persistence in the directional movement of interest rates. To repeat, interest rates should not be random walk even under certainty-equivalence. But the degree, the extent, of gradualism exhibited in interest rate policy is far higher than the dynamic structure of serial correlation in the economy alone can justify.

An excellent paper by Brian Sack (1998a; see also 1998b) of the staff in the Fed's Board examined, by using a VAR model, initially with additive uncertainty, what the expected policy in adjusting the fed funds rate would have been if policy was to be optimised. He found (page 4) that:

'The optimal policy displays a tendency to move in a particular direction over sustained periods of time, as found in the data. Still, the optimal policy responds more aggressively to changes in the state of the economy than the observed policy. As a result, the funds rate path under the expected policy is more volatile than the actual funds rate. Moreover, the observed policy tends to lag behind the expected policy, limiting any changes in the funds rate and gradually moving towards the optimal policy over a period of six months. The actual policy is therefore described by an excessive amount of interest rate smoothing that cannot be explained strictly by the dynamic behaviour of the variables to which the Fed is responding. The interest rate smoothing that is observed indicates that the analysis under additive uncertainty ignores an important element of policy making'.

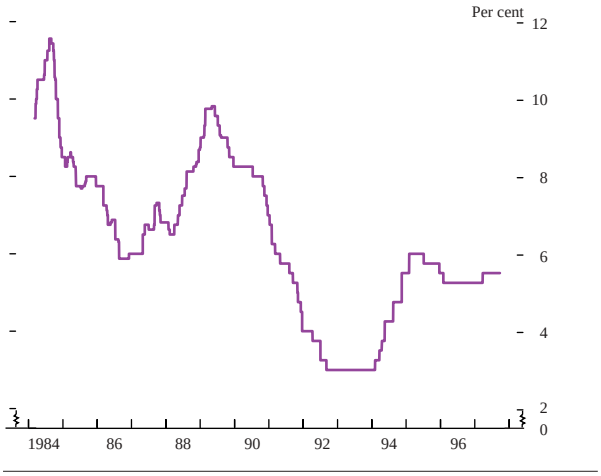
One way of expressing this difference visually is to compare the path of the calculated 'optimal' and actual fed funds rate, as Sack does in his Figure 2, here Chart 4. You can see that the green optimal expected line is more jagged, with more reversals of direction than the actual fed funds path. As you can see from the time path of the actual planned target rate

Chart 4
Actual and optimal funds rate under additive uncertainty

Note: The optimal funds rate is based on the policy rule that solves the dynamic programming problem. It is the rate predicted by the policy rule given the actual history of the economy at each point in time.

(see Chart 5), most of the changes amount to small steps in the same direction. The cumulative distribution for the expected optimal policy with additive uncertainty is very different from that of the actual policy followed.

Chart 5
Actual federal funds rate



There are, however, some technical problems relating to the estimation and assessment of the calculated optimal interest rate change at any time. For example, should this be done on a one step ahead basis, starting from the actual level of interest rates in the preceding period, or on a dynamic basis starting from what would have been the optimal level of interest rates in the preceding period? In practice, when the actual level of interest rates is not too far from the estimated optimal level, the results are qualitatively pretty similar.

Anyhow, both sets of results are shown in Table B. This compares the actual changes in interest rates in each month in the United States with those that would have been made under the optimal policy rule(s), assuming stochastic additive uncertainty. The interest changes, which in the model can take any size, are here grouped into 'bins', whereby any optimal change between plus and minus 12½ basis points is counted as a 'no change' decision, any optimal change between 12½ and 37½ basis points is grouped into the 25 basis point (¼%) change 'bin', and so on. You should also note that, for reasons that will become increasingly obvious, I have grouped all changes that were continuations of an existing direction of change on the left of the table, and all changes that reversed the direction of movement on the right hand side. Let me draw three features to your attention. First, under the optimal policy, there would have been 55 (47) changes(1) over this time period of ½% or more; in reality, there were 23. So policy is less aggressive than the model would suggest was optimal. Second, no change was made in practice more than twice as often as this model indicated would be optimal. Third, whereas the number of continuations in the model, 76 (58), was very close to the number actually made, the number of reversals in the model, 36 (55), was about four times those made historically (10). Compared with the model predictions, the Fed has a bias to make no change, appeared extraordinarily reluctant to reverse the direction of change, and tended to eschew large, aggressive movements.

Because of the importance I attach to this kind of analysis, I have been encouraging the Bank staff to complete a companion study for the United Kingdom to that done by Sack for the United States—not that they needed much encouragement from me; it was already on their agenda. Unfortunately, the estimation of satisfactory VAR models for the United Kingdom is a much more complex exercise. The United Kingdom a more open economy, which requires a model with a larger dimension; policy regime changes have been more frequent and more drastic; and the price puzzle(2) has been even more stubbornly pervasive in the UK than in US models. Be that as it may, despite all the difficulties, Chris Salmon and Ben Martin of the Bank of England staff are now constructing a VAR model (on a broadly similar basis to that estimated by Sack for the United States) for the United Kingdom. I hope that their work will soon appear as a Bank of England *Working Paper*. This VAR is quarterly, from 1981 Q2 to 1998 Q2. A serious problem with this is that there were several major monetary policy regime changes during this period, which have, perforce, to be averaged out in this exercise.

Moreover, in the United Kingdom, for a variety of reasons relating to shifting policy regimes (eg Medium Term Financial Strategy, shadowing the DM, exchange rate mechanism, etc), and/or possibly to policy errors, actual interest rates were often markedly out of line for persistent periods from the optimal policies estimated from VARs. So the only comparison that made sense in the United Kingdom was that between actual policy and that estimated

Table B
Optimal interest rate changes from the United States

Certainty	Number of continuations							Number of reversals						
	Up >0.5	Down >0.5	Up 0.5	Down 0.5	Up 0.25	Down 0.25	No change	Up 0.25	Down 0.25	Up 0.5	Down 0.5	Up >0.5	Down >0.5	
(a) One step ahead change on actual	9	6	11	10	21	19	40	8	9	7	6	3	3	152
(b) Dynamic change on own lag	7	3	4	11	12	21	39	20	13	5	8	3	6	152
(c) Actual policy	1	6	9	5	9	20	92	4	4	1	1	0	0	152

(1) The number refers to row (a) and the number in brackets refers to row (b) of Tables B and F throughout this article.
(2) In such VAR models, the initial response of inflation to an interest rate increase is often, perversely, to increase.

Table C
Actual number of interest rate changes

	Number of continuations									Number of reversals							
	Up >1	Down >1	Up 0.75	Down 0.75	Up 0.5	Down 0.5	Up 0.25	Down 0.25	No change	Up 0.25	Down 0.25	Up 0.5	Down 0.5	Up 0.75	Down 0.75	Up >1	Down >1
UK additive uncertainty (a)	4	6	2	3	3	5	3	1	1	2	4	7	5	2	2	8	8
UK actual policy (a)	2	8	2	3	2	9	2	8	14	1	0	1	2	2	1	5	4
US actual policy (b)	2	1	2	5	3	5	2	7	15	1	2	1	0	1	1	0	1

(a) 1981:3–1998:2 (66 observations).
(b) 1984:3–1996:4 (49 observations).

Table D
Percentage of total interest rate decisions

	Number of continuations									Number of reversals							
	Up >1	Down >1	Up 0.75	Down 0.75	Up 0.5	Down 0.5	Up 0.25	Down 0.25	No change	Up 0.25	Down 0.25	Up 0.5	Down 0.5	Up 0.75	Down 0.75	Up >1	Down >1
UK additive uncertainty (a)	6	9	3	5	5	8	5	2	2	3	6	11	8	3	3	12	12
UK actual policy (a)	3	12	3	5	3	14	3	12	21	2	0	2	3	3	2	8	6
US actual policy (b)	4	2	4	10	6	10	4	14	31	2	4	2	0	2	2	0	2

(a) 1981:3–1998:2 (66 observations).
(b) 1984:3–1996:4 (49 observations).

as the optimal dynamic change on the previous optimal value.

Anyhow, we have now used this quarterly model for the United Kingdom to try to replicate Sack's results. This is shown for quarterly data in Table C, on the assumption of stochastic additive uncertainty only (ie certainty-equivalence). Recall, however, that Sack's model was monthly, which accords more closely with the periodicity of monetary decision-making. So if there were three consecutive monthly 25 basis point changes in the quarter in the United Kingdom, this would come out in our quarterly figures as a single 75 basis point change. To facilitate comparison, we have also recalculated Sack's results for US actual policy at a quarterly frequency, and this is also shown in Table C for the actual numbers, and in Table D for exactly comparable proportions.

What this shows is that, as in the United States, 'optimal' policy, subject only to additive uncertainty, would be far more activist (only one 'no change' in 17 years, compared with 14 in reality), and much more prone to reversals (38 under the optimal policy, compared with 16 in reality); the number of continuations in practice (36) was again quite close to that under the optimal policy. What is, however, strikingly different between the two countries is the apparently much greater willingness in the United Kingdom to change interest rates by considerably larger steps. We believe that this is because UK policy had to respond to larger shocks, more regime changes and perhaps worse policy errors.

So the gist of my assessment is that, both in the United Kingdom and the United States, there are about the same number of steps in the same continuing direction, many more 'no change' decisions, and many fewer reversals of direction than might appear optimal under a certainty-equivalent model. In the United States, but not in the United Kingdom, there were also fewer large changes in interest rates than would have appeared optimal. Moreover, this is not just an Anglo-Saxon phenomenon. A general dislike of making large aggressive changes in interest rates, and the bias towards 'no change' decisions, is well documented for all developed countries. What I would like to emphasise here is that a concern to avoid reversals of direction is also well-nigh universal, as documented in the latest 1998 BIS *Annual Report*. This *Report* comments (page 68), and I quote,

'There is some evidence that a dislike of reversals of this sort is not uncommon in the industrial countries. Central banks generally move interest rates several times in the same direction before reversing policy. Moreover, the interval between policy adjustments is typically considerably longer when the direction is changed. As the size of the steps at turning-points is not systematically larger than at other times, this pattern of adjustments risks being interpreted as a tendency to move 'too little, too late'. One possible rationalisation for such behaviour is uncertainty about the policy impulses. Such uncertainty is likely to be greatest at the turning-points of the interest rate cycle. A further reason for wishing to avoid frequent interest rate reversals is the desire to provide clear guidance to markets, both to strengthen the pass-through along the yield curve and to avoid destabilising markets'.

If you rank countries in terms of the ratio of continuations to reversals, with the top being Austria with 63 continuations to 2 reversals, the United Kingdom comes 9th out of 12, well below the median, so the evidence suggests that we have actually been comparatively more willing than most to change direction.

Table E
Policy rate adjustments

	Sequence of adjustment											
	Number of changes				Average duration (a)				Average change (b)			
	+ +	+ -	- +	- -	+ +	+ -	- +	- -	+ +	+ -	- +	- -
United States	6	1	2	22	41	108	321	39	0.46	0.25	0.25	0.28
Germany	65	31	31	107	22	24	34	14	0.25	0.19	0.12	0.15
France	8	5	6	86	47	72	77	31	0.51	0.40	0.83	0.21
Italy	9	6	6	24	122	182	121	83	1.31	0.88	0.96	0.73
United Kingdom	28	17	18	84	36	69	49	23	0.94	0.50	0.77	0.37
Canada	10	1	2	21	22	57	103	21	0.43	0.25	0.25	0.25
Spain	4	5	4	33	56	72	67	35	0.42	0.24	0.35	0.38
Australia	2	1	1	17	43	413	264	67	1.00	0.50	0.75	0.79
Netherlands	55	27	28	108	16	15	32	15	0.42	0.53	0.40	0.21
Belgium	9	7	8	82	17	10	82	10	0.45	0.24	0.34	0.14
Sweden	14	1	2	24	16	132	146	10	0.12	0.25	0.27	0.18
Austria	15	1	1	48	70	42	150	34	0.38	0.50	0.25	0.16

Notes: + + = two successive increases (tightenings); + - = increase followed by decrease;
- + = decrease followed by increase; - - = two successive decreases (easings).

Policy rates and starting dates of the sample periods: Australia, official target rate, 23 January 1990; Austria, GOMEX, 6 May 1985; Belgium, central rate, 29 January 1991; Canada, operating bands 15 April 1994; France, tender rate, 4 January 1982; Germany, repurchase rate, 19 June 1979; Italy, discount rate, 1 January 1978; Netherlands, special advances rate, 1 January 1978; Spain, repurchase rate, 14 May 1990; Sweden, repurchase rate, 1 June 1994; United Kingdom, Band 1 bank bills, 1 January 1978; United States, federal funds target rate, 10 August 1989. End of sample periods: 31 March 1998.

(a) In days.
(b) In percentage points.

So the common practice among central banks is to make long series of small steps in the same direction. This behavioural pattern is partly, but only partly, picked up in the econometrics for the Taylor rule, in the guise of the near-unitary value of the lagged dependent variable.

John Taylor, of the eponymous rule, has studied the comparative virtues of rules of this kind, both with and without smoothing of the form empirically observed, in simulations carried out in some ten models of various economies. His conclusions (1998d, page 11) are that, 'Comparing such rules [with smoothing] with the two rules that do not respond to the lagged interest rate shows that neither type of rule dominates across all models. However, for a number of models the rules with lagged interest rates have very poor performance with extraordinarily large variances. These could be Great Depression or Great Inflation scenarios in some models. It turns out, however, that the models that predict very poor performance for the lagged interest rate rules are models without rational expectations, or in which forward looking effects are not strong in the model. Why? Interest rate rules which respond with a lag exploit people's forward-looking behaviour; these rules assume that people will expect later increases in interest rates if such increases are needed to reduce inflation'.

Put another way, it is alright for the authorities to act slowly in a series of cautious small steps, just as long as a forward-looking public can effectively undo such cautious lags by immediate anticipation. In a similar vein, Marvin Goodfriend (1991) has argued that an anticipated series of small steps in short rates will trigger off a large change in longer-term bond yields when the sequence starts, and that it may be the latter that has more effect in some economies in influencing demand. This may be particularly the case in countries where the objectives, and forecasts of the likelihood of reaching those objectives, are not regularly and publicly quantified.

It surely must be the case that the eventual determination to vary interest rates enough to defeat inflation is more important than the speed, or path, by which this is done: the Bundesbank, for example, is even more prone to smoothing than has been the case in the United Kingdom. When the reputation for determination is in place, then the ultimate measures will probably be broadly anticipated by the public. But even if it can thus be claimed that smoothing is, in general, a fairly harmless exercise, it still leaves the question of why the monetary authorities in virtually all major countries have adhered to this behaviour pattern so determinedly. What have we failed to understand?

The failings, of course, lie far more in the standard economic models than in the practical behaviour of central bankers. One of the central problems is that uncertainty is far more complex, insidious and pervasive than represented by the additive error terms in standard models. The more essential uncertainty is multiplicative, ie attached to the coefficients in the models—or, in simpler terms, we do not know the true workings of the economic system. In some cases, we do not even know which coefficients are non-zero, ie which variables are relevant. But even when we do know which variables to include in our equations, we certainly do not know what the true value of their coefficients may be.

Let me give you just two topical examples of such general uncertainties. First, in an open economy, one of the main ways in which interest rate changes have an impact on the economy is via their effect on exchange rates. But can anyone, you, me, the MPC, predict the market's response at all accurately in advance? Second, to revert to the Taylor rule, discussed earlier, life would be so much easier if we knew exactly, when we come to take decisions, what was the sign of the output gap, or of its kissing cousin, the natural rate of unemployment, let alone their true arithmetic values. The regressions on the Taylor rule that I showed you earlier were predicated on the assumption that the way

we estimate the underlying rate of productive potential is absolutely correct, and known with certainty.(1) Whereas, in practice, most governments' supply-side measures are intended to give a beneficial shift to the growth of productive potential and to the natural rate of unemployment. Moreover, it is patently obvious that such supply-side factors have varied over time, though, as in continental Europe, not always for the better.

As the Governor recently said in his speech to the TUC,

'The truth is that neither we, nor they, nor anyone else, can know with any great certainty *precisely* where demand is in relation to capacity in the economy as a whole. Still less do we know where it is likely to be over the next couple of years—and that is the more relevant consideration, given the time it takes before changes in interest rates have their full effects'.

What even is the current sign of the output gap? As is evidenced by our differing votes, we in the MPC can and do individually see the same underlying data having different implications for that gap. Even in the United States, where the natural rate has been historically most stable, there are always arguments that new developments, a new paradigm, may have caused significant shifts in underlying productivity and the natural rate.

Such uncertainty would matter less if it was not for the associated stylised fact that policy actions, notably monetary policy, only take effect with long lags. In the presence of multiplicative uncertainty, it would seem optimal to proceed cautiously, as Bill Brainard (1967) first demonstrated. Indeed, but if there were not such long lags, then the sensibly cautious tendency to underdo the dosage would become rapidly apparent, and just as rapidly rectified. But the problem is that it can take so long for cautious moves to become recognised as such, that the inherent dynamic of the economy can lead to inflationary, or deflationary, momentum building up in the meantime. Or in simpler terms, excessive caution, even though entirely understandable in an uncertain world, can lead to the syndrome of 'too little, too late', or, as the Americans put it, 'falling behind the curve'.

It is, perhaps, in this latter context that the publication of a central bank's inflation forecast becomes so crucial. Despite being properly hedged around with probability distributions, where our uncertainties decently peep out from under our fan charts, and with, of course, the repeated mantra that we never take the forecast either literally or slavishly, the publication of the forecast nevertheless acts as a discipline on us. Against the natural tendency to defer action in an uncertain context, the publication of the forecast holds the MPC's feet to the fire. If the projected outcome for prospective inflation is significantly different from the target (and please allow me just for today to duck the question of how one might assess exactly what is a 'significant' difference), then the MPC comes under strong pressure to rectify the situation. We all know that forecasts are fallible, but without a published forecast, in a world of long lags, the tendency towards 'too little, too late' would become much worse.

'Too little, too late' could, in principle, be perfectly symmetric, in the sense that the response to deflationary pressures could be just as delayed and hesitant as the response to inflationary pressures. And we can all think of episodes, though mostly in other countries, where we might have preferred a more aggressively expansionary response to deflationary pressures. Yet it is my personal opinion that this syndrome is likely to be somewhat asymmetric. Interest rate increases are rarely popular, while expansionary measures are so. In a world of uncertainty, where what you surely know is that you do not know either the future, or even really the present state of the economy, there is in my view an absolutely natural, and perfectly human, tendency towards delaying restrictive action for longer than expansionary measures. I must, however, add that an equally common public perception is that central bankers so hunger for 'credibility' that they have an asymmetric bias towards tightening. Perhaps the two biases roughly balance out?

Again, my discussant, Charlie Bean, got the analysis absolutely right. Having, correctly in my view, largely dismissed the idea that politicians underhandedly try to aim for output levels intentionally in excess of the equilibrium, he goes on to say,

(1) There is some (slight) distinction between parameter uncertainty, whereby $Y_t = a + (b + \varepsilon_t)X_t + u_t$,

$\mu\varepsilon = 0,\ \sigma^2\varepsilon = K_1,\ \mu u = 0,\ \sigma^2 u = K_2$

and measurement error of Y_t, (or less likely in most cases of X_t), whereby the ultimate best estimate of Y is inaccurately measured, especially at first, by $\acute{Y}_t$, with

$Y_t = \acute{Y}_t + \eta_t$, so that

$(\acute{Y}_t + \eta_t) = a + b(X_t) + u_t$

$\mu\eta = 0,\ \sigma^2\eta = K_3,\ \mu u = 0,\ \sigma^2 u = K_2$, ($K$s are constants),

as my discussant, Charlie Bean, has pointed out. As the above formulation indicates, however, their implications are very closely similar.

Orphanides (1998b, also see 1998a) commented as follows:

'In summary, the presence of noise in the data acts as a counterweight to the highly responsive policy that policy-makers might have otherwise adopted to stabilise the economy. This result can be understood intuitively. When a policy-maker suspects that the information he is being provided with regarding the state of the economy is subject to significant noise, he should be reluctant to adjust his policy instrument as much as he would if he could trust the picture of the economy being painted with the data. This suggests that policy will be less activist than would be efficient with better information. More generally, in an environment where the observed behaviour of the economy does not conform well with the policy-maker's beliefs about the underlying state of the economy, the policy-maker ought to properly take into account that much of the information he is provided with describes the economy with substantial error. This, then will call for a cautious response to apparent imbalances in the economy.

It is worth noting that the motivation for this caution differs from the one associated with uncertainty regarding the model's parameters. Following Brainard (1967), it has been recognised that parameter uncertainty may lead a Bayesian policy-maker to reduce the policy instrument responsiveness to economic imbalances'.

'A far more plausible explanation as to why governments might be inclined to push output above the natural rate is that they are expected to deliver a high level of output through the *whole range* of their policies, and are rewarded by the electorate if they achieve this, and punished if they do not. The level of economic activity thus becomes a signal of government competence. Furthermore the natural rate is not known with any certainty, and the beneficial output effects of monetary policy expansion typically show through a year or so ahead of their effects on inflation. Thus governments, particularly near election time, may be more prepared to risk an expansionary monetary policy than is really prudent, arguing that such a policy is not likely to be inflationary, but rather is consistent with their successful effects to raise the output potential of the economy'.

The point that I would like to make here is that such pressures affect central bankers, and even independent members of MPCs, in exactly the same kind of way, even if not to the same extent, that they affect politicians. Nevertheless, there are reasons to hope, and indeed to expect, that an operationally independent monetary authority should be much more resistant to an asymmetric, and excessive, caution in response to uncertainty. First, we do not have colleagues who look to us for re-election. Second, we have a publicly stated, quantified, and symmetric, inflation target to meet, and we can and should be held accountable for achieving that. Third, we have imposed on ourselves the discipline of a regularly published forecast of inflation, which provides a continuing public score-card of how we feel that we are doing in meeting that objective, and we are more likely to respect that discipline than politicians have, perhaps, been in the past.

Let me revert to my central concern about the nature of uncertainty. Unless there is a good reason, and there usually is not, to believe that there is negative inverse correlation between the additive and multiplicative sources of uncertainty, then the existence of multiplicative uncertainty and measurement noise will generally cause the authorities to move in smaller steps. On average, they should underdo the dosage, since a larger change in the instrument, given multiplicative uncertainty, will add to the variance of outcomes. Given the loss function, there is a trade-off between getting as near as possible to the desired value of the target variable and increasing the prospective variance of the target variable(s).

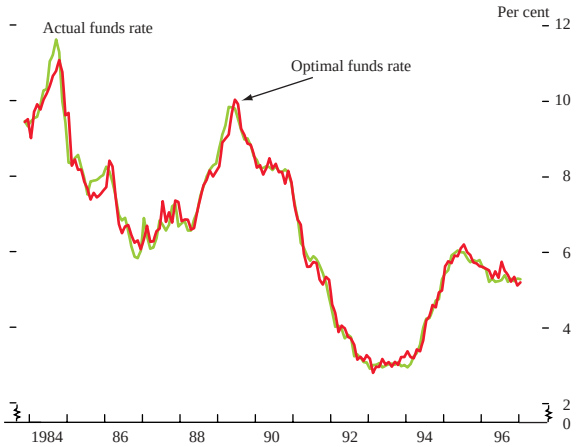
From my personal viewpoint, the essential features of the economy that both set the agenda for, and complicate the life of, the monetary authorities are the interaction between the effects, and implications, of multiplicative uncertainty on the one hand and long lags in the effects of monetary policy on the other. I need hardly remind you that virtually all analysis of monetary policy games, going well beyond textbooks to what are presumed to be state-of-the-art articles, has been based on models in which neither feature appears at all.

We all know that, in principle, such multiplicative Brainard uncertainty should lead to greater caution in varying policy instruments, here interest rates, because a large change in rates will have an uncertain effect on outcomes, and hence raise the possibility of potentially large social losses. But a problem for practitioners is that no one until recently has made much empirical study of how quantitatively important such Brainard uncertainty should be regarded as in practice. Let me put it another way: the manner in which monetary authorities around the world appear to vary interest rates in a series of consecutive small steps of the same sign might be optimal if, and very likely only if, multiplicative uncertainty was indeed a problem of the first order of importance.

Is it such? Even if practical central bankers may not have known that they were talking prose all their lives, have they in practice been acting almost optimally? Until recently, there was no serious attempt to measure this empirically. But now, Brian Sack of the staff of the Fed's Board of Governors has made an excellent first stab of doing just that, in the article that I have already quoted. He uses a five-variable VAR model with production, unemployment, inflation and commodity prices as the non-policy variable, and the federal funds rate as the policy variable. This exercise can both incorporate the long lags involved, and allow one to estimate the variance/co-variance matrix for the coefficients, and hence the extent of multiplicative uncertainty.

Not surprisingly, he found that such an exercise brought the actual historical conduct of US monetary policy much closer into line with what the model indicated would be optimal—see, for example, his Figure 5, here Chart 6. Thus he concluded (page 28),

Chart 6
Actual and optimal funds rate under parameter uncertainty



Note: The optimal funds rate is based on the policy rule that solves the dynamic programming problem. The optimal funds rate value is the rate predicted by the policy rule given the actual history of the economy at each point in time.

'Gradual movements in the federal funds rate do not necessarily indicate that the Federal Reserve has an interest rate smoothing incentive. Dynamic structure and parameter uncertainty can account for a considerable portion of the

gradual funds rate movements that are observed. The intertemporal behaviour of the targeted variables causes the funds rate to move in a particular direction over substantial periods of time. However, under additive uncertainty, the expected path of the funds rate is much more volatile and reacts to changes in the economy more aggressively than the observed funds rate. This smoothing of the interest rate can be explained by the fact that the Fed does not know perfectly the structure of the economy. Uncertainty arising from imprecise estimation of the VAR coefficients is minimised at the level of the funds rate predicted by the policy rule that has been historically implemented. An aggressive policy would result in high expected variance for the targeted variables because the Fed has traditionally smoothed the funds rate. The policy rule that accounts for parameter uncertainty therefore reacts to changes in the state of the economy with gradual movements in the funds rate, which reduces the excess volatility of the expected policy and limits the deviation of this policy from the observed level of the funds rate.

Although the uncertain dynamic structure results in gradual funds rate movements, there remains an element of interest rate smoothing that cannot be explained in this exercise'.

Nonetheless, there are still several remaining differences between such central bank behaviour in practice and those actions that would appear optimal, even after taking account of multiplicative Brainard uncertainty. Let me revert to Table B, showing the implied distribution of interest rate changes, but this time also including the result with multiplicative Brainard uncertainty.

What this table, Table F, shows is that once one takes Brainard uncertainty into account, the paucity of large aggressive jumps in interest rates becomes largely explained. With Brainard uncertainty, there would only have been 23 (24) changes[1] of 50 basis points, or more in the US case, compared with the 23 found historically.

What, however, the empirical application of Brainard uncertainty still largely fails to explain is the small number of reversals. Under our VAR models, with or without Brainard uncertainty, the number of reversals of direction of policy should have been some three to five times as common as found in practice, depending on whether one uses as the basis for judgment the one step ahead or the dynamic prediction from the model.

Once again, I have been encouraging the Bank staff to replicate this same study for the United Kingdom, and for the VAR model, already briefly described, the results of the dynamic optimal policy under multiplicative uncertainty are shown in Table G (alongside the optimal policy with additive uncertainty only, and actual policy). As with the United States, recognition of multiplicative uncertainty should make policy-makers far more cautious, with many fewer large step changes. Indeed, what is remarkable from Table G is that the actual number of large step changes (more than 1% in a quarter), at 19, was more than four times the number (4) that should have been made in this period had policy-makers been consistently following an average optimal policy adjusted for multiplicative uncertainty.

What is also remarkable is that such reversals as occurred in practice in the United Kingdom were predominantly very large (9 of 1% or more, as compared with 7 under 1%), in contrast with actual continuations (10 of 1% or more, 26 under 1%). Under multiplicative uncertainty, the numbers

Table F
Optimal interest rate changes for the United States

Certainty	Number of continuations							Number of reversals						
	Up >0.5	Down >0.5	Up 0.5	Down 0.5	Up 0.25	Down 0.25	No change	Up 0.25	Down 0.25	Up 0.5	Down 0.5	Up >0.5	Down >0.5	
(a) One step ahead change on actual	9	6	11	10	21	19	40	8	9	7	6	3	3	152
(b) Dynamic change on own lag	7	3	4	11	12	21	39	20	13	5	8	3	6	152
(c) Actual policy	1	6	9	5	9	20	92	4	4	1	1	0	0	152
Uncertainty	Number of continuations							Number of reversals						
	Up >0.5	Down >0.5	Up 0.5	Down 0.5	Up 0.25	Down 0.25	No change	Up 0.25	Down 0.25	Up 0.5	Down 0.5	Up >0.5	Down >0.5	
(a) One step ahead change on actual	1	0	7	9	31	18	50	12	18	5	0	1	0	152
(b) Dynamic change on own lag	1	0	5	8	19	35	57	8	9	3	3	2	2	152
(c) Actual policy	1	6	9	5	9	20	92	4	4	1	1	0	0	152

		Total continuations			Total reversals	
		Up	Down	No change	Up	Down
(a) One step ahead change on actual	Certainty	41	35	40	18	18
	Uncertainty	39	27	50	18	18
(b) Dynamic change on own lag	Certainty	23	35	39	28	27
	Uncertainty	25	43	57	13	14
(c) Actual policy		19	31	92	5	5

1984:5–1996:12 (152 observations).

(1) See footnote (1) on page 106.

Table G
Optimal interest rate changes for the United Kingdom

	Number of continuations									Number of reversals							
	Up >1	Down >1	Up 0.75	Down 0.75	Up 0.5	Down 0.5	Up 0.25	Down 0.25	No change	Up 0.25	Down 0.25	Up 0.5	Down 0.5	Up 0.75	Down 0.75	Up >1	Down >1
Additive uncertainty	4	6	2	3	3	5	3	1	1	2	4	7	5	2	2	8	8
Multiplicative uncertainty	0	3	3	2	1	7	6	10	14	4	4	3	3	3	2	0	1
Actual policy	2	8	2	3	2	9	2	8	14	1	0	1	2	2	1	5	4

1981:3–1998:2 (66 observations).

for reversals were 1 of 1% or more, 19 under, and for continuations, 3 of 1% or more, 29 under. If we should make the (admittedly extreme) assumption that these really large reversals were mainly due to regime changes and recognition of prior policy errors, then the UK figures show roughly the same ratio of smaller reversals between optimal policy under multiplicative uncertainty to those in practice, ie 19 to 7, as in the United States.

Thus, in the United Kingdom, one problem is to explain why there were so many really large changes in interest rates in practice, given that under Brainard uncertainty, the optimal changes should have ideally been smaller. If these, especially the reversals, can be accounted for by regime changes/policy errors, then we are left, as in the US case, with a problem of accounting for a general, apparent reluctance to reverse the direction of change. And let me emphasise and repeat that I do not think that this latter is just an Anglo-Saxon propensity. It is, I believe, common to all major central banks.

The distributions from such a VAR model probably provide an upper bound on the degree of caution, and interest rate smoothing, that should theoretically be undertaken, because the construction of this model completely leaves out the advantage that can be obtained from more aggressive action, whereby one then learns more about the working of the economy—which should, in principle, reduce *future* uncertainty (see, for example, Sack (1998b)). Thus, Volker Wieland (1998, page 2) wrote,

'There are a number of reasons to believe that such a Brainard-type analysis overstates the case for gradualism. For example, Caplin and Leahy (1996) show that in a game between a policy-maker who attempts to stimulate the economy and potential investors, a cautious policy move may be ineffectual, because investors anticipate lower interest rates in the future. Another reason, investigated in this paper, is that a more aggressive policy move may generate more information, which would improve the precision of future estimates and thereby future policy performance'.

Indeed, two eminent American economists, Tom Sargent (1998) and James Stock (1998), have recently argued that a central bank seeking to insure against the worst risks coming about (a 'minimax' strategy) in the context of multiplicative uncertainty should actually be more aggressive, not less. The implied corollary, of course, is that if such aggression should prove to have been unnecessary, the measures can be reversed in a subsequent period. But such a reversal of policy is just what central banks appear, on this evidence, loth to do.

Not only the evidence that I have presented here, but also other anecdotal reports, suggest that central bankers are, as a class, notably reluctant to make a move on interest rates that might subsequently need to be reversed (except under crisis conditions, eg relating to a pegged exchange rate target, or after a major policy regime change), and much more so than our currently best models suggest would be optimal.

There are two reasons, not mutually exclusive, why this might be so. The first I owe mainly to Michael Woodford (1998). Assume that for some reason the central bank wants to reduce the variance of the level of short-term interest rates. Nevertheless, the central bank wants to maintain the ability to have a quick and strong effect on the economy at a time of a major shock hitting the economy. If the central bank can commit to behaving in such a way that any small reversal in direction of change will be followed by several similar steps in the same direction, then forward-looking rational agents will make large changes to their behaviour whenever reversals occur. But the downside for the central bank, the corollary, is that it must be cautious about reversing direction in the face of minor shocks, since too many short-lived reversals would limit its power to combat major shocks, given of course the initial reluctance to increase the variance of short-term rates.

The second reason is tied up with the credibility issue. As I explained earlier, when policy is already just about on course, so that the decision is finely balanced, it might indeed be technically optimal to change one's views and one's decisions, and the direction of movement of interest rates, as news comes in, even from month to month, certainly from quarter to quarter. It seems difficult to explain this to outside commentators, who often perceive such reversals as evidence of inconsistency, patent error, and irresolution. We all react to criticism. As long as commentators castigate the monetary authorities for moves that turn out after the event to have been inappropriate and unnecessary, then that will tend to reinforce the tendency towards 'too little, too late'. The lessons from such outside criticism on changing one's mind is that no change in interest rates should be made unless and until the probability is quite strong that a subsequent change in the same direction will also subsequently be needed. That is, I would argue, not the optimal way to conduct policy, but it is, I believe, what happens around the world.

To conclude, there is an absolute yawning gap between the general perception of non-economist outsiders that reversals of policy, changes of mind, are to be deplored and castigated as evidence of error, irresolution and general incompetence, and the apparent findings from our economic models that such reversals should optimally occur some four, or so, times more frequently than they do in practice. Maybe our models are missing something important. If not, we have then singularly failed to explain to the world at large how policy should be carried out. Either way, there is still an enormous amount of work to be done.

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Discussion of Charles Goodhart's lecture: 'Central bankers and uncertainty'

by Charles Bean, London School of Economics

Charles's most insightful lecture focuses on an issue that is of the utmost importance to central bankers, and indeed to all policy-makers, but about which the academic literature—with the glowing exception of a venerable contribution by Bill Brainard (1967)—presently has relatively little useful to say. This issue is the question of how policy-makers should treat uncertainty: uncertainty about where the economy is and where it is going, and uncertainty about the impact of policy. This is not to say that the literature ignores uncertainty—far from it—but that usually the uncertainty enters in a relatively uninteresting way, most usually in the form of an additive disturbance that does not affect the optimal policy rule.

Now theory suggests, to a first-order of approximation and with high-frequency data, that short-term interest rates should be not far from being a 'random walk' (or more strictly a first-order autoregressive process), with changes in interest rates being largely a response to 'news' about the economic environment. Since 'news' is necessarily unpredictable, it then follows that roughly half the time an increase in interest rates should be followed by a decrease and *vice versa*. It is worth emphasising that this is only an *approximate* result, as if interest rates are above their long-run level (given by the equilibrium real interest rate plus the target rate of inflation), then they must be expected to decline over time. Similarly, if events are expected to cause a boom in the future, eg because of an announcement of future high levels of public spending, then the central bank might plan to raise interest rates in the future, but hold off from doing so at present. Nevertheless, the random walk model provides a useful benchmark against which to evaluate actual policy, which appears to deviate from this benchmark in a variety of ways. The question is: to what extent are these deviations a rational response to uncertainty (ie theory is wrong or incomplete), and to what extent do the deviations reflect sub-optimal policy?

In discussing the impact of uncertainty on the setting of interest rates, I think it is helpful to distinguish four distinct types of behaviour that seem to be characteristic of many central banks. These are: caution; conservatism; gradualism; and delay. Let me start with caution, by which I mean the tendency to move interest rates by only small amounts. There are two very good reasons for this. The first is that the data about the current state of the economy are frequently unreliable and prone to revision—witness the debacle over the earnings figures last year. Wise central bankers will thus tend to discount new information, particularly when it conflicts with other information that is available, and consequently the response to news will be muted. This is recognised in the literature as constituting a 'signal-extraction' problem, and such behaviour is entirely consistent with optimality. The second argument is that the effect of policy actions may be uncertain. In that case, large actions will tend to increase the amount of uncertainty in the economy, and a more cautious approach is warranted. This was Brainard's argument; in essence, he simply formalised Friedman's insight that the existence of 'long and variable lags' in the transmission mechanism of monetary policy should lead central bankers to be modest in their aspirations to control the level of nominal demand.

By conservatism, I mean the tendency for central bankers to tighten policy when there may be little sign yet of inflationary pressure to the man in the street (or the businessman in his office). In part, this is simply a recognition of the lags and inertia in the economy, but seemingly there is also something *asymmetric* about it: central bankers have a tendency to harp on about the dangers of inflation, but warnings about the dangers of recession or deflation are rarer. Such conservatism can be rationalised as constituting an optimal policy when the Phillips curve is convex (an x% positive output gap raises inflation by more than an x% negative output gap reduces it) and aggregate demand is imperfectly controllable, or the natural rate of output is uncertain.[1] This is a case of a 'stitch in time saves nine': prompt and modest action now avoids taking much nastier medicine later. This explains why a rational central bank would aim to hold activity not at the natural rate, but rather a little below it. There is, however, a counter-argument to this line of thinking, which runs as follows. Suppose we are unsure of the natural rate, then some judicious probing of the limits to expansion may be worthwhile.[2] This seems to be a pretty good description of what the US Fed has been doing in recent years.

Rather harder to rationalise from a policy optimisation perspective are gradualism and delay. By gradualism, I mean a tendency to make a large change in interest rates in a sequence of small steps (note that this is different from caution, which simply says that small rather than large changes are usually the appropriate action). In this class I would place the MPC's collective decisions over interest rates in summer 1997: it was hardly a secret that the Bank thought interest rates ought to have been higher in the

(1) Charles mentions that uncertainty about the natural rate can induce Brainard-style caution without a non-linear Phillips curve. This is not strictly true if the uncertainty is about the natural rate *per se*. However, estimates of the natural rate are usually derived as a by-product of estimation of a model of wage and price formation. If the uncertainty about the natural rate is then a *consequence* of uncertainty about other parameters in the system, eg the effect of unemployment on wages, then the policy multipliers become uncertain and Brainard's analysis becomes relevant.

(2) This argument is due to G Bertocchi and M Spagat (1993). The analogy is with a new car: the easiest way to find out how fast it goes is to put one's foot on the accelerator and test it out. Of course, one does not want to put it down too far, which would be a recipe for having a nasty accident!

run-up to the election, yet the MPC collectively chose not to raise rates significantly immediately on taking over responsibility for interest rates, preferring instead a sequence of ¼% point steps. This also shows up in the empirical results cited by Charles, particularly the serial correlation in the sign of the changes in interest rates that is apparent in many countries.(1) Such interest rate smoothing could be justified if there are costs of adjusting interest rates, particularly if those costs increase more than linearly with the size of the interest rate change. However, I find it difficult to see what those costs might be. In particular, I do not see how Brainard-style uncertainty about the policy multipliers plus lags in the transmission mechanism produce the desired result. What that does is generate smaller, but more persistent, changes in interest rates in response to news, rather than a lagged response to that news.

Finally, there is delay. It seems clear, both from the fact that the average length of time before a policy reversal greatly exceeds that between interest rate changes of the same sign, as well as a reading of the minutes of the MPC, that inaction is frequently justified on the grounds that a policy change might soon have to be reversed.(2) There is an analogy here with the literature on irreversible investment under uncertainty. If investment is costly to reverse and demand is uncertain, a wise businessman will not invest when the present value of expected profits just exceeds the cost of the investment; instead, he will want to take account of the possibility that a downturn in demand might occur. Waiting thus has an option value.

Now, while the 'wait and see' argument makes sense in an investment context, once again I find it harder to see what the real costs of interest rate reversals might be. Indeed, the possibility of a credit crunch or liquidity trap could push the argument the other way, for once such a phenomenon has developed, monetary policy becomes much less effective; acting pre-emptively to head off the mere possibility of such an event then has value. Despite all this, it is clear that there is a presentational problem with policy reversals, as commentators are apt to see them as reflecting indecision or incompetence on the part of the authorities.

The problem, of course, with both gradualism and delay is that they tend to result in monetary policy being 'behind the curve' and thus inefficient. It also means that policy-makers may not get the credit they deserve, because their actions will sometimes appear belated. To the extent that all this is simply a response to ill-informed attitudes on the part of the media or the markets, it is rather unfortunate, to say the least. But let me finish on an optimistic note. In the region of an optimum, first-order changes in policy will have only second-order effects on welfare.(3) Consequently, it does not matter much whether policy is exactly right or merely approximately right. And I am pretty confident that the MPC has at least got it approximately right.

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(1) The presence of lagged interest rates in estimated reaction functions is not evidence for such conscious interest rate smoothing, as inevitably central bankers respond to a whole range of economic indicators beyond those typically included in such models. In such circumstances, lagged interest rates will inevitably proxy such omitted variables, and consequently the coefficient will be biased.
(2) See, for instance, minutes of the February and October 1998 MPC meetings; in the latter case, the argument related to the size of the cut in rates, rather than whether to cut or not.
(3) This follows from the 'Envelope Theorem'.

Discussion of Professor Goodhart's lecture: 'Central bankers and uncertainty'

by Charles Freedman, Deputy Governor, Bank of Canada[1]

The Keynes lecture, like so much of Professor Goodhart's writing, presents thoughtful insights, dressed in elegant prose, on issues of real importance to policy-makers and economists. In 'Central bankers and uncertainty', Professor Goodhart has two interrelated themes—the minor and less developed one relates to the various ways of characterising central bank behaviour in adjusting interest rates; the second and more developed theme addresses the question of why central banks tend to 'change interest rates, in response to shocks, by a series of small steps in the same direction, rather than attempting more aggressively to offset that shock quickly in order to return the economy to equilibrium'.

My comments are in two parts. First, I extend somewhat and complement Professor Goodhart's characterisation of central bank behaviour under explicit or implicit inflation targets; second, I comment on his explanation of the phenomenon of interest rates typically adjusting by small amounts and with infrequent reversals.

There are three related ways of characterising central bank policy-making in an inflation-targeting regime. The first, which is at the heart of much of the current academic literature,[2] involves the central bank minimising a loss function of the form:

$$L = E\{\sum \beta^i[(\pi_{t+i} - \pi^*)^2 + \lambda (Q_{t+i} - Q^*)^2]\},$$

where π and π^* are the actual and target inflation rate, Q and Q^* are actual and capacity output, β is a discount factor, and λ is the weight of output deviations relative to inflation deviations in the loss function. Depending on the complexity of the model of the economy that constrains the minimisation, the outcome can be a complex or relatively simple interest rate setting equation.

The second characterisation of interest rate setting is the Taylor rule, that (in its principal variant) relates the short-term interest rate which the authorities are targeting to the current output gap and the current deviation of inflation from its target, along with the equilibrium real interest rate. To fit the data well, ie to pick up the gradualism in interest rate movements, the Taylor rule usually also contains a lagged dependent variable. The Taylor rule is typically, but not always, treated as descriptive rather than prescriptive. However, in some very simple models, a Taylor-like rule is the optimal rule.

The Taylor rule focuses attention on the importance for stability of raising or lowering real interest rates when inflation rises or falls. At times in the past, as Professor Goodhart notes, this condition was not met. This insufficiently strong response to inflation pressures was very probably an important contributing factor to the high rates of inflation experienced in a number of countries in the post-war period.[3]

The third characterisation, based on the approach used in some central banks, makes the change in interest rates a function of the deviation of the forecast inflation rate in some future period from the target rate of inflation (sometimes called an 'inflation forecast based rule'). On the surface, this formulation appears to ignore fluctuations in output. In fact, by focusing on an inflation forecast six to eight quarters in the future, the central banks using this approach have effectively lessened output fluctuations. Consider, for example, a price shock to the economy. Attempting to get inflation back to its target very quickly would result in sharp swings in output to offset the inflation pressures. However, when the interest rate setting rule is based on a gradual return of inflation to its target, the effects on output are muted, at the expense of inflation remaining away from its target for a longer period.

I believe that one can summarise current thinking about the relationship of the three characterisations of interest rate setting as follows. Minimisation of the loss function in a given model by definition gives optimal outcomes in that model, but the resulting interest rate rule is not likely to be very robust across models, thereby giving rise to the risk of poor outcomes if the model being used is not a good representation of the economy. The Taylor rule appears to be relatively robust across models, which is a very useful attribute for a reaction function in circumstances of model-uncertainty. On the other hand, in most of its variants it totally ignores exchange rate movements, an important channel through which monetary policy operates in a small open economy under flexible exchange rates.[4] And it often treats the equilibrium real interest rate as a constant over the last thirty years, an assumption that is inconsistent with other studies of the behaviour of real interest rates over this period.

(1) I would like to thank Pierre Duguay, Paul Jenkins, David Laidler, David Longworth, Tiff Macklem, Jack Selody, and Gabriel Srour for comments on an earlier draft of these remarks.

(2) One of the interesting aspects of inflation targeting is that it was developed in the central banks with virtually no academic input. Research by academics on inflation targeting began in the mid 1990s in response to the adoption of this new approach to policy by several central banks. In this respect, the situation was very different from that at the time monetary targeting was introduced in the mid 1970s, when a very large amount of academic research was available before central banks adopted the approach.

(3) It is worth noting that one of the problems Canada faced in its monetary-targeting period (1975–82) was the high interest rate elasticity of the narrow monetary aggregate (M1) used as the target, which implied insufficiently aggressive interest rate responses to inflation shocks. See Thiessen (1983).

(4) Svensson (1998) and Ball (1998) analyse policy-making in a small open economy with flexible exchange rates in the context of the loss-minimisation approach. In Ball's model, the optimal rule is like a Taylor rule but includes the real exchange rate.

Adjusting interest rates in response to the deviation of forecast inflation from the target appears to provide a good approximation to the optimal rule in some models of the economy (eg Haldane and Batini (1998)) but not in others (eg Rudebusch and Svensson (1998)). Such a rule requires the same response to a forecast increase in inflation, regardless of whether the source is a supply shock or demand shock. Both the Taylor rule and the loss-minimisation approach require a less aggressive interest rate response to supply shocks than to demand shocks. Thus, in the case of supply shocks, output and inflation movements have offsetting effects on the interest rate in the Taylor rule, while in the case of demand shocks they push in the same direction. In practice, central banks using rules based on the deviation of forecast inflation from its target get a similar (but not identical) result to the other approaches by specifying the inflation variable on which they are targeting so as to exclude certain types of price changes that typically result from supply shocks (for example, food and energy prices). This eliminates the need to respond to such supply shocks unless they begin to affect the inflation process, ie to affect wage and price-setting behaviour in the economy. Also, by aiming at the rate of inflation six to eight quarters in the future, central banks do not need to react to what are perceived to be temporary price shocks.

The issues of the trade-off between output volatility and inflation volatility and the distance of horizon at which the central bank should aim are interesting and important questions, on which Professor Goodhart comments briefly. He argues that in the United Kingdom, the trade-off frontier is nearly rectangular (thereby effectively removing the trade-off as an issue), and that the central bank should target a rate of inflation six to eight quarters out. Two caveats are in order here. First, Bank of Canada research[1] suggests a negative trade-off curve between inflation volatility and output volatility in the context of inflation forecast based rules, implying that this issue remains on the table at least for some countries. Second, and perhaps more relevant for the United Kingdom, a recent Bank of Canada study[2] has indicated that the inflation horizon that the authorities should target can change with changes in certain types of economic behaviour. For example, when the credibility of the central bank improves, as reflected by private sector expectations of inflation being more firmly anchored on the inflation target, it is possible to simultaneously reduce the variability of inflation and that of output. However, to reap these benefits, the central bank may have to adjust its rule to take account of the change in credibility. Using a Canadian model, the study illustrates the need to shorten the horizon for inflation at which the authorities are aiming as credibility increases. Moreover, and more strikingly, it shows that leaving the rule unchanged in the face of an increase in credibility may actually result in a deterioration of the performance of the economy.[3]

All this leads to the conclusion that the comparison of the benefits of complex but optimal rules, on the one hand, and simple but robust rules, on the other, remains an important subject for future research.

Now let me turn to the central question posed by Professor Goodhart in this paper—why are central bank adjustments to the benchmark interest rate so gradual and why are there so few reversals in direction?

Let me begin by making a few comments on the data presented in Table E of the paper. First, while the characteristics of interest rate changes in terms of sign, duration and size of change are presented for twelve countries, a number of those countries were operating under a fixed-exchange regime for a good part of the sample period and consequently have tended to follow the behaviour of the country to which their currency was in effect tied. This is clearly the case for the Netherlands and Germany, although even here the table shows differences in the size of the average change that I found surprising. And the apparent differences between Austria and Germany relate to a difference in sample period, rather than to a difference in behaviour. Second, a couple of countries, Australia and Italy, show less gradualism in their changes, raising the question of why they behaved differently from the others. Third, it would be interesting, as more data become available, to address the very interesting question as to whether the introduction of formal targets for inflation has changed the behaviour of central banks operating under such a regime. This is similar to the point made by Professor Goodhart that increased independence for central banks may have resulted in a change in behaviour. Fourth, given all the discussion in recent years of pre-emptive actions and 'getting ahead of the curve', it would be interesting to know if central banks behaved any differently in the 1990s from in early periods.[4]

Professor Goodhart's approach to assessing whether interest rate movements were too gradual and too frequently in the same direction is to compare the actual movements with those that would be implied by optimal policy, using a VAR model of the economy. The results for both US and UK models of the economy show that in the case of additive uncertainty, the actual movements are both more gradual and more one-way than in an optimal policy. In the case of multiplicative uncertainty, the difference between actual and optimal actions diminishes considerably with respect to the size of the movements, but the difference with respect to reversibility of movements largely remains, though less so in the United Kingdom.

I would pose a couple of technical questions about these results. First, Brian Sack's study (1998) of the United States, used by Professor Goodhart for his assessment of the Federal Reserve's behaviour, uses an objective function that

(1) Black, Macklem and Rose (1998).
(2) Amano, Coletti and Macklem (1998).
(3) According to some recent research at the Bank of Canada by Robert Amano, this result does not carry over to Taylor rules, which do not appear to require an adjustment in the interest rate response to benefit from increased credibility.
(4) The fact that the 1990s provided, for the most part, a more stable environment (until recently) might make it hard to reach any definitive conclusion, however.

includes the difference of inflation from its target, unemployment from its target, and the growth of production from its target. The latter term, the deviation of production growth from its target (as opposed to the deviation of the level of output from its target), is unusual for such a study, and I wondered whether incorporating it made much difference to the results. I also worried about whether the use of a constant target rate of inflation of 2.8% reflected reality in a period during which the 'acceptable' rate of inflation in the United States seems to have fallen from about 4% to closer to 2%, and whether having different inflation targets over sub-periods would influence the results. A second technical point to which I would draw attention is that there are two ways of interpreting multiplicative uncertainty—that parameters are random variables that change over time, and that the true values of parameters are unchanged over time but that our estimates are imprecise and may change over time. As Brainard showed in his original 1967 article, these alternatives have somewhat different implications for optimal policy. Sack used the second interpretation, that of imprecise estimate, in his study, and I would simply raise the question of whether the results would differ much if optimal policies were generated using the first interpretation, that of true parameter variability.

More importantly, in addition to additive and multiplicative uncertainty, there is a third type of uncertainty, namely model-uncertainty, that deserves more attention than it typically receives, and that was not discussed by Professor Goodhart. We can never be certain that the (explicit or implicit) model we are using to help determine the appropriate setting of interest rates (or the appropriate level of monetary conditions) is an accurate representation of the economy. Indeed, in response to model-uncertainty, many central banks use alternative models (eg inflation forecasts based on money growth) as a cross-check to the forecast of inflation emerging from their central model or their judgment. It may well be that the relatively strong responses of interest rates to shocks using an optimal rule within a given model, VAR or otherwise, would lead to less good outcomes than the more cautious approach of the authorities, if the underlying economy were very different from that specified in the model. And this concern about model-uncertainty may help to explain the pattern of central bank behaviour on which Professor Goodhart is focusing.

That said, I believe that it is interesting and useful to address the questions of excessive gradualism and insufficiently frequent reversals on the part of central banks, even when account is taken of the different types of uncertainty. A variety of reasons for interest rate smoothing have been offered in the literature, by Professor Goodhart himself in an earlier study (1997) and by others.(1) Some have focused on the costs of interest rate volatility, an argument that is difficult to formalise, and one that is increasingly difficult to make in a world with financial instruments that allow financial market participants to protect themselves to a considerable extent against interest rate volatility. Another argument emphasises that smoothing movements in short-term rates increases the effect of central bank action on medium and long-term rates, and that this could be an important factor in an economy in which spending behaviour is particularly sensitive to such medium and longer-term rates.(2) While it is undoubtedly the case that the adjustment by a central bank of its benchmark rate can lead to a larger response in long-term rates if such a movement is interpreted as one of a series of movements in the same direction, the central bank might be able to achieve a similar outcome by larger moves in its benchmark rate, even if these were reversed more frequently.(3)

The third type of explanation, and the one favoured by Professor Goodhart, is a more psychological explanation, related to the credibility of policy-makers. There is certainly a tendency among commentators on central bank behaviour (both from financial markets and the media) to treat a quick reversal in the direction of interest rate movements as a sign of a central bank that is unable to make up its mind or is inconsistent. And this type of attitude, which has the potential to bring about a loss of credibility of the central bank, may make it more difficult for policy-makers to react appropriately to incoming data.

Let me begin my assessment of this explanation by examining the situation in which demand shocks have hit the system in such a way that the economy is clearly moving above or below potential, and the forecast rate of inflation is moving above or below its target. Even in such a case, where the direction of the appropriate interest rate movement is clear, the appropriate size of the adjustment to interest rates may not be clear. We know that such demand shocks are frequently autocorrelated and, moreover, that they are typically propagated through the economic system in a way that magnifies their effects. If policy-makers had perfect foresight, they might respond very aggressively to a demand shock, on the basis of the potential effects that it could have on the economy and on inflation. But policy-makers, sad to say, do not have perfect foresight. Shocks can be temporary or long-lasting, and it is rarely entirely clear at the time of the shock exactly what type of shock one is facing in reality, as opposed to in the models. And of course, there may be a number of shocks occurring at the same time, making interpretation even more difficult.

In the event, what seems to happen in response to these kinds of shocks is an adjustment of the benchmark interest rate to the shock that is perceived to be taking place, without taking fully into account the possibility that it may be the first in a sequence of shocks in the same direction. And if the initial interest rate movement is not sufficient, further action is taken. This is what we used to call 'successive approximation'. The outcome will be a cycle of inflation

(1) Lowe and Ellis (1997), for example.
(2) This is less relevant for the United Kingdom and Canada than, for example, for the continental European countries or the United States.
(3) It is also of interest to note that some observers have complained that Federal Reserve policy in recent years has led to more volatility in longer-term rates than in the fed funds rate.

around its target, but if the central bank reaction is not excessively little or excessively late, it will be a limited cycle, without inflation or deflation becoming entrenched.[1] Nonetheless, inflation and output cycles may be more pronounced than if the central bank took more aggressive action, in expectation of a sequence of shocks in the same direction.

The alternative approach, and one that is implicit in a lot of modelling, is to take account of the average degree of autocorrelation of shocks when setting interest rates.[2] Though this approach would be reasonable in a situation where the degree of autocorrelation was fairly stable, policy-makers might find it hard to take the strong action in response to a shock indicated by such an approach, because of the difficulty in explaining and justifying such an action on the basis of inherently uncertain forecasts.[3]

Near turning-points, when even the sign of the needed action may not be clear or may change from one policy meeting to the next, the challenge facing policy-makers may be even more difficult. I agree with Professor Goodhart that there is currently some effect on the credibility of policy-makers of changing views as to the appropriate direction of policy on the basis of data that arrived between meetings. But this may change as we live through a longer period of very low inflation or price stability. Indeed, success in maintaining good inflation outcomes will itself bring credibility, not only to the inflation target, but also to the operational mechanism used by the central bank to achieve this result.

As far as the asymmetry of policy is concerned, I would add a couple of points to those made by Professor Goodhart with regard to it being easier to lower rates than to raise rates. It is certainly correct that it is usually much easier to convince the public and most of the media of the appropriateness of a rate cut than of a rate increase. But financial markets sometimes respond in the opposite way, expressing concerns about overly easy policies and the need for more vigilance against inflation. Moreover, in countries in which the exchange rate plays an important role in the transmission mechanism, it can sometimes be more difficult to lower interest rates than to raise them. In particular, if there is a lack of confidence in the currency, lowering or, in some cases, even leaving unchanged the benchmark short-term interest rate can lead to a counterproductive rise in medium and long-term interest rates.

In short, I agree with Professor Goodhart that concern about credibility may have been an important factor in the gradual nature of interest rate movements and the infrequency of reversals that we have seen in the past. But the inherent difficulty of forecasting future developments, and uncertainty about the appropriate model of the economy and about the transmission mechanism have also been important factors. However, I think that the growing credibility of inflation-targeting regimes and the increased attention being paid by financial markets to the need for central banks to get 'ahead of the curve' bode well for future monetary policy actions being closer to the optimal path, with more reversals in response to changes in view or new information than we have seen in the past. Indeed, we are already seeing some signs of such a change in approach in a number of countries. And if I am wrong, we can always look forward to future papers by Professor Goodhart explaining why such a change in approach did not happen.

(1) To the extent that the inflation target is credible, the central bank has some room for manoeuvre and can act somewhat later than otherwise without setting off a wage-price spiral. See Freedman (1996).
(2) Srour (1998) shows that this is an optimal response.
(3) Ironically, even if a central bank were entirely accurate in its forecasts and its judgments, and if it were able to precisely offset the potential effect of shocks by prompt and strong action, it would still be faced with the complaint that there was no reason for it to have adjusted its interest rate since, in the event, there were no signs of upward or downward pressure on inflation.

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Openness and Growth book

The Openness and Growth book, published in October 1998, contains the proceedings of an academic conference held at the Bank of England in September 1997. The research described in the book investigates the link between productivity growth and the international openness of the UK economy. The price of the book is £10.00 plus postage and packaging.

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