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Interest Rate Forecasts: A Pathology

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<u>Interest Rate Forecasts: A Pathology</u>

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<u>Abstract</u>

This is the first of three prospective papers examining how well forecasters can predict the future time path of short-term interest rates. Most prior work has been done using US data; in this exercise we use forecasts made for New Zealand (NZ) by the Reserve Bank of New Zealand (RBNZ), and those derived from money market yield curves in the UK. In this first exercise we broadly replicate recent US findings for NZ and UK, to show that such forecasts in NZ and UK have been excellent for the immediate forthcoming quarter, reasonable for the next quarter and useless thereafter. Moreover, when ex post errors are assessed depending on whether interest rates have been upwards, or downwards, trending, they are shown to have been biased and, apparently, inefficient. In the second paper we shall examine whether (NZ and UK) forecasts for <u>inflation</u> exhibit the same syndromes, and whether errors in inflation forecasts can help to explain errors in interest rate forecasts. In the third paper we shall set out an hypothesis to explain those findings, and examine whether the apparent <u>ex post</u> forecast inefficiencies may still be consistent with <u>ex ante</u> forecast efficiency.

Even if the forecasts may be <u>ex ante</u> efficient, their negligible ex post forecasting ability suggests that, beyond a six months' horizon from the forecast date, they would be better replaced by a simple 'no-change thereafter' assumption.

I. Introduction

The short-term policy interest rate has generally been adjusted in most developed countries, at least during the last 20 years or so, in a series of small steps in the same direction, followed by a pause and then a, roughly, similar series of steps in the opposite direction. Figures 1, 2 and 3 show the time-path of policy rates for New Zealand, UK and USA.

Figure 1
Official Cash Rate: Reserve Bank of New Zealand
(Source: Reserve Bank of New Zealand)

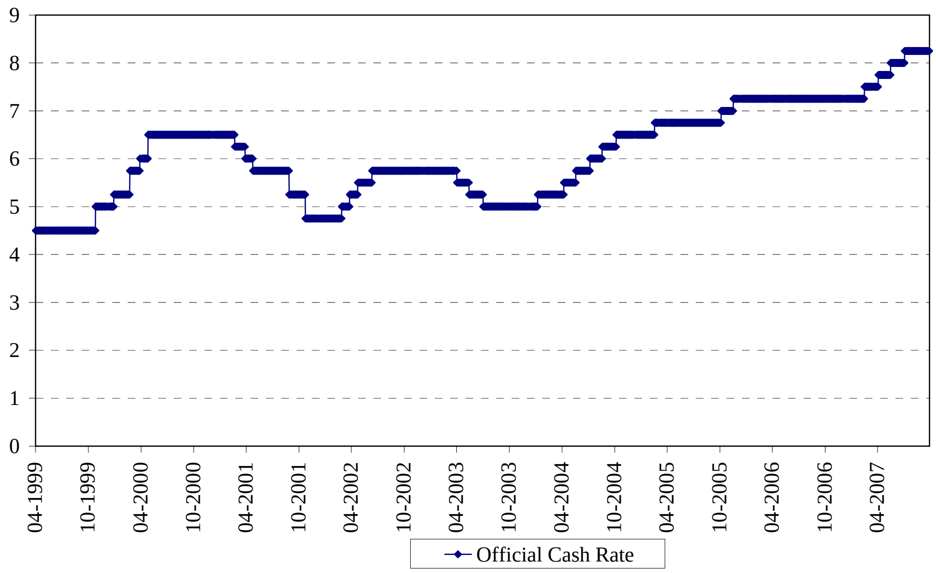


Figure 2
Official Bank Rate: Bank of England
(Source: Bank of England website)

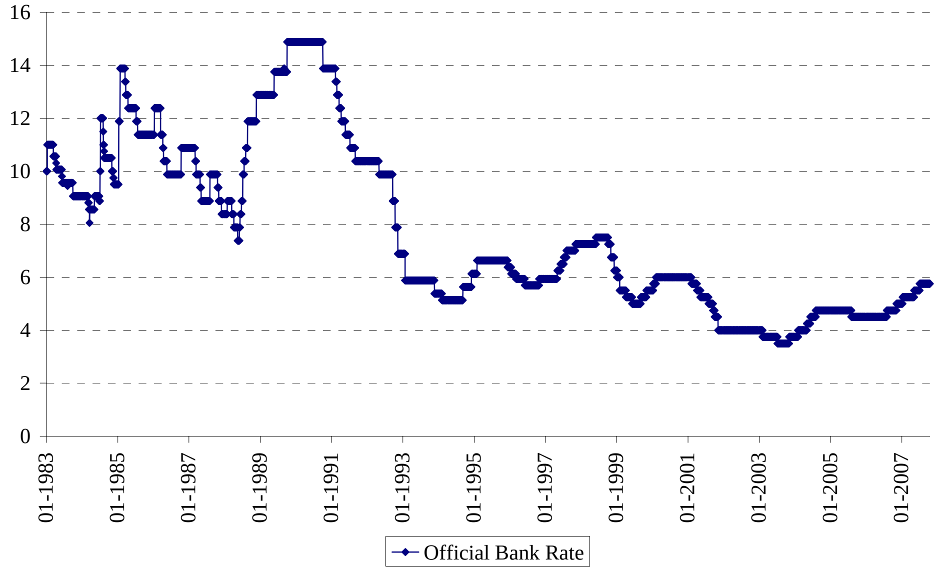
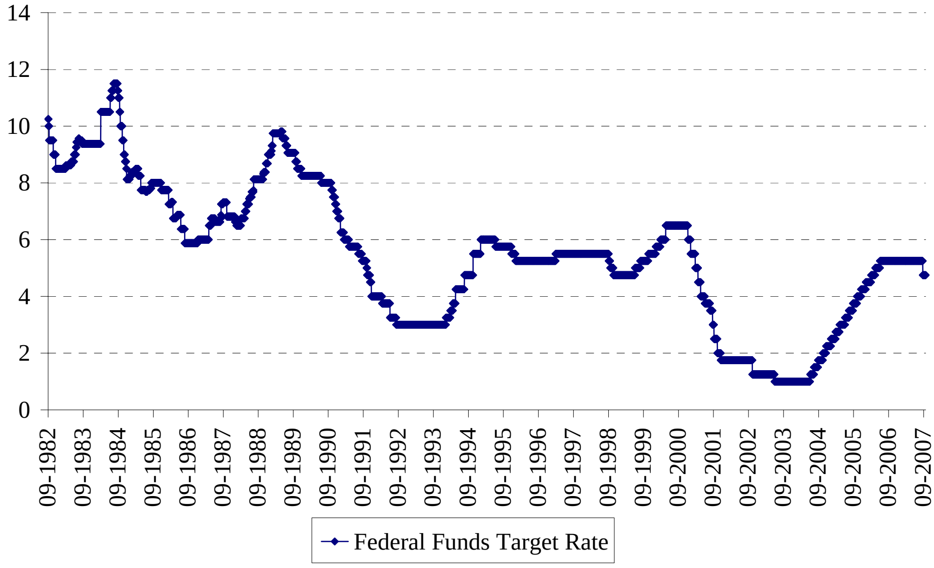


Figure 3
Federal Reserve
Federal Funds Target Rate



On the face of it, such a behavioural pattern would appear quite easy to predict. Moreover, Central Bank behaviour has typically been modelled by fitting a Taylor reaction function incorporating a lagged dependent variable with a large, (often around 0.8 at a quarterly periodicity), and highly significant coefficient. But if this was, indeed, the reason for such gradualism, then the series of small steps should be highly predictable in advance.

The problem is that the evidence shows that they are <u>not</u> well predicted, beyond the next few months. There is a large body of, mainly American, literature to this effect, with the prime exponent being Glenn Rudebusch with a variety of co-authors, see in particular Rudebusch (1995, 2002 and 2006). Indeed, prior to the mid 1990s, there is some evidence that the market could hardly predict the likely path, or direction of movement, of policy rates over the next few months in the USA (see Rudebusch 1995 and 2002 and the literature cited there). More recently, with Central Banks having become much more transparent about their thinking, their plans and their intentions, market forecasts of the future path of policy rates have become quite good over the immediately forthcoming quarter, and better than a random walk (no change) assumption over the following quarter. But thereafter they remain as bad as ever, (Rudebusch, 2006, and Lange, Sack and Whitesell, 2003).

We contribute to this literature first by extending the empirical analysis to New Zealand and the UK, though some similar work on UK data has already been done by Lildholdt and Wetherilt (2004). The work on New Zealand is particularly interesting since the forecasts are <u>not</u> those derived from the money market, but those made available by the Reserve Bank of New Zealand in their Monetary Policy Statements about their current expectations for their own future policies.

One of the issues relating to the question of whether a Central Bank should attempt to decide upon, and then publish, a prospective future path for its own policy rate, as contrasted with relying on the expected path implicit in the money market yield curve, is the relative precision of the two sets of forecasts. A discussion of the general issues involved is provided by Goodhart (forthcoming 2008). For an analytical discussion of the effects of the relative forecasting precision on that decision, see Morris and Shin (2002) and Svensson (2006).

The question of the likely precision of a Central Bank's forecast of its own short-run policy rate is, however, at least in some large part, empirical. The Reserve Bank of New Zealand (RBNZ), a serial innovator in so many aspects of central banking, including inflation targeting and the transparency (plus sanctions) approach to bank regulation, was, once again, the first to provide a forecast of the (conditional) path of its own future policy rates. It began to do so in 2000 Q1. That gives 28 observations between that date and 2006 Q4, our sample period. While still short, this is now long enough to undertake some preliminary tests to examine forecast precision.

Partly for the sake of comparison[1], we also explore the accuracy of the implicit market forecasts of the path of future short term interest rates in the UK. We use estimates provided by the Bank of England over the period 1992 Q4 until 2004 Q4. There are two such series, one derived from the Libor yield curve and one from short-dated government debt. We base our choice between these on the relative accuracy of their forecasts. On this basis, as described in Section 3, we choose, and subsequently use, the government debt series and its implied forecasts.

In the next Section, Section 2, we report and describe our data series. Then in Section 3 of this paper we examine the predictive accuracy of these sets of interest rate forecasts. The results are closely in accord with the earlier findings in the USA. Whether the forecast comes from the central bank, or from the market, the predictive ability is good, by most econometric standards, over the first quarter following the date of the forecast; poor, but significantly better than a no-change, random walk forecast, over the second quarter, (from end-month 3 to end-month 6), and effectively useless from that horizon onwards.

Worse, however, is to come. The forecasts, once beyond the end of the first quarter, are not only without value, they are, when compared with ex post outcomes, also strongly and significantly biased. This does not, however, necessarily mean that the

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[1] The UK and New Zealand are different economies, and so one is <u>not</u> strictly comparing like with like. If one was, however, to compare the NZ implicit market forecast accuracy, with that of the RBNZ forecast over the same period, (a comparison which we hope that the RBNZ will do), the former will obviously be affected by the latter (and possibly vice versa). Again if a researcher was to compare the implied accuracy of the market forecast <u>prior</u> to the introduction of the official forecast with the accuracy of the market/official forecast <u>after</u> the RBNZ had started to publish, (another exercise that we hope that the RBNZ will undertake), then the NZ economy, their financial system and the economic context may have changed over time. So one can <u>never</u> compare an implicit market forecast with an official forecast for interest rates on an exactly like for like basis. Be that as it may, we view the comparison of the RBNZ and the implied UK interest rate forecasts as illustrative, and not definitive in any way.

forecasts were ex ante inefficient. We shall demonstrate in Paper 3 of this series how ex post bias can yet be consistent with ex ante efficiency in forecasting.

This bias can actually be seen clearly in a visual representation of the forecasts. The RBNZ forecasts, and outcome are shown in Figure 4 and the UK forecast derived from the short-dated Government debt yield curve in Figure 5.

Figure 4
RBNZ interest rate forecast (90days, annualized rate)
published in successive Monetary Policy Statement

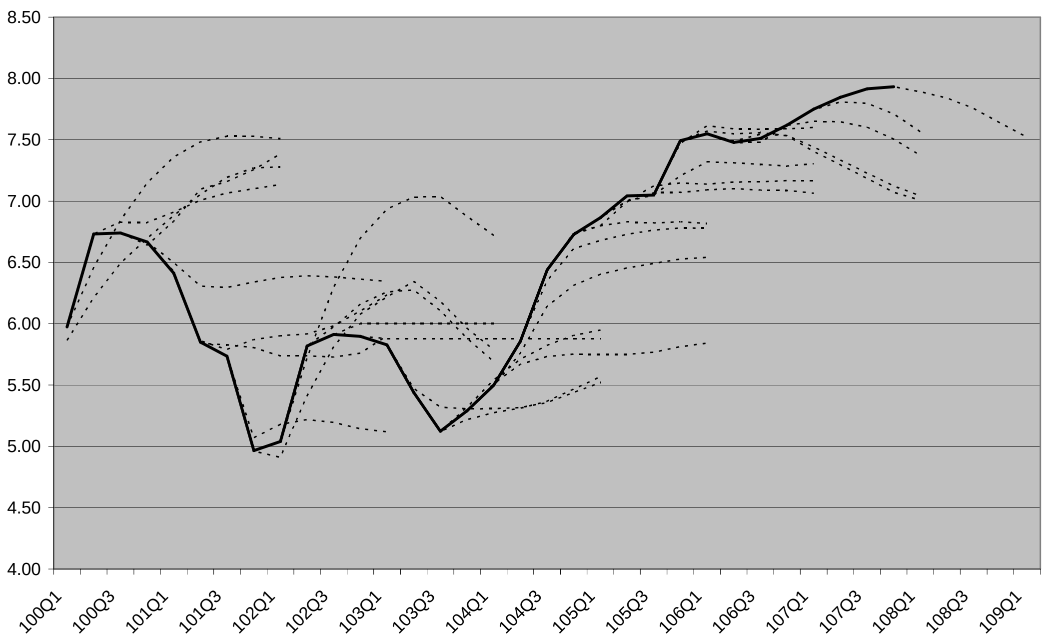
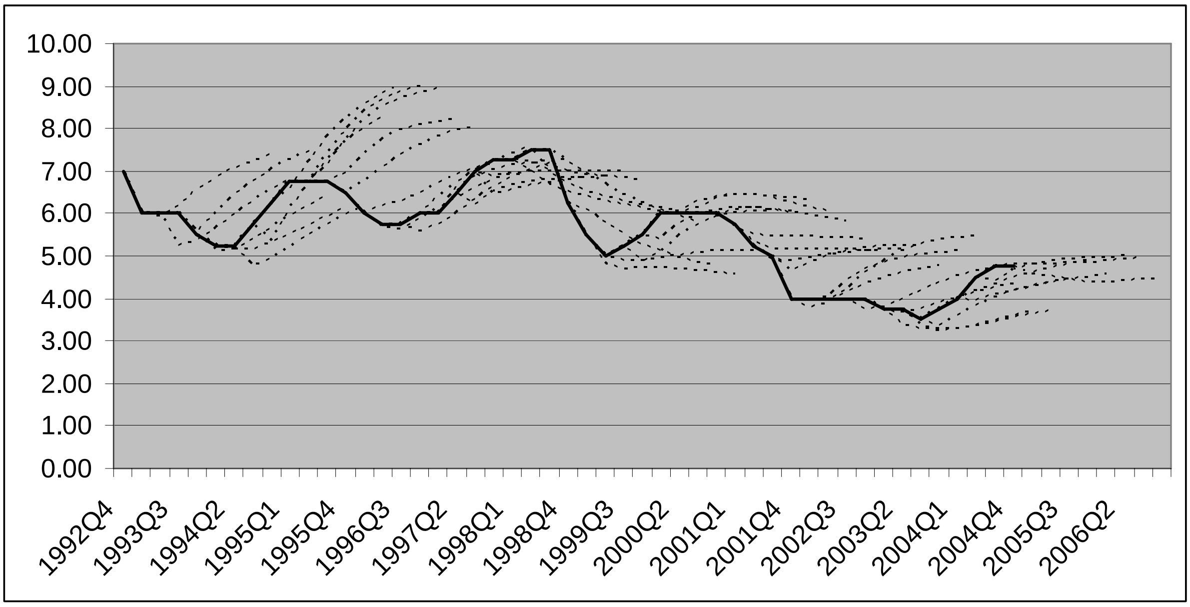


Figure 5
UK interest rate forecast (90days, annualized rate)
derived from the short dated government debt yield curve



What is apparent by simple inspection is that when interest rates are on an upwards (downwards) cyclical path, the forecast under (over) estimates the actual subsequent path of interest rates. Much the same pattern is also observable in Rudebusch, 2007, Figures 1, reproduced as Figure 6 here, for the USA and Sweden, see Adolfson, et al., 2007, reproduced as Figure 7 here. One of the reasons why this bias has not been more widely recognised is that the biases during up and down cyclical periods are almost exactly offsetting, so if an econometrician applies her tests to the complete time series (as usual) (s)he will find no aggregate sign of bias. The distinction between the bias in ’up’ and ‘down’ periods is crucial. A problem with some time series, e.g. those for inflation in Paper 2, is that the division of the sample into ‘up’, ‘down’, and in some cases ‘flat’ periods is not always easy, nor self-evident. But this is not the case for short term interest rates where the, ex post, timing of turning points is relatively easier.

Figure 6
Actual and expected federal funds rate

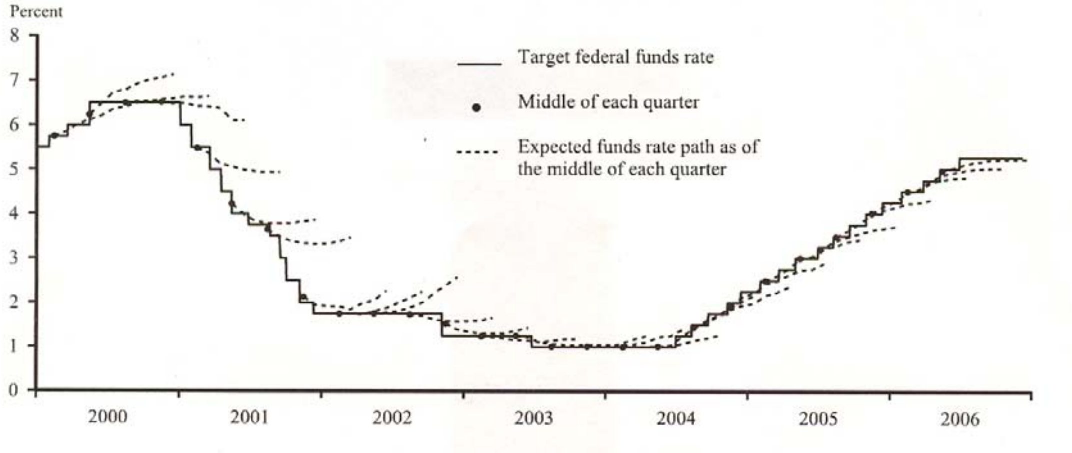
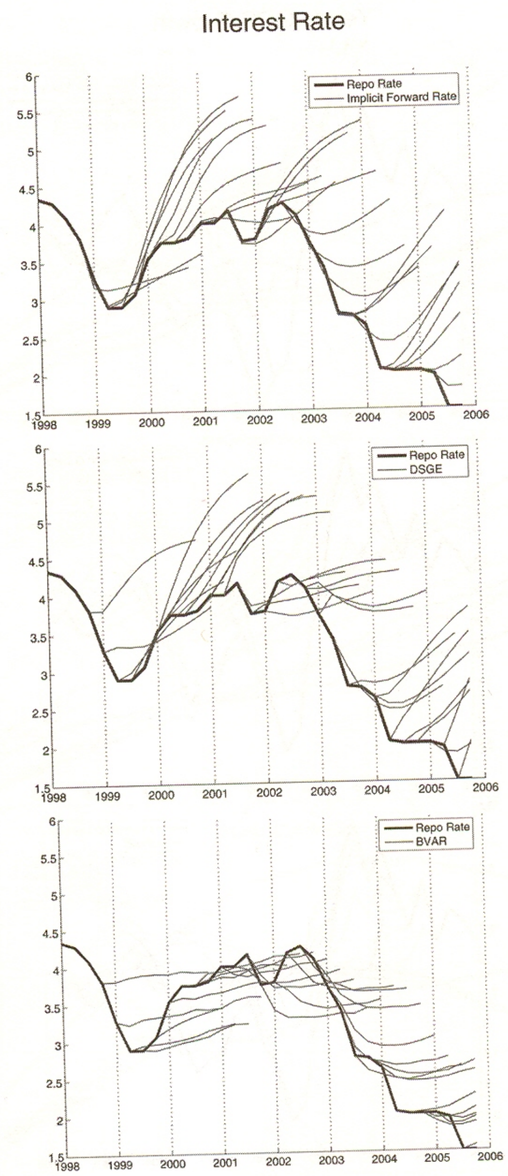


Figure 7
Sequential Forecasts of Sweden's Repo Rate, 1999:Q1 – 2005:Q5, from the Riksbank (First Row), the DSGE Model (Second Row), and the BVAR Model (Third Row)



The sequencing of this paper proceeds as follows. We report our data base in Section II. We examine the accuracy of the interest rate forecasts in Section III, and we offer some interim conclusions in Section IV. Recall that we shall continue this exercise in Paper 2, exploring whether inflation forecasts exhibit similar error patterns, which latter may help to explain the errors in the interest rate forecast; and then in Paper 3 we shall assess whether forecasts which appear ex post biased can still be ex ante efficient.

II. The Data Base

Our focus in this paper concerns the accuracy of forecasts for short-term policy-determined interest rates measured in terms of unbiasedness and the magnitude of forecast error. We examine the data for two countries. We do so first for New Zealand, because this is the country with the longest available published series of official projections, as presented by the Reserve Bank of New Zealand (RBNZ) in their quarterly Monetary Policy Statement. Our second country is the UK. In this case the Bank of England assumed unchanged future interests, from their current level, as the basis of their forecasts, until they moved onto a market-based estimate of future policy rates in November 2004. As described below, we use two alternative estimates of future (forecast) policy rates.

In NZ policy announcements, and the release of projections, are usually made early in the final month of the calendar quarter, though the research work and discussions in their Monetary Policy Committee, will have mostly taken place a couple of weeks previously. Thus the Statement contains a forecast for inflation for the current quarter (h = 0), though that will have been made with knowledge of the outturn for the first month, and some partial evidence for the second. The Policy Target Agreement between the Treasurer and the Governor is specified in terms of the CPI, and the forecast is made in terms of the CPI. This does not, however, mean that the RBNZ focuses exclusively on the overall CPI in its assessment of inflationary pressures.

Indeed we think that the distinction between the (forecast) path of CPI and of other measures of inflationary pressures, e.g. domestically generated CPI, may have been influential in policy decisions at certain times, as discussed further in Section 5.

In NZ the policy-determined rate is taken to be the 90 day (3 month) rate, and the forecasts are for that rate. Thus the current quarter interest rate observation contains nearly two months of actual 90 day rates, and just over one month of market forward one month rates. If the MPC meeting results in a (revisable) decision to change interest rates in a way that is inconsistent with the prediction that was previously embedded in market forward interest rates, then the assumption for the current quarter can be revised to make the overall 90 day track look consistent with the policy message. Finally the policy interest rate can be adjusted, after the forecast is effectively completed, right up to the day before the Monetary Policy Statement; this was done in September 2001 after the terrorist attack. So, the interest rate forecast for the current quarter (h = 0) also contains a small extent of uncertain forecast.

The data, for published official forecasts of the policy rate start in 2000 Q1. We show that data, the forecasts, and the resulting errors, for the policy rate in Appendix Tables 1A and B. The data are shown in a format where the forecasts are shown in the same row as the actual to be forecast, so the forecast errors can be read off directly.

The British case is somewhat more complicated. In the past, during the years of our sample, the MPC used a constant forward forecast of the repo rate as the conditioning assumption for its forecasting exercise. Whether members of the MPC made any mental reservations about the forecast on account of a different subjective view about the future path of policy rates is an individual question that only they can answer personally. But it is hard to treat that constant path as a pure, most likely, forecast. At the same time there are, at least, two alternative time series of implied market forecasts for future policy rates, that derived from the yield curve of short-dated government debt and that derived from the London Inter-Bank Offer Rate (LIBOR). There are some complicated technical issues in extracting implied forecasts from market yield curves, and such yield curves can be distorted, especially the Libor yield curve, as experience in 2007 revealed. We do not rehearse these difficulties here; instead we simply took these data from the Bank of England website, see www.bankofengland.co.uk for more information on the procedures used to obtain such implicit forecast series, see Anderson and Sleath, (1999, 2001), Brooks, Cooper and Scholtes (2000), and Joyce, Relleen and Sorensen (2007). As will be reported in the next Section, the government debt implicit market forecast series had a more accurate forecast than the Libor series over our data period, 1992-2004. Since the constant rate assumption was hardly a forecast, most of our work was done with the government debt implicit forecast series. This forecasts the three month Treasury Bill series. These series, actual, forecast and errors, (with the forecast lined up against the actual it was predicting) are shown in Appendix Table 2A and B, for the government debt series, (the other series for Libor is available from the authors on request).

III. How Accurate are the Interest Rate Forecasts?

We began our examination of this question by running four regressions both for the NZ data series and for two sets of implied market forecasts for the UK, derived from the LIBOR and Government Debt yield curve respectively. These regression equations were:-

(1) $IR(t + h) = C_1 + C_2$ Forecast $(t, t + h)$

(2) $IR(t + h) – IR(t) = C_1 + C_2$ (Forecast t, t + h – IRt)

(3) $IR(t + h) – IR(t + h – 1) = C_1 + C_2$ (Forecast, t, t + h – Forecast, t, t + h – 1)

(4) $IR(t + h) – IR(t + h – 1) = C$ (Forecast, t, t + h – Forecast, t, t + h – 1).

Where: Forecast (t,t+h) = forecast of IR(t+h) made at time, t

IR(t) = actual interest rate outurn at time, t

The first equation is essentially a Mincer-Zarnowitz regression (Mincer and Zarnowitz, 1969), evaluating how well the forecast can predict the actual h-period ahead interest rate outturn (h = 0 to n). If the forecast perfectly matches the actual interest rate outturn for every single period, we would expect to have $C_2 = 1$, and $C_1 = 0$. This can be seen as an evaluation of the bias of the forecast. Taking expectation on both sides, E{IR(t+h)} = E {$C_1 + C_2$ [Forecast(t,t+h)]}. A forecast is unbiased, i.e. E{IR(t+h)} = E{[Forecast(t,t+h)]} for all t, if and only if $C_2 = 1$, and $C_1 = 0$. The second regression, by subtracting the interest rate level from both sides, allows us to focus our attention on the performance of the forecast interest rate difference {IR(t + h) – IR(t)}. It asks, as h increases, how accurately can the forecaster forecast h-quarter ahead interest rate <u>changes</u> from the present level. The third regression is a slight twist on the second, focussing on one-period ahead forecasts; the regression examines the forecast performance of one-period ahead interest rate changes {IR(t + h) – IR(t + h – 1)}, as h increases. The fourth equation just repeats equation 3, but drops the constant term.

All four regressions assess the accuracy/biasness of interest rate forecasts from slightly different angles. In the first three equations, an unbiased forecast will necessarily implies a constant term of zero, and a slope coefficient of one. In all four equations the coefficient C_2 should be unity. We can test whether these conditions are fulfilled with a joint hypothesis test:

$$H_0: C_1=0 \text{ and } C_2=1$$

With four equations, three data sets, and h = 0 to 5 for NZ and h = 1 to 8 for the UK series, we have some 88 regression results and statistical test scores to report. Rather than asking the reader to plough through them all, we collect these together in Appendix 2. Interpretation of regression results is somewhat subjective. We give our interpretation of them here; the sceptical reader is invited to examine Appendix 2 and make his/her own assessment.

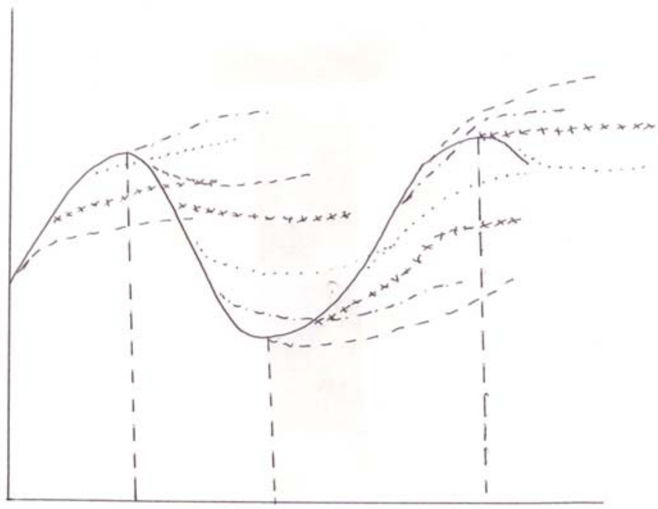
Let us start with NZ. What these results demonstrate is that the RBNZ forecast is excellent one quarter ahead, but then becomes useless in forecasting the subsequent direction, or extent, of change. Thus the coefficient C_2 in equation (3) becomes -0.04 at h = 2 (with a R squared of zero), and negative thereafter. Much the same is true for equation 4. When the equation is run in levels, rather than first differences, i.e. equations 1 and 2, the excellent first quarter forecast feeds through into a significantly positive forecast of the <u>level</u> in the next few quarters, though it is just the first quarter forecast doing all the work.

Turning next to the UK, and starting with the implied forecasts from the government debt yield curve, what these tables indicate is that, in the first quarter after the forecast is made, the forecast precision of this derived forecast is mediocre (joint test for null hypothesis is rejected for h=3-8) , certainly significantly better than random walk (no change), but not nearly as good as the NZ forecast over its first quarter. However, this market based forecast is able also to make a good forecast of the change in rates between Q1 and Q2, (whereas the RBNZ could not do that). The Government yield forecast for h = 2 in Tables 3 and 4 is somewhat better than for h = 1. So the ability of the Government yield forecast to predict the level of the policy rate two quarters (six months) hence is about the same, or a little better than that of the RBNZ. Thereafter, from Q2 onwards, the predictive ability of the Government yield forecast becomes insignificantly different from zero, but at least the coefficients have the right sign (unlike the RBNZ).

Finally for the implicit forecasts derived from the Libor yield curve these tables indicate that, over this sample period, such implicit forecasts have been comprehensively worse than those from the Government yield curve, or the RBNZ. These provided poor forecasts even for the first two quarters, and useless forecasts thereafter. There are several possible reasons for such worse forecasts, e.g. time varying risk premia, data errors in a short sample, but it is beyond the scope of this paper to try to track them down. Instead we will focus on the forecasts implied by the government yield curve since they have a better record, at least at the short end.

The conclusion of this set of tests is that the precision of interest forecasts beyond the next quarter, or two, is approximately zero, whether they are made by the RBNZ or the UK market. Given the gradual adjustments in actual policy rates, this might seem surprising. Why does it happen? In order to start to answer this question, we start with a stylised fact. When one looks at most macro-economic forecasts, and notably so for interest rates, see Figures 4-7 above, they tend to follow a pattern. When the macro-variable is rising, the forecast increasingly falls below it. When the macro-variable is falling, the forecast increasingly lies above it. This pattern is shown again in illustrative form in Figure 8.

Figure 8



So, if we divide the sample period into periods of rising and falling values for the variable of concern, in this case the interest rate, during up periods, Actual minus Forecast will be tend to persistently positive and during down periods Actual minus Forecast will tend to be persistently negative. There is, however, an important caveat. A forecast made during an up (down)-period may extend over several quarters beyond the turning point into the next down (up)-period. Consider, for example, the final turning point in Figure 8. Three forecasts made in the earlier part of the prior upturn (---, xxx and …) have a positive Actual minus Forecast after the sign change from up to down, and three forecasts made in the latter part of the upturn (-.-.-, ---- and xxx) a negative Actual minus Forecast. Clearly the tendency for Actual minus Forecast to be negative in an upturn will be most marked for Forecasts made in an upturn so long as that upturn continues, i.e. until the next sign change from up to down, or vice versa. Nevertheless we still expect on balance that forecasts made during an upturn (downturn) will tend to have positive (negative) Actual minus Forecast outturns even after such a sign change, but the result is clearly uncertain.[2] Third, the forecasts made for the policy rate in the next quarter, (and to a lesser extent into the second quarter) are so good, especially for the next quarter for the RBNZ, that no such bias may exist.

In Figures 9 and 10 we reproduce the charts for the policy rate in NZ and UK, marking the points at which we have taken the turning points to be. Given these turning points we reproduce the number of observations of errors (Actual minus Forecast) until the first sign change in up and down periods separately, and then between the first and second sign change, of all forecasts made during up and down periods respectively, together with their mean error and standard deviation, and we show the p values of such values coming from a distribution whose true underlying mean error was zero. This is shown in Table 1 for the RBNZ forecast and in Table 2 for the Government yield forecasts.

[2] When interest rates are volatile, and sign changes are more frequent, nothing useful can be said about the likely outcomes of Actual minus Forecast after a second sign change.

Figure 9
RBNZ interest rate (3 months annualized rate)

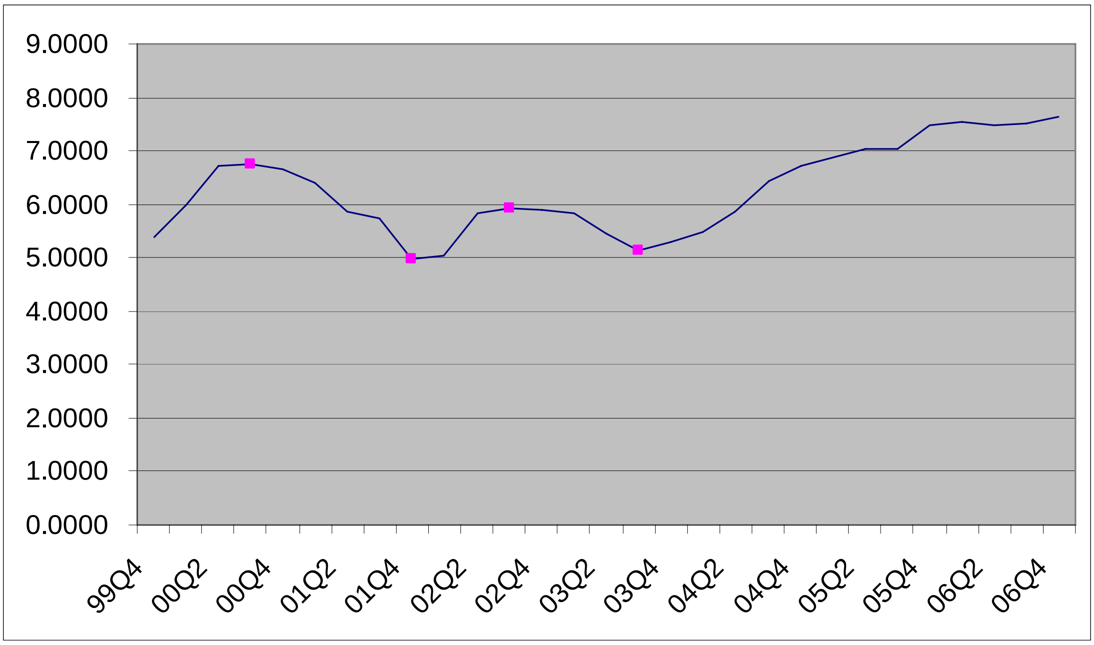
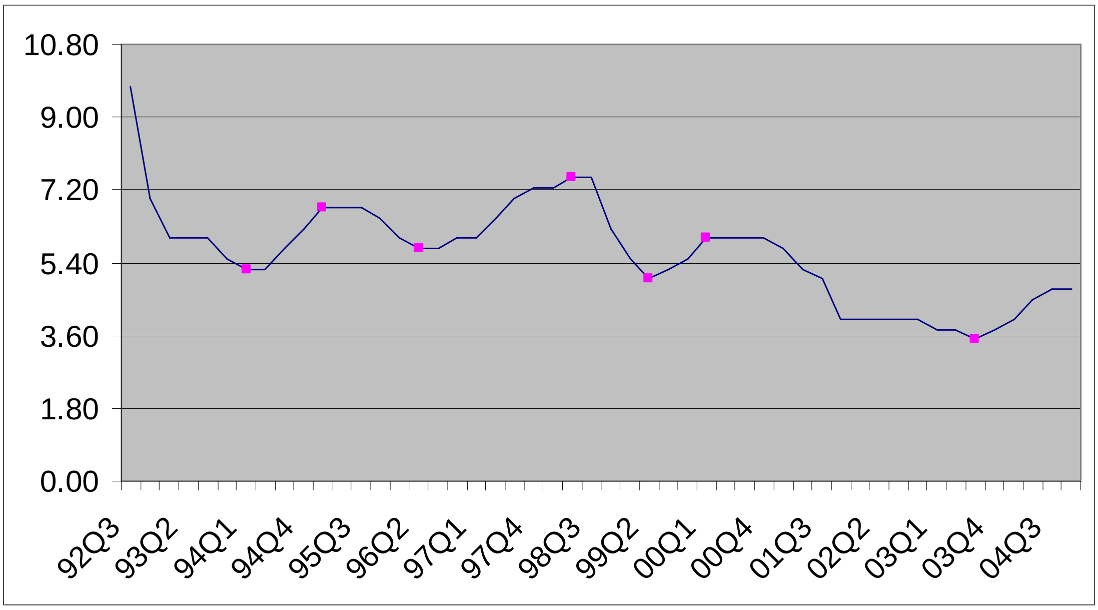


Figure 10
UK Gov curve implied forward rate (3 months annualized rate)



Let us go through the RBNZ Table 1 starting with the top left quadrant table. The top line shows that there were 19 forecasts made during up periods. Of these in their first quarter, 11 had positively signed errors (Actual > Forecast) and 8 negatively signed errors (Actual < Forecast). The mean error was a very small positive sum (0.04), with a p value of 0.06. Of these 19 forecasts, for 16 the up period of actual policy rates was still in place in their second quarter. Of these 16, 9 had a positive error and 7 a negative error. Again the mean error was small positive, insignificantly different from zero. From then on out to quarter 9, the general picture changes. There are 45 positive errors and only 4 negative errors. The mean size of the positive error rises steadily to over 100 basis points, and the mean error is statistically significantly different from zero in a couple of cases.

Table 1

RBNZ Interest Rate

Initial Sign: Up

Up error					
#	+ ve	- ve	Mean	SD	P-value
19	11	8	0.0391	0.0825	0.0594
16	9	7	0.0737	0.2237	0.2213
13	10	3	0.1942	0.2150	0.0087
10	9	1	0.3628	0.2924	0.0048
9	9	0	0.5016	0.3310	0.0027
8	8	0	0.6618	0.3273	0.0011
5	5	0	0.7827	0.3559	0.0117
3	3	0	1.0812	0.5647	0.1136
1	1	0	1.7079		
84	65	19	0.3184	0.4052	0.0000

Initial Sign: Down

Down error					
#	+ ve	- ve	Mean	SD	P-value
9	3	6	-0.0435	0.0489	0.0360
7	0	7	-0.3835	0.2722	0.0136
5	0	5	-0.7927	0.2824	0.0049
3	0	3	-1.2244	0.3015	0.0290
1	0	1	-2.2901		
0	0	0			
0	0	0			
0	0	0			
0	0	0			
25	3	22	-0.5201	0.5821	0.0002

After first sign change

Down error					
#	+ ve	- ve	Mean	SD	P-value
0	0	0			
2	0	2	-0.2104	0.0736	0.2143
4	0	4	-0.5527	0.1682	0.0108
6	0	6	-0.7092	0.4840	0.0221
6	0	6	-1.0664	0.5457	0.0072
5	0	5	-1.5902	0.5153	0.0035
3	0	3	-1.6932	0.7783	0.0914
1	0	1	-2.3042		
0	0	0			
27	0	27	-1.0600	0.6904	0.0000

After first sign change

Up error					
#	+ ve	- ve	Mean	SD	P-value
0	0	0			
2	1	1	-0.0339	0.1499	0.8584
4	2	2	-0.0140	0.6199	0.9712
6	3	3	0.0114	0.5816	0.9668
7	3	4	-0.1149	0.7958	0.7356
7	3	4	-0.1304	1.2080	0.8003
4	3	1	0.6687	0.8337	0.2590
2	2	0	1.0957	0.3509	0.1973
1	1	0	0.9847		
33	18	15	0.1236	0.8385	0.4035

Let us next turn to the next right hand side sub-table. Here there were nine forecasts made during periods of downturn. In the first quarter of the forecast, there were three positive errors and six negative errors, the mean error was a small negative total (-0.04) with a p value of 0.04. Interest rate downturns are shorter and sharper than upturns, so no forecast originally made in a downturn had that down period of actual interest rates last beyond the fifth quarter. Once the forecast was still in a downturn (beyond the first quarter) the asymmetry becomes extreme; there are 16 negative errors and 0 positive errors. The absolute size of the negative error rises rapidly to over 100 bps by Q4, and is significantly different from zero in Qs 3 and 4.

The bottom left hand sub-table shows the outcome for forecasts made in a period when actual interest rates had been going down, but after the sign change from a down period to an up period. By definition there can be no observations in the top row. In two cases the down period of actual interest rates switched to an up period in the second quarter of the forecast. In this sub-table every single observation is again negative (Actual < Forecast), the absolute scale of the negative values rises, again to over -100 bps and several are significantly different from zero.

In the case of the bottom right hand side sub-table, the outcome is much less marked and extreme. This sub-table shows the error outcome for forecasts made initially during upturns, but after there has been a change to a downturn. In this case there is rough equality between positive and negative errors, the mean size of error is usually small and except in one case (involving only two observations) totally insignificant.

Overall upturns last longer than downturns, so more forecasts are made during upturns, and there are more error observations during upturns (117) than in downturns (52). In contrast, the extent of bias and inefficiency in errors in forecasts made initially during downturns is considerably greater than those made during upturns. So if you take the sample period as a whole, containing both periods of upturn and downturn, the biases net out. Regression analyses covering the whole sample period, therefore, tend to show that forecasts, though poor, are neither inefficient nor biased. But this obscures the finding here that there are, in fact, large, but offsetting, biases and inefficiencies in forecasts made during upturns and downturns.

Perhaps an easier and more standard way of demonstrating this result, suggested to us by Andrew Patton, is to run a regression of the forecast error, at various horizons, against two indicator variables, one for up periods (C1) and one for down periods (C2). The hypothesis is that the up period indictor variable (C1) is positive (actual > forecast) and the down period indicator (C2) is negative (actual < forecast).

The results for NZ are as follows:-

Table 2

(A) Indicator variable is based on state at out-turn date (whole data set)

H =	Adj R-sqr	C(1)	P-value	C(2)	P-value
Q1	0.41	0.06	0.26	-0.35	0.00
Q2	0.62	0.15	0.07	-0.69	0.00
Q3	0.58	0.23	0.06	-0.88	0.00
Q4	0.36	0.23	0.23	-0.99	0.00
Q5	0.27	0.24	0.33	-1.06	0.01
Q6	0.20	0.23	0.49	-1.07	0.05
Q7	0.03	0.13	0.79	-0.95	0.27
Q8	-0.30	0.04	0.97	-0.52	0.78

(B) Indicator variable is based on state at out-turn date,
but only includes period during which sign is unchanged

H =	Adj R-sqr	C(1)	P-value	C(2)	P-value
Q1	0.41	0.06	0.26	-0.35	0.00
Q2	0.76	0.22	0.00	-0.70	0.00
Q3	0.87	0.41	0.00	-1.13	0.00
Q4	0.81	0.56	0.00	-1.53	0.00
Q5	0.86	0.73	0.00	-2.13	0.00
Q6	-	-	-	-	-
Q7	-	-	-	-	-
Q8	-	-	-	-	-

(C) Indicator variable is based on state at forecast date (whole data set)

H =	Adj R-sqr	C(1)	P-value	C(2)	P-value
Q1	0.41	0.06	0.26	-0.35	0.00
Q2	0.51	0.12	0.17	-0.64	0.00
Q3	0.39	0.16	0.25	-0.76	0.00
Q4	0.17	0.15	0.50	-0.72	0.02
Q5	0.05	0.10	0.72	-0.57	0.13
Q6	-0.07	-0.15	0.72	-0.17	0.73
Q7	0.00	-0.49	0.38	0.41	0.57
Q8	-0.29	-0.27	0.80	0.23	0.86

(D) Indicator variable is based on state at forecast date,
but only includes period during which sign is unchanged

Same results as (B) above.

Turning next to the Table (Table 3) showing the results for the Government yield implied forecasts, we find in effect qualitatively <u>identical</u> results.

Table 3

GOV Interest Rate

Initial Sign: Up

Up error

#	+ ve	- ve	Mean	SD	P-value
13	11	2	0.3772	0.2542	0.0002
14	13	1	0.4633	0.3375	0.0003
12	11	1	0.5630	0.4362	0.0013
8	7	1	0.5728	0.5197	0.0225
5	4	1	0.4272	0.3595	0.0762
3	3	0	0.2375	0.2019	0.2381
2	1	1	0.1410	0.4474	0.8056
1	0	1	-0.0761		
58	50	8	0.4445	0.3744	0.0000

Initial Sign: Down

Down error

#	+ ve	- ve	Mean	SD	P-value
20	12	8	-0.0289	0.3573	0.7280
24	6	18	-0.3196	0.4542	0.0026
20	1	19	-0.7738	0.4911	0.0000
16	0	16	-1.1407	0.4963	0.0000
12	0	12	-1.4608	0.5352	0.0000
9	0	9	-1.4664	0.4316	0.0000
8	0	8	-1.6312	0.4575	0.0000
7	0	7	-1.7305	0.3724	0.0000
116	19	97	-0.8578	0.6997	0.0000

After first sign change

Down error

#	+ ve	- ve	Mean	SD	P-value
0	0	0			
2	2	0	0.5085	0.4241	0.4425
6	3	3	-0.0752	0.4818	0.7411
9	4	5	-0.2765	0.8081	0.3614
11	4	7	-0.5033	1.1638	0.2014
11	3	8	-0.8292	1.3532	0.0814
10	3	7	-0.9444	1.2117	0.0441
9	2	7	-1.0630		
58	21	37	-0.6136	1.0948	0.0001

After first sign change

Up error

#	+ ve	- ve	Mean	SD	P-value
0	0	0			
4	4	0	0.3164	0.2398	0.1064
8	6	2	0.2537	0.4798	0.2046
12	6	6	-0.0081	0.9716	0.9785
15	6	9	-0.2285	1.0896	0.4458
16	5	11	-0.5811	1.2364	0.0887
14	3	11	-0.7001	1.1241	0.0427
12	4	8	-0.7740	0.9715	0.0229
81	34	47	0.0151	0.7842	0.8637

Again we run the same, simpler, regression exercise. The results are:-

Table 4

(A) Indicator variable is based on state at out-turn date (whole data set)

H =	R-sqr	S1	P-value	S2	P-value
1	0.37	0.38	0.00	-0.03	0.69
2	0.39	0.43	0.00	-0.26	0.00
3	0.53	0.44	0.00	-0.61	0.00
4	0.40	0.22	0.21	-0.83	0.00
5	0.30	-0.06	0.78	-0.91	0.00
6	0.25	-0.48	0.09	-0.82	0.00
7	0.31	-0.78	0.01	-0.80	0.00
8	0.41	-1.04	0.00	-0.83	0.00

(B) Indicator variable is based on state at out-turn date,
but only includes period during which sign is unchanged

H =	R-sqr	S1	P-value	S2	P-value
1	0.37	0.38	0.00	-0.03	0.69
2	0.47	0.46	0.00	-0.32	0.00
3	0.70	0.56	0.00	-0.77	0.00
4	0.81	0.57	0.00	-1.17	0.00
5	0.88	0.43	0.07	-1.46	0.00
6	0.93	0.24	0.32	-1.47	0.00

(C) Indicator variable is based on state at forecast date (whole data set)

H =	R-sqr	S1	P-value	S2	P-value
1	0.37	0.38	0.00	-0.03	0.69
2	0.38	0.47	0.00	-0.23	0.01
3	0.34	0.35	0.02	-0.48	0.00
4	0.27	0.12	0.57	-0.66	0.00
5	0.22	-0.21	0.45	-0.70	0.00
6	0.24	-0.62	0.05	-0.68	0.01
7	0.32	-0.97	0.00	-0.70	0.00
8	0.44	-1.26	0.00	-0.72	0.00

(D) Indicator variable is based on state at forecast date,
but only includes period during which sign is unchanged.

Same results as (B) above.

In this latter, UK case, however, the forecasts included some sizeable average errors, whereby the forecasts implied that interest rates would tend to become higher than was the case in the historical event (actual < forecast). This average error tended to increase, approximately linearly, as the horizon (h) increased. This is shown in Figure 11 and Table 5 below:-

Figure 11

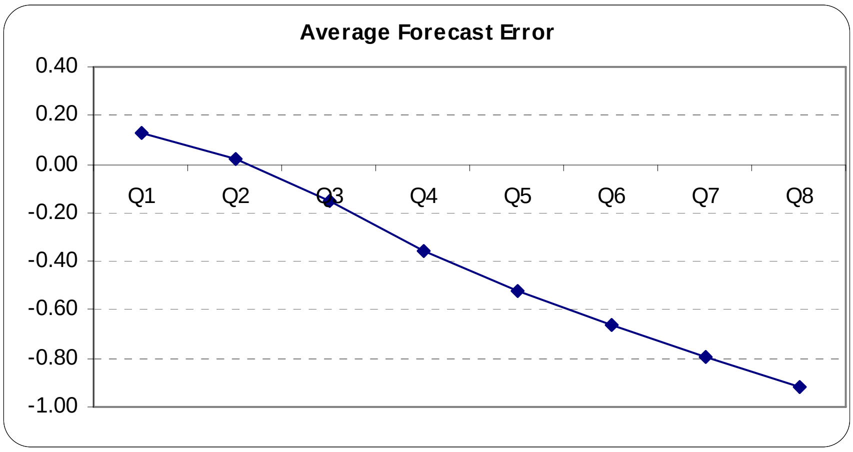


Table 5

H=	Average Forecast Error
Q1	0.1311
Q2	0.0250
Q3	-0.1552
Q4	-0.3612
Q5	-0.5240
Q6	-0.6616
Q7	-0.7939
Q8	-0.9217

After correcting for this average error, and re-running,[3] the results became:-

Table 6

(A) Indicator variable is based on state at out-turn date
(whole data set, with average forecast error removed)

H =	Adj R-sqr	C(1)	P-value	C(2)	P-value
Q1	0.27	0.25	0.01	-0.16	0.03
Q2	0.37	0.41	0.00	-0.28	0.00
Q3	0.50	0.59	0.00	-0.46	0.00
Q4	0.30	0.59	0.00	-0.47	0.01
Q5	0.12	0.46	0.06	-0.38	0.08
Q6	0.00	0.18	0.50	-0.16	0.53
Q7	-0.02	0.01	0.97	-0.01	0.97
Q8	-0.02	-0.12	0.67	0.09	0.70

(B) Indicator variable is based on state at out-turn date, but only includes period during which sign is unchanged, with average forecast error removed

H =	Adj R-sqr	C(1)	P-value	C(2)	P-value
Q1	0.27	0.25	0.01	-0.16	0.03
Q2	0.45	0.44	0.00	-0.34	0.00
Q3	0.66	0.72	0.00	-0.62	0.00
Q4	0.74	0.93	0.00	-0.78	0.00
Q5	0.79	0.95	0.00	-0.94	0.00
Q6	0.83	0.90	0.00	-0.80	0.00
Q7	0.80	0.93	0.00	-0.84	0.00
Q8	0.85	0.85	0.00	-0.81	0.00

[3] The average forecast error in NZ was much smaller, and did not vary systematically with h. We ran similar adjusted regressions for NZ, but the results were closely similar to those shown in Table 3 above.

(C) Indicator variable is based on state at forecast date
(whole data set, with average forecast error removed)

H =	Adj R-sqr	C(1)	P-value	C(2)	P-value
Q1	0.27	0.25	0.01	-0.16	0.03
Q2	0.37	0.44	0.00	-0.25	0.00
Q3	0.29	0.51	0.00	-0.32	0.01
Q4	0.14	0.48	0.03	-0.29	0.08
Q5	0.02	0.31	0.26	-0.18	0.40
Q6	-0.02	0.04	0.91	-0.02	0.93
Q7	-0.01	-0.17	0.58	0.10	0.68
Q8	0.03	-0.34	0.24	0.20	0.37

(D) Indicator variable is based on state at forecast date, but only includes period during which sign is unchanged, with average forecast error removed

H =	Adj R-sqr	C(1)	P-value	C(2)	P-value
Q1	0.27	0.25	0.01	-0.16	0.03
Q2	0.45	0.44	0.00	-0.34	0.00
Q3	0.66	0.72	0.00	-0.62	0.00
Q4	0.74	0.93	0.00	-0.78	0.00
Q5	0.79	0.95	0.00	-0.94	0.00
Q6	0.83	0.90	0.00	-0.80	0.00
Q7	0.80	0.93	0.00	-0.84	0.00
Q8	0.85	0.85	0.00	-0.81	0.00

It was known before in the literature that interest rate forecasts beyond the next few months were abysmally poor, with no precision nor predictive power. What we add here is the finding is that, once one separates the data period into periods of cyclical rises (falls) in actual policy rates, they are significantly biased as well.

VI. Conclusions

(1) The official, and market, forecasts of interest rates that we have studied here have significant predictive power over the next two quarters, but virtually none thereafter. When forecast precision is effectively zero, as after two

quarters hence, it is probably best to acknowledge this, e.g. by using a 'no change' thereafter assumption.

(2) These interest rate forecasts are systematically biased, underestimating future policy rates during upturns and overestimating them during downturns. We shall now proceed to explore reasons why this might have been so in Papers 2 and 3.

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Appendix Table 1A: RBNZ interest rate forecast

Date	Interest Rate	r(t,t)	r(t-1,t)	R(t-2,t)	r(t-3,t)	r(t-4,t)	r(t-5,t)	r(t-6,t)	r(t-7,t)	r(t-8,t)
00Q1	5.974	5.86	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
00Q2	6.732	6.46	6.21	N/A	N/A	N/A	N/A	N/A	N/A	N/A
00Q3	6.740	6.83	6.84	6.49	N/A	N/A	N/A	N/A	N/A	N/A
00Q4	6.667	6.64	6.83	7.15	6.70	N/A	N/A	N/A	N/A	N/A
01Q1	6.412	6.50	6.84	6.91	7.36	6.88	N/A	N/A	N/A	N/A
01Q2	5.850	5.84	6.31	7.10	7.01	7.48	7.05	N/A	N/A	N/A
01Q3	5.736	5.79	5.83	6.30	7.16	7.07	7.53	7.19	N/A	N/A
01Q4	4.966	5.07	5.87	5.81	6.34	7.26	7.10	7.53	7.27	N/A
02Q1	5.040	4.91	5.18	5.90	5.74	6.38	7.38	7.13	7.51	7.28
02Q2	5.819	5.72	5.41	5.22	5.92	5.74	6.39	N/A	N/A	N/A
02Q3	5.913	5.97	6.30	5.81	5.20	5.98	5.73	6.38	N/A	N/A
02Q4	5.898	6.00	6.16	6.70	6.08	5.14	6.10	5.76	6.36	N/A
03Q1	5.828	5.88	6.00	6.26	6.93	6.22	5.12	6.23	5.90	6.35
03Q2	5.439	5.47	5.88	6.00	6.27	7.03	6.34	N/A	N/A	N/A
03Q3	5.123	5.12	5.32	5.88	6.00	6.11	7.04	6.18	N/A	N/A
03Q4	5.290	5.32	5.22	5.31	5.88	6.00	5.88	6.87	5.96	N/A
04Q1	5.498	5.51	5.54	5.28	5.31	5.88	6.00	5.69	6.72	5.79
04Q2	5.857	5.76	5.67	5.71	5.31	5.32	5.88	N/A	N/A	N/A
04Q3	6.440	6.35	6.14	5.73	5.82	5.37	5.36	5.88	N/A	N/A
04Q4	6.728	6.74	6.61	6.31	5.75	5.90	5.47	5.44	5.88	N/A
05Q1	6.865	6.80	6.80	6.68	6.40	5.75	5.95	5.57	5.52	5.88
05Q2	7.043	7.00	7.00	6.83	6.73	6.45	5.75	N/A	N/A	N/A
05Q3	7.049	7.05	7.12	7.07	6.82	6.76	6.49	5.77	N/A	N/A
05Q4	7.493	7.47	7.21	7.15	7.07	6.83	6.78	6.53	5.81	N/A
06Q1	7.549	7.57	7.61	7.32	7.14	7.09	6.82	6.78	6.54	5.84
06Q2	7.478	7.49	7.55	7.59	7.31	7.15	7.10	N/A	N/A	N/A
06Q3	7.511	7.48	7.55	7.56	7.58	7.30	7.16	7.09	N/A	N/A
06Q4	7.643	7.62	7.62	7.53	7.53	7.59	7.29	7.17	7.09	N/A

Appendix Table 1B

Forecast Error	r(t,t)	r(t-1,t)	r(t-2,t)	r(t-3,t)	r(t-4,t)	r(t-5,t)	r(t-6,t)	r(t-7,t)	r(t-8,t)
00Q1	0.11	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
00Q2	0.27	0.52	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
00Q3	-0.09	-0.10	0.25	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
00Q4	0.03	-0.16	-0.48	-0.03	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
01Q1	-0.09	-0.42	-0.50	-0.95	-0.47	#VALUE!	#VALUE!	#VALUE!	#VALUE!
01Q2	0.01	-0.46	-1.25	-1.16	-1.63	-1.20	#VALUE!	#VALUE!	#VALUE!
01Q3	-0.05	-0.09	-0.56	-1.42	-1.33	-1.79	-1.46	#VALUE!	#VALUE!
01Q4	-0.10	-0.90	-0.84	-1.37	-2.29	-2.13	-2.56	-2.30	#VALUE!
02Q1	0.13	-0.14	-0.86	-0.70	-1.34	-2.34	-2.10	-2.47	-2.24
02Q2	0.10	0.41	0.60	-0.10	0.08	-0.57	#VALUE!	#VALUE!	#VALUE!
02Q3	-0.06	-0.38	0.10	0.72	-0.07	0.18	-0.47	#VALUE!	#VALUE!
02Q4	-0.10	-0.26	-0.80	-0.18	0.75	-0.21	0.14	-0.47	#VALUE!
03Q1	-0.05	-0.17	-0.43	-1.11	-0.39	0.71	-0.41	-0.07	-0.52
03Q2	-0.03	-0.44	-0.56	-0.84	-1.59	-0.90	#VALUE!	#VALUE!	#VALUE!
03Q3	0.00	-0.20	-0.76	-0.88	-0.98	-1.91	-1.06	#VALUE!	#VALUE!
03Q4	-0.03	0.07	-0.02	-0.59	-0.71	-0.59	-1.58	-0.67	#VALUE!
04Q1	-0.01	-0.04	0.22	0.19	-0.38	-0.50	-0.19	-1.22	-0.29
04Q2	0.10	0.19	0.15	0.55	0.54	-0.02	#VALUE!	#VALUE!	#VALUE!
04Q3	0.09	0.30	0.71	0.62	1.07	1.08	0.56	#VALUE!	#VALUE!
04Q4	-0.01	0.11	0.41	0.98	0.82	1.26	1.29	0.85	#VALUE!
05Q1	0.06	0.07	0.19	0.46	1.11	0.92	1.30	1.34	0.98
05Q2	0.04	0.05	0.21	0.31	0.59	1.29	#VALUE!	#VALUE!	#VALUE!
05Q3	0.00	-0.07	-0.02	0.23	0.29	0.56	1.28	#VALUE!	#VALUE!
05Q4	0.02	0.29	0.35	0.42	0.66	0.71	0.97	1.68	#VALUE!
06Q1	-0.02	-0.06	0.23	0.41	0.46	0.73	0.77	1.01	1.71
06Q2	-0.01	-0.07	-0.11	0.17	0.32	0.38	#VALUE!	#VALUE!	#VALUE!
06Q3	0.03	-0.04	-0.05	-0.07	0.21	0.35	0.42	#VALUE!	#VALUE!
06Q4	0.02	0.03	0.11	0.11	0.05	0.36	0.48	0.56	#VALUE!

Appendix Table 2A

Table 1: UK interest rate forecast implied by government yield curve

	r	R(t-1,t)	R(t-2,t)	R(t-3,t)	R(t-4,t)	R(t-5,t)	R(t-6,t)	R(t-7,t)	R(t-8,t)
1992Q4	7.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1993Q1	6.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1993Q2	6.00	N/A	5.95	N/A	N/A	N/A	N/A	N/A	N/A
1993Q3	6.00	N/A	5.22	6.18	N/A	N/A	N/A	N/A	N/A
1993Q4	5.50	N/A	5.60	5.36	6.56	N/A	N/A	N/A	N/A
1994Q1	5.25	N/A	5.12	6.02	5.66	6.85	N/A	N/A	N/A
1994Q2	5.25	N/A	5.14	5.17	6.43	5.98	7.07	N/A	N/A
1994Q3	5.75	N/A	4.77	5.17	5.38	6.76	6.28	7.24	N/A
1994Q4	6.25	N/A	5.36	4.94	5.30	5.65	7.03	6.56	7.40
1995Q1	6.75	N/A	6.55	6.08	5.21	5.49	5.92	7.26	6.81
1995Q2	6.75	N/A	N/A	7.23	6.73	5.49	5.71	6.17	7.47
1995Q3	6.75	N/A	7.14	7.42	7.80	7.27	5.75	5.93	6.40
1995Q4	6.50	6.49	6.97	7.73	7.97	8.24	7.69	5.98	6.14
1996Q1	6.00	N/A	6.76	7.39	8.20	8.39	8.57	8.01	6.18
1996Q2	5.75	5.68	6.16	7.08	7.73	8.52	8.68	8.83	8.26
1996Q3	5.75	N/A	5.64	6.29	7.39	7.95	8.72	8.88	9.02
1996Q4	6.00	5.60	N/A	5.84	6.50	7.63	8.09	8.85	9.00
1997Q1	6.00	N/A	5.74	6.42	6.12	6.71	7.82	8.18	8.93
1997Q2	6.50	N/A	6.63	6.01	6.74	6.37	6.90	7.96	8.24
1997Q3	7.00	6.22	N/A	6.88	6.34	7.01	6.60	7.06	8.06
1997Q4	7.25	6.87	6.51	6.43	7.04	6.62	7.24	6.80	7.19
1998Q1	7.25	7.26	6.95	6.67	6.57	7.13	6.86	7.43	6.97
1998Q2	7.50	7.00	7.22	6.99	6.76	6.66	7.19	7.04	7.58
1998Q3	7.50	6.94	6.69	7.10	6.99	6.80	6.73	7.23	7.19
1998Q4	6.25	7.21	6.71	6.51	7.00	6.98	6.83	6.78	7.25
1999Q1	5.50	6.10	6.96	6.53	6.39	6.93	6.98	6.85	6.82
1999Q2	5.00	4.80	5.79	6.69	6.41	6.30	6.87	6.98	6.87
1999Q3	5.25	4.89	4.69	5.51	6.46	6.31	6.21	6.82	6.98
1999Q4	5.50	4.89	4.89	4.71	5.28	6.26	6.21	6.13	6.77
2000Q1	6.00	5.37	5.10	4.94	4.72	5.10	6.09	6.13	6.05
2000Q2	6.00	6.07	5.79	5.45	5.02	4.70	4.96	5.93	6.05
2000Q3	6.00	6.14	6.29	6.00	5.75	5.08	4.66	4.86	5.80
2000Q4	6.00	5.95	6.36	6.40	6.09	5.93	5.11	4.61	4.77
2001Q1	5.75	5.65	6.08	6.44	6.43	6.13	6.02	5.13	4.56
2001Q2	5.25	5.34	5.52	6.12	6.43	6.43	6.13	6.06	5.13
2001Q3	5.00	4.90	5.16	5.47	6.09	6.36	6.41	6.10	6.06
2001Q4	4.00	4.66	4.89	5.14	5.46	6.03	6.26	6.38	6.05
2002Q1	4.00	3.77	4.83	4.95	5.14	5.46	5.96	6.15	6.34
2002Q2	4.00	4.01	3.92	5.01	5.02	5.15	5.44	5.89	6.04
2002Q3	4.00	4.17	4.41	4.14	5.12	5.08	5.14	5.42	5.82
2002Q4	4.00	3.74	4.59	4.68	4.32	5.19	5.12	5.13	5.39
2003Q1	3.75	3.72	3.80	4.90	4.85	4.47	5.22	5.14	5.12
2003Q2	3.75	3.38	3.68	3.98	5.12	4.97	4.59	5.24	5.15
2003Q3	3.50	3.34	3.27	3.76	4.19	5.27	5.04	4.69	5.24
2003Q4	3.75	3.36	3.27	3.24	3.89	4.37	5.37	5.09	4.77
2004Q1	4.00	3.96	3.60	3.28	3.29	4.02	4.52	5.44	5.12
2004Q2	4.50	3.95	4.18	3.84	3.35	3.38	4.13	4.64	5.49
2004Q3	4.75	4.42	4.10	4.35	4.03	3.44	3.49	4.24	4.73
2004Q4	4.75	4.80	4.68	4.19	4.49	4.18	3.54	3.60	4.33

Forecast Error	R(t-1,t)	R(t-2,t)	R(t-3,t)	R(t-4,t)	R(t-5,t)	R(t-6,t)	R(t-7,t)	R(t-8,t)
1992Q4	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
1993Q1	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
1993Q2	#VALUE!	0.05	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
1993Q3	#VALUE!	0.78	-0.18	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
1993Q4	#VALUE!	-0.10	0.14	-1.06	#VALUE!	#VALUE!	#VALUE!	#VALUE!
1994Q1	#VALUE!	0.13	-0.77	-0.41	-1.60	#VALUE!	#VALUE!	#VALUE!
1994Q2	#VALUE!	0.11	0.08	-1.18	-0.73	-1.82	#VALUE!	#VALUE!
1994Q3	#VALUE!	0.98	0.58	0.37	-1.01	-0.53	-1.49	#VALUE!
1994Q4	#VALUE!	0.89	1.31	0.95	0.60	-0.78	-0.31	-1.15
1995Q1	#VALUE!	0.20	0.67	1.54	1.26	0.83	-0.51	-0.06
1995Q2	#VALUE!	#VALUE!	-0.48	0.02	1.26	1.04	0.58	-0.72
1995Q3	#VALUE!	-0.39	-0.67	-1.05	-0.52	1.00	0.82	0.35
1995Q4	0.01	-0.47	-1.23	-1.47	-1.74	-1.19	0.52	0.36
1996Q1	#VALUE!	-0.76	-1.39	-2.20	-2.39	-2.57	-2.01	-0.18
1996Q2	0.07	-0.41	-1.33	-1.98	-2.77	-2.93	-3.08	-2.51
1996Q3	#VALUE!	0.11	-0.54	-1.64	-2.20	-2.97	-3.13	-3.27
1996Q4	0.40	#VALUE!	0.16	-0.50	-1.63	-2.09	-2.85	-3.00
1997Q1	#VALUE!	0.26	-0.42	-0.12	-0.71	-1.82	-2.18	-2.93
1997Q2	#VALUE!	-0.13	0.49	-0.24	0.13	-0.40	-1.46	-1.74
1997Q3	0.78	#VALUE!	0.12	0.66	-0.01	0.40	-0.06	-1.06
1997Q4	0.38	0.74	0.82	0.21	0.63	0.01	0.45	0.06
1998Q1	-0.01	0.30	0.58	0.68	0.12	0.39	-0.18	0.28
1998Q2	0.50	0.28	0.51	0.74	0.84	0.31	0.46	-0.08
1998Q3	0.56	0.81	0.40	0.51	0.70	0.77	0.27	0.31
1998Q4	-0.96	-0.46	-0.26	-0.75	-0.73	-0.58	-0.53	-1.00
1999Q1	-0.60	-1.46	-1.03	-0.89	-1.43	-1.48	-1.35	-1.32
1999Q2	0.20	-0.79	-1.69	-1.41	-1.30	-1.87	-1.98	-1.87
1999Q3	0.36	0.56	-0.26	-1.21	-1.06	-0.96	-1.57	-1.73
1999Q4	0.61	0.61	0.79	0.22	-0.76	-0.71	-0.63	-1.27
2000Q1	0.63	0.90	1.06	1.28	0.90	-0.09	-0.13	-0.05
2000Q2	-0.07	0.21	0.55	0.98	1.30	1.04	0.07	-0.05
2000Q3	-0.14	-0.29	0.00	0.25	0.92	1.34	1.14	0.20
2000Q4	0.05	-0.36	-0.40	-0.09	0.07	0.89	1.39	1.23
2001Q1	0.10	-0.33	-0.69	-0.68	-0.38	-0.27	0.62	1.19
2001Q2	-0.09	-0.27	-0.87	-1.18	-1.18	-0.88	-0.81	0.12
2001Q3	0.10	-0.16	-0.47	-1.09	-1.36	-1.41	-1.10	-1.06
2001Q4	-0.66	-0.89	-1.14	-1.46	-2.03	-2.26	-2.38	-2.05
2002Q1	0.23	-0.83	-0.95	-1.14	-1.46	-1.96	-2.15	-2.34
2002Q2	-0.01	0.08	-1.01	-1.02	-1.15	-1.44	-1.89	-2.04
2002Q3	-0.17	-0.41	-0.14	-1.12	-1.08	-1.14	-1.42	-1.82
2002Q4	0.26	-0.59	-0.68	-0.32	-1.19	-1.12	-1.13	-1.39
2003Q1	0.03	-0.05	-1.15	-1.10	-0.72	-1.47	-1.39	-1.37
2003Q2	0.37	0.07	-0.23	-1.37	-1.22	-0.84	-1.49	-1.40
2003Q3	0.16	0.23	-0.26	-0.69	-1.77	-1.54	-1.19	-1.74
2003Q4	0.39	0.48	0.51	-0.14	-0.62	-1.62	-1.34	-1.02
2004Q1	0.04	0.40	0.72	0.71	-0.02	-0.52	-1.44	-1.12
2004Q2	0.55	0.32	0.66	1.15	1.12	0.37	-0.14	-0.99
2004Q3	0.33	0.65	0.40	0.72	1.31	1.26	0.51	0.02
2004Q4	-0.05	0.07	0.56	0.26	0.57	1.21	1.15	0.42

Appendix 2

Regression results of running the following regressions:-

(1) $IR(t + h) = C_1 + C_2$ Forecast $(t, t + h)$

(2) $IR(t + h) – IR(t) = C_1 + C_2$ (Forecast t, t + h – IRt)

(3) $IR(t + h) – IR(t + h – 1) = C_1 + C_2$ (Forecast, t, t + h – Forecast, t, t + h – 1)

(4) $IR(t + h) – IR(t + h – 1) = C$ (Forecast, t, t + h – Forecast, t, t + h – 1).

The first two equations allow us to undertake the Mincer-Zarnowitz test (WBL ref) of the null hypothesis that $C_1 = 0$ and $C_2 = 1$.

The results were:-

A. New Zealand

Equation (1)

h =	C_1 (P value)	C_2 (P value)	R sq	DW
0	-0.01 (0.96)	1.00 (0.00)	0.99	1.77
1	-0.23 (0.64)	1.02 (0.00)	0.88	1.53
2	0.30 (0.74)	0.93 (0.00)	0.65	0.93
3	1.51 (0.24)	0.74 (0.00)	0.39	0.34
4	3.71 (0.03)	0.40 (0.12)	0.11	0.28
5	5.71 (0.00)	0.09 (0.76)	0.00	0.15

Mincer-Zarnowitz test

$IR(t + h) = C_1 + C_2 * Forecast(t, t + h)$

Null hypothesis: $C_1 = 0$ and $C_2 = 1$

H	0	1	2	3	4	5
F-statistics	0.7245	0.4351	0.3441	0.2153	0.0459	0.0095
Chi-square	0.7216	0.4229	0.3277	0.1934	0.0285	0.0029

Equation (2)

h =	C_1 (P value)	C_2 (P value)	R sq	DW
1	-0.16 (0.07)	1.60 (0.00)	0.34	1.61
2	-0.15 (0.31)	1.02 (0.02)	0.19	1.01
3	-0.09 (0.66)	0.72 (0.12)	0.10	0.45
4	0.13 (0.61)	0.10 (0.84)	0.00	0.47
5	0.37 (0.20)	-0.38 (0.46)	0.03	0.34

Mincer-Zarnowitz test

$IR(t + h) – IR(t) = C_1 + C_2 * Forecast(t, t + h) – IR(t)]$

Null hypothesis: $C_1 = 0$ and $C_2 = 1$

H	1	2	3	4	5
F-statistics	0.1886	0.3878	0.4224	0.1595	0.0327
Chi-square	0.1679	0.3732	0.4087	0.1356	0.0175

Equation (3)

i =	C_1 (P value)	C_2 (P value)	R sq	DW
1	0.13 (0.07)	1.29 (0.00)	0.43	2.06
2	0.04 (0.65)	-0.04 (0.94)	0.00	1.23
3	0.07 (0.37)	-0.68 (0.39)	0.03	1.37
4	0.09 (0.28)	-1.29 (0.22)	0.07	1.37
5	0.09 (0.26)	-1.28 (0.18)	0.08	1.28

Equation (4)

h =	C_1 (P value)	R sq	DW
1	0.93 (0.00)	0.35	1.66
2	0.11 (0.79)	-0.01	1.26
3	-0.31 (0.64)	-0.00	1.27
4	-0.77 (0.41)	0.02	1.25
5	-0.92 (0.31)	0.02	1.19

B. UK Forecasts derived from the Short-term Government Yield Curve

Table 1

h =	C_1 (P value)	C_2 (P value)	R sq	DW
1	0.37 (0.22)	0.95 (0.00)	0.91	1.61
2	0.77 (0.06)	0.86 (0.00)	0.77	0.88
3	1.21 (0.02)	0.76 (0.00)	0.62	0.55
4	1.82 (0.01)	0.63 (0.00)	0.45	0.40

5	2.39 (0.00)	0.52 (0.00)	0.32	0.32
6	2.68 (0.00)	0.46 (0.00)	0.26	0.31
7	2.51 (0.00)	0.48 (0.00)	0.27	0.30
8	2.04 (0.02)	0.54 (0.00)	0.33	0.32

Mincer-Zarnowitz test

$IR(t + h) = C_1 + C_2 * Forecast(t, t + h)$

Null hypothesis: $C_1 = 0$ and $C_2 = 1$

H	1	2	3	4	5	6	7	8
F-statistics	0.1130	0.1727	0.0133	0.0002	0.0000	0.0000	0.000	0.000
Chi-square	0.0962	0.1601	0.0085	0.0000	0.0000	0.0000	0.000	0.000

Table 2

h =	C_1 (P value)	C_2 (P value)	R sq	DW
1	0.08 (0.39)	0.73 (0.03)	0.14	1.52
2	0.01 (0.91)	0.90 (0.00)	0.34	0.95
3	-0.15 (0.18)	0.88 (0.00)	0.34	0.63
4	-0.31 (0.04)	0.73 (0.00)	0.26	0.48
5	-0.39 (0.03)	0.58 (0.00)	0.19	0.41
6	-0.45 (0.02)	0.48 (0.01)	0.15	0.39
7	-0.53 (0.01)	0.48 (0.00)	0.18	0.38
8	-0.64 (0.00)	0.51 (0.00)	0.26	0.41

Mincer-Zarnowitz test

$IR(t + h) – IR(t) = C_1 + C_2$* [Forecast (t, t + h) – IR(t)]

Null hypothesis: $C_1 = 0$ and $C_2 = 1$

H	1	2	3	4	5	6	7	8
F-statistics	0.1120	.08374	0.3063	0.0190	0.0014	0.0001	0.0000	0.0000
Chi-square	0.0953	0.8368	0.2965	0.0129	0.0004	0.0000	0.0000	0.0000

Table 3

i =	C_1 (P value)	C_2 (P value)	R sq	DW
1	0.08 (0.39)	0.73 (0.03)	0.14	1.51
2	-0.14 (0.04)	0.84 (0.01)	0.19	1.52
3	-0.10 (0.16)	0.46 (0.10)	0.06	1.12
4	-0.07 (0.38)	0.24 (0.42)	0.02	1.01
5	-0.08 (0.30)	0.46 (0.21)	0.03	1.05
6	-0.07 (0.32)	0.61 (0.15)	0.05	1.05
7	-0.05 (0.47)	0.53 (0.30)	0.03	1.03
8	-0.05 (0.45)	0.52 (0.38)	0.02	1.00

Table 4

h =	C (P value)	R sq	DW
1	0.54 (0.03)	0.12	1.39
2	0.63 (0.05)	0.07	1.29
3	0.23 (0.32)	0.01	1.05
4	0.07 (0.75)	-0.00	0.98
5	0.23 (0.42)	0.01	1.02
6	0.36 (0.30)	0.02	1.02
7	0.34 (0.44)	0.01	1.00
8	0.31 (0.54)	0.01	0.99

<u>C. UK Forecasts derived from the Libor Yield Curve</u>

Table 1

h =	C_1 (P value)	C_2 (P value)	R sq	DW
1	0.82 (0.08)	0.82 (0.00)	0.71	0.75
2	1.19 (0.03)	0.75 (0.00)	0.60	0.52
3	1.81 (0.01)	0.63 (0.00)	0.42	0.46
4	2.35 (0.01)	0.52 (0.00)	0.28	0.37
5	2.74 (0.00)	0.44 (0.00)	0.20	0.30
6	2.93 (0.00)	0.40 (0.01)	0.16	0.33
7	2.34 (0.02)	0.48 (0.00)	0.21	0.33
8	1.18 (0.25)	0.64 (0.00)	0.33	0.33

Mincer-Zarnowitz test

$IR(t + h) = C_1 + C_2 *$ Forecast $(t, t + h)$

Null hypothesis: $C_1 = 0$ and $C_2 = 1$

H	1	2	3	4	5	6	7	8
F-statistics	0.0168	0.0027	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
Chi-square	0.0115	0.001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 2

h =	C_1 (P value)	C_2 (P value)	R sq	DW
1	-0.07 (0.35)	0.20 (0.24)	0.03	1.49
2	-0.12 (0.25)	0.33 (0.08)	0.07	0.73
3	-0.16 (0.28)	0.27 (0.18)	0.04	0.61
4	-0.21 (0.25)	0.27 (0.20)	0.04	0.50
5	-0.30 (0.16)	0.29 (0.15)	0.05	0.47
6	-0.39 (0.10)	0.30 (0.13)	0.05	0.43
7	-0.62 (0.01)	0.45 (0.02)	0.14	0.45
8	-0.91 (0.00)	0.63 (0.00)	0.29	0.39

Mincer-Zarnowitz test

$IR(t + h) – IR(t) = C_1 + C_2 * [Forecast (t, t + h) – IR(t)]$

Null hypothesis: $C_1 = 0$ and $C_2 = 1$

H	1	2	3	4	5	6	7	8
F-statistics	0.0000	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
Chi-square	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 3

h =	C_1 (P value)	C_2 (P value)	R sq	DW
1	-0.07 (0.35)	0.20 (0.23)	0.03	1.49
2	-0.03 (0.65)	0.30 (0.24)	0.03	2.03
3	-0.05 (0.52)	0.37 (0.34)	0.02	2.04
4	-0.0 (0.31)	0.56 (0.19)	0.04	2.06
5	-0.05 (0.60)	0.27 (0.60)	0.01	2.01
6	-0.03 (0.79)	0.06 (0.91)	0.00	2.00
7	-0.03 (0.79)	0.04 (0.95)	0.00	2.00
8	-0.03 (0.74)	0.00 (1.00)	0.00	2.01

Table 4

h =	C (P value)	R sq	DW
1	0.16 (0.33)	0.01	1.51
2	0.27 (0.27)	0.03	2.02
3	0.23 (0.47)	0.01	2.01
4	0.26 (0.40)	0.02	2.01
5	0.09 (0.78)	0.00	1.99
6	-0.04 (0.92)	-0.00	1.99
7	-0.08 (0.87)	-0.00	1.99
8	-0.14 (0.80)	-0.00	2.01