Bank of Canada Workshop

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Contribution to Panel Discussion

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My assignment from Fred
(draft programme, July 2007)

- communications
- uncertainty
- role of judgement
- where should we improve?

I shall argue (with examples) that:

Reporting forecast uncertainty improves

(a) communication

- by providing a fuller picture of future prospects

(b) forecast monitoring

- by reducing the need for elaborate discussion of every observed deviation from a point forecast.

Statements about uncertainty can be unambiguously interpreted and their reliability assessed only if they are expressed in quantitative terms.

Variant forecasts, scenarios, and so forth do not by themselves convey verifiable information about uncertainty.

UK government economic forecasts

From the beginning of the publication of official forecasts in the late 1960s, warnings were always included that forecasts are subject to a wide margin of error and there is considerable uncertainty.

These were not quantified until the Industry Act 1975 required the publication of the margin of error attaching to any forecast.

How to calculate this?

Calculating forecast error margins

Textbooks give algebraic formulae for calculating forecast standard errors in a wide range of linear forecasting models:

- univariate and multivariate
- static and dynamic
- single-equation and multiple-equation.

In non-linear models, equivalent calculations are done numerically, using stochastic simulation methods.

Calculating forecast error margins…

But the choice of model is uncertain, and practical forecasts incorporate various judgemental adjustments.

So the margins of error are typically calculated with reference to the errors made in past forecasts, the two standard summary measures being the root mean squared error and the mean absolute error.

The MAEs over the previous ten years were first published alongside the point forecasts of key variables in the Government economic forecast in 1979.

This practice has continued to the present day
(plus or minus 1MAE is a 57% interval under normality).

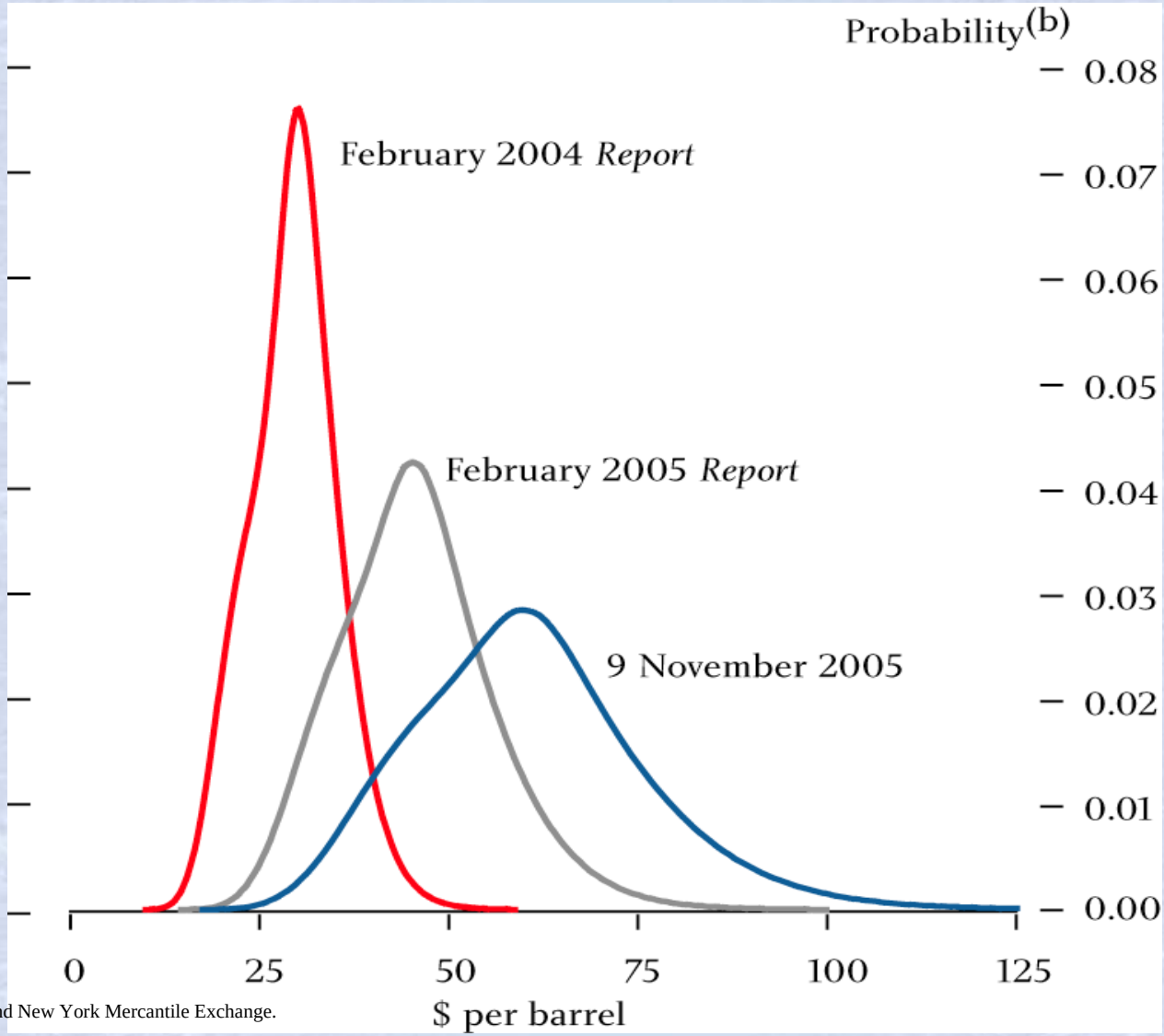
Calculating forecast error margins…

In using these measures to indicate the margin of error of a current forecast it is implicitly assumed that uncertainty remains at the same level in the future as in the past.

Otherwise judgemental adjustments may be made to these quantities, just as with point forecasts.

A recent example: increased uncertainty about future oil prices is increasing the uncertainty of inflation forecasts (Bank of England *Inflation Report*, November 2005).

Chart 4.3
Market beliefs about oil prices six months ahead[(a)]



Sources: Bank of England, Bloomberg and New York Mercantile Exchange.

(a) Data refer to the price of West Texas Intermediate crude oil.
(b) Each curve is a probability density function, the area under which sums to one. The area under the curve between two points indicates the inferred probability that market participants attach to oil prices being between two different levels. See footnote 1 on page 23 for further details.

Density forecasts

A density forecast is an estimate of the complete probability distribution of the possible future values of the variable of interest.

It gives a full description of the uncertainty associated with a forecast.

In decision theory, it is needed to evaluate the expected loss whenever the loss function is anything other than a *quadratic* function of the future state variable.

Density forecasts…

The earliest examples in economics come from the ASA-NBER quarterly survey, which began in 1968, and which is now known as the Survey of Professional Forecasters (SPF).

Mean Probability Distributions of Changes in GNP and Prices, 1968–69

Per Cent Change	Mean Probabilities Attached to Possible Per Cent Changes, 1968 to 1969, in GNP in Current $	Mean Probabilities Attached to Possible Per Cent Changes, 1968 to 1969, in Implicit Price Deflator
+10.0 or more	1.3	0.1
+9.0 to +9.9	1.8	0.1
+8.0 to +8.9	7.8	0.5
+7.0 to +7.9	25.1	1.1
+6.0 to +6.9	29.6	3.8
+5.0 to +5.9	17.4	6.9
+4.0 to +4.9	7.3	21.7
+3.0 to +3.9	4.1	41.6
+2.0 to +2.9	2.4	15.1
+1.0 to +1.9	1.1	5.1
0 to +0.9	1.5	2.0
−0.1 to −1.0	0.3	1.5
−1.1 to −2.0	0.1	0.2
−2.1 to −3.0	0.1	0.1
−3.1 or less	0.1	0.1
Total	100.0	99.9

Note: The total number of forecasters included is 89. Percentages may not total 100 due to rounding.

Source: American Statistical Association and National Bureau of Economic Research, Business Outlook Survey, December 1968.

Density forecasts…

In February 1996 the Bank of England and NIESR both began to publish density forecasts of inflation.

NIESR assumed a normal distribution, and presented a histogram in tabular form:

Table 1. Growth and inflation forecasts

CPI inflation	2005Q4	2006Q4	GDP growth	2005	2006
Central projection	1.9	2.0		2.0	2.5
Root mean squared error	0.51	0.85		0.81	1.3
Probability of 12 month CPI inflation falling in the following ranges			*Probability of annual growth rate falling in the following ranges*		
less than 1 per cent	4	12	less than 0 per cent	1	3
1 to 1.5 per cent	18	16	0 to 1 per cent	10	10
1.5 to 2 per cent	36	22	1 to 2 per cent	39	22
2 to 2.5 per cent	30	22	2 to 3 per cent	39	30
2.5 to 3 per cent	10	16	3 to 4 per cent	10	23
more than 3 per cent	2	12	more than 4 per cent	1	12
	100	100		100	100

Density forecasts…

The Bank's fan chart allows for some skewness over and above the normal distribution, to reflect the balance of risks on either side of the central projection as perceived by the Monetary Policy Committee.

The variance is initially calibrated with reference to past forecast errors, and again modified to reflect the judgement of the Monetary Policy Committee.

Density forecasts…

A precursor to the Bank's fan chart argued for the selective shading of quantiles to draw attention to the uncertainty in forecasting:

Journal of Business & Economic Statistics, October 1986

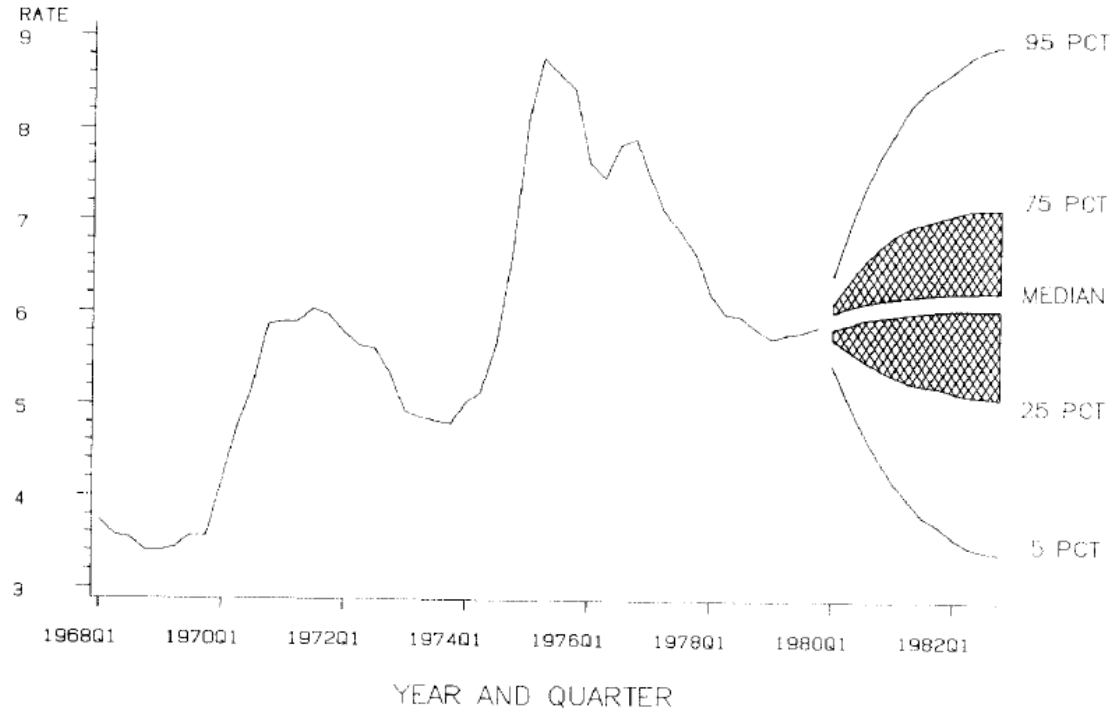
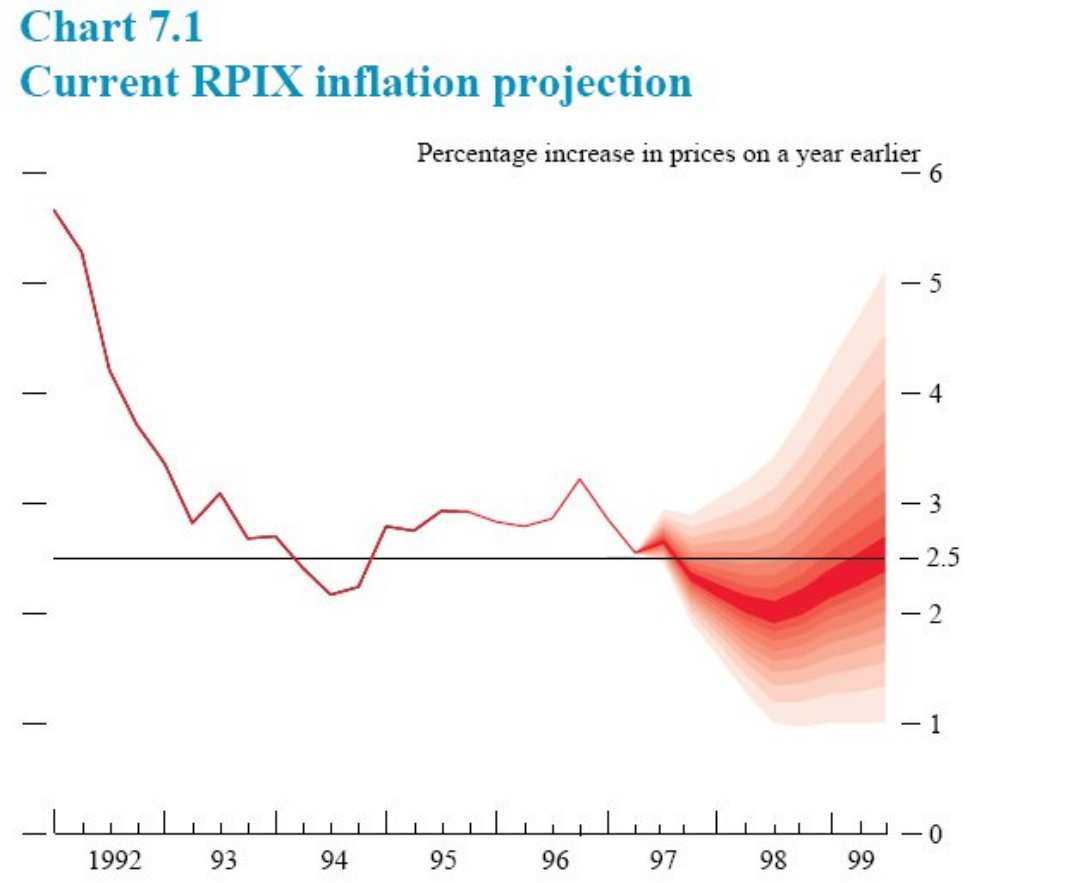


Figure 3. U.S. Quarterly Unemployment Rate: Observed, 1968–1979; Percentile Forecasts, 1980–1982.

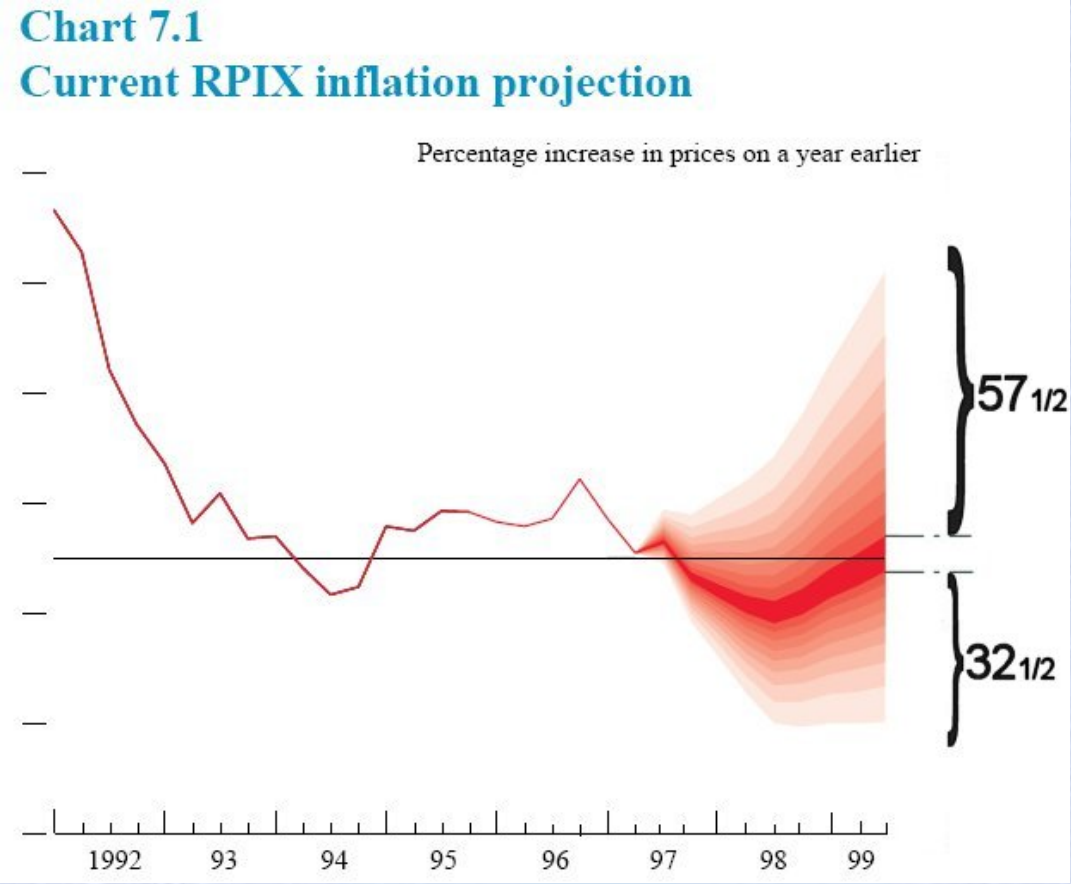
Density forecasts…

The Bank's fan chart consists of a set of forecast intervals covering 10, 20, 30,…, 90% of the probability distribution at each forecast horizon:



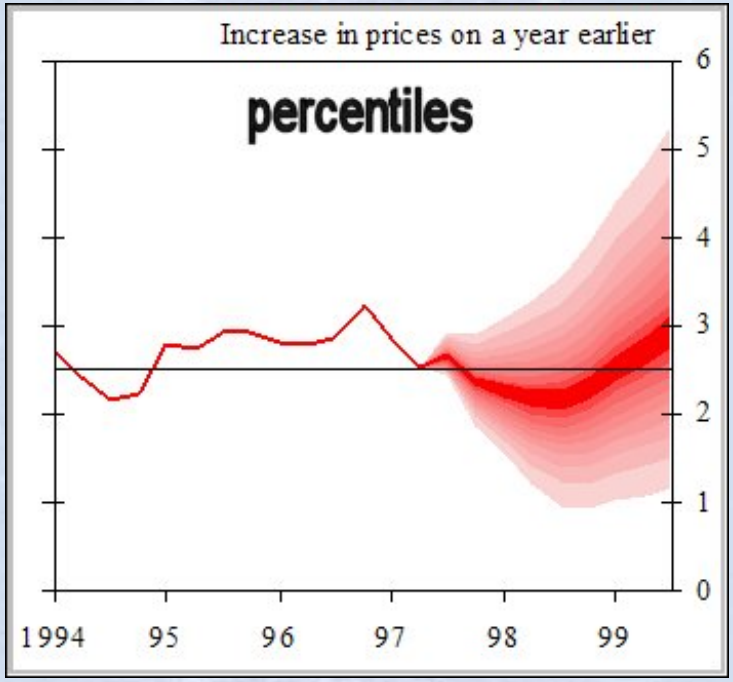
Density forecasts…

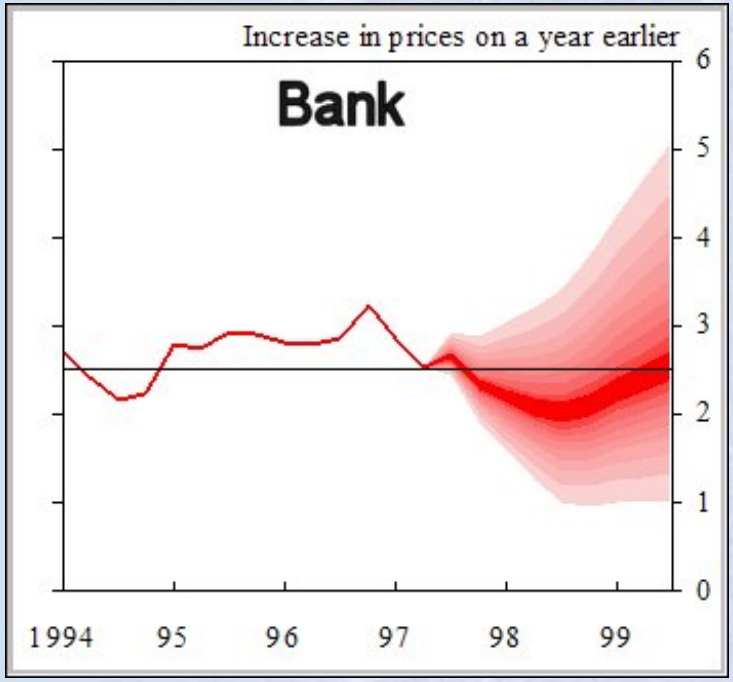
These are not percentiles, however, but the shortest intervals for the given probabilities, which centre on the mode. If the distribution is asymmetric, the probabilities in the upper and lower same-colour segments are not equal, but their values are not reported. Likewise, the tail probabilities are unequal but not reported.



Density forecasts…

In an article in 1999 I argued that the Bank should follow standard practice in statistics and use percentiles to report probability distributions. I have not changed my view, nor has the Bank!





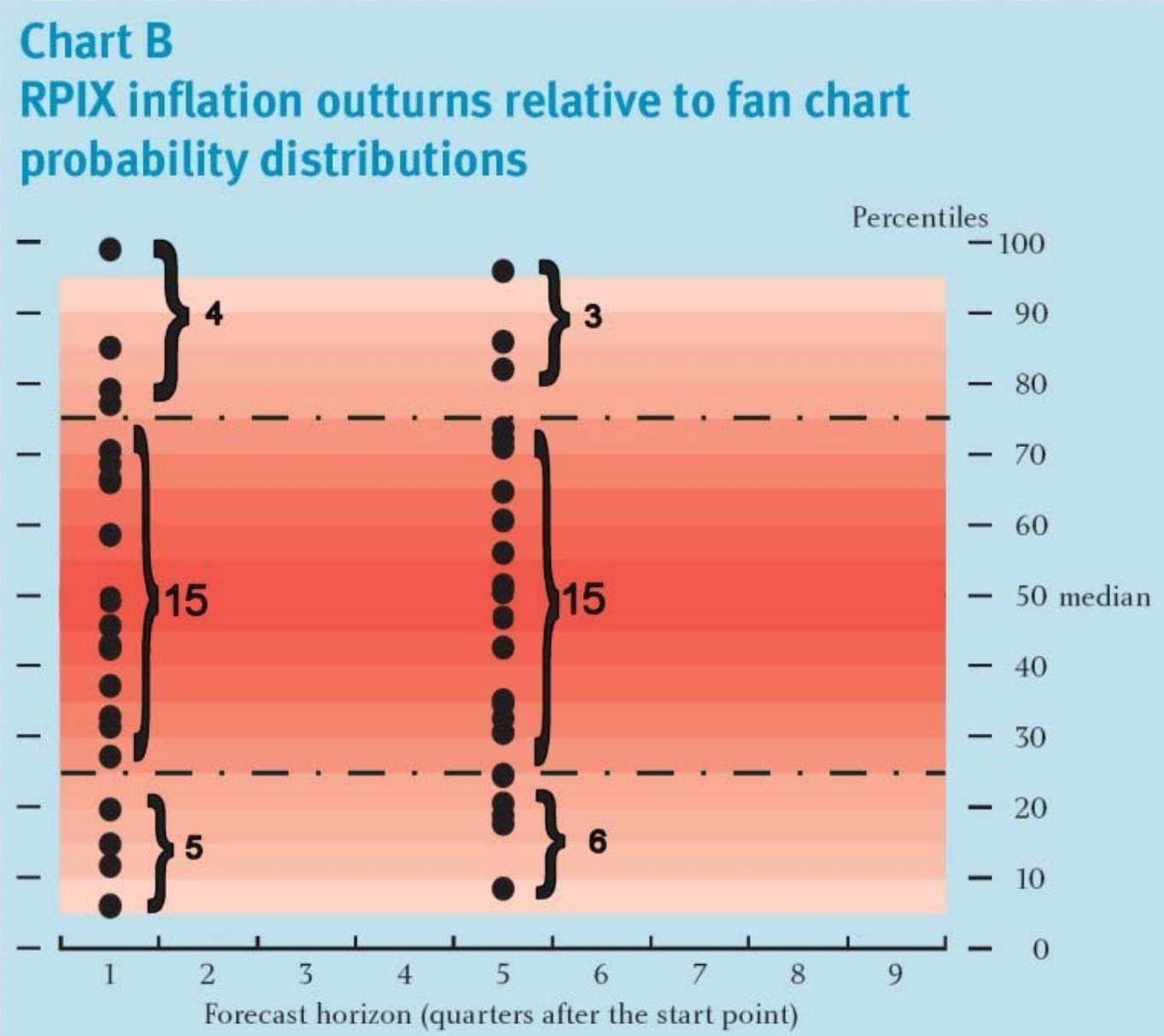
Density forecast evaluation

Reliability: are the probabilities accurate, that is, do the outcomes fall equally often in equal-probability bands?

In an article in 2004 I showed that the Bank of England and NIESR had overestimated uncertainty in their current-quarter and year-ahead inflation forecasts. Fewer outcomes fell in the tails of the distributions than the probabilities had led users to expect.

This analysis has been revisited by Mitchell (*NIER*, July 2005) and the Bank (*Inflation Report*, August 2005):

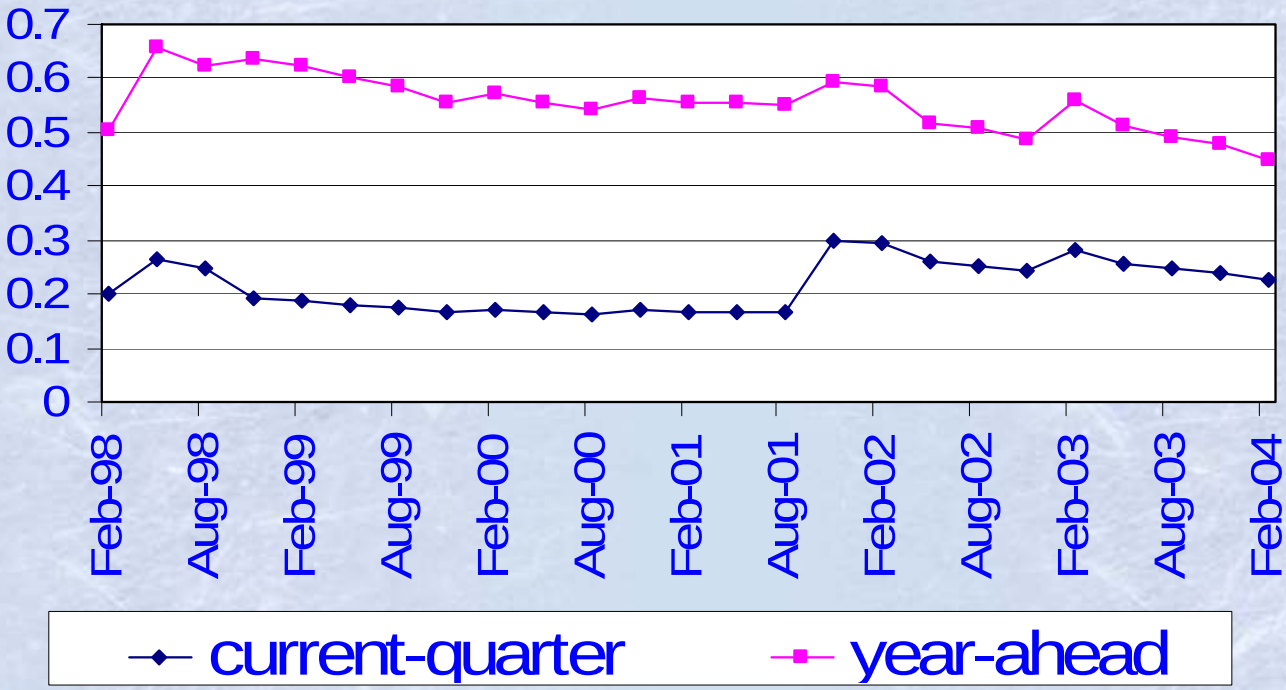
Density forecast evaluation…



Density forecast evaluation…

With 24 observations, we expect 12 outcomes in the interquartile range and 6 in each of the tails if the fan chart probabilities are correct. For the current-quarter and year-ahead forecasts, there are 15 outcomes inside and 9 outcomes outside the interquartile range: these intervals were too wide, and uncertainty was overestimated.

Fan chart standard deviations



I have attempted to persuade you that:

Reporting forecast uncertainty improves communication and forecast monitoring.

Statements about uncertainty can be unambiguously interpreted and their reliability assessed only if they are expressed in quantitative terms.

"All factors considered, the Bank judges that the risks to the projection for inflation are roughly balanced, with perhaps a slight tilt to the downside." (*BoC MPR*, October 2007)

There is room for improvement in many quarters.