Operating Procedures and the Expectations Theory of the Term Structure of Interest Rates: the New Zealand Experience from 1989 to 2008

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Abstract: The operating procedure of a central bank influences in no small measure whether the behavior of interest rates is consistent with the expectations hypothesis. In New Zealand, the predictive content of the term spread improves markedly in the wake of the switch from a quantity-based to a price-based operating procedure in March 1999. The Official Cash Rate system has made it easier for market participants to understand the day-to-day conduct of monetary policy. As a result, market interest rates have become more predictable, thereby contributing to the success of the expectations hypothesis in explaining the behavior of yields on short-dated financial instruments.

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In an influential paper, Mankiw & Miron (1986) conjecture that the implementation of monetary policy bears on the validity of the expectations hypothesis of the term structure of interest rates (EH). Employing a simple two-period framework, they find supportive evidence for the expectations hypothesis in short-term US data before the founding of the Federal Reserve in 1915 but none after. In their view, the founding of the Federal Reserve had led to a dramatic change in the behavior of interest rates – it had significantly reduced the predictability of interest rates – and hence diminished the ability of the term spread to predict future changes in short term interest rates. Mankiw and Miron's findings have not gone unchallenged.[1] For example, Kool & Thornton (2004) argue that the econometric methodology employed by Mankiw and Miron tends to generate supportive results for the expectations hypothesis during periods when short-term interest rates are relatively more volatile than long-term interest rates. They also argue that the EH receives more support when the term spread is negative, that is, when the yield curve is inverted. New hope for the EH has emerged more recently. Extending the time series of synthetic US Treasury yields, originally developed by McCullough and Kwon (1993), to 2009 and examining the predictive ability of the term spread from 1991 onward, Bulkley, Harris, and Nawosah (2011) find far more empirical support for the EH in the post McCullough-Kwon period than before. Indeed they argue that "across all of the tests we use, and for almost all of the bond maturities that we consider, the estimated coefficients in the EH tests are substantially closer to unity (their value under the EH) in the post McCullough-Kwon sample than they are in the McCullough-Kwon sample," (p. 1203). Bulkley et al. attribute the failure of the EH in earlier periods to the existence of transitory pricing anomalies. These irregularities have been eliminated by the increased sophistication of financial markets in more recent times, i.e. the implementation of trading rules, the development of new financial products, and the emergence of powerful hedge funds that exploit existing profit opportunities. Because financial markets have become more efficient over the past 20 years, yields on financial instruments now behave more in line with the predictions of the expectations hypothesis.

[1] Some of the criticism is actually leveled against a companion paper. Mankiw, Miron, and Weil (MMW) (1987) claim that the founding of the Fed fundamentally changed the behavior of short term interest rates in the United States. Fishe and Wohar (1990) question the reliability of the data used in the study and challenge MMW's finding that the structural break in the 180-day rate coincided with the founding of the Fed. Examining the behavior of short-term interest rates around the time the Fed was created, Angelini (1994) finds no evidence for a regime change. In their reply, MMW (1994) point to the low power of the test employed by Angelini.

In this paper, we test the expectations hypothesis on New Zealand data. Our approach is by and large the same as Mankiw and Miron's (1986) in that we focus on the potential link between the operational framework of monetary policy and its effect on the EH. We test the empirical validity of the theory at the short end of the maturity spectrum, using 30-day and 60-day and 90-day and 180-day bank bill rates, respectively, in a two-period framework. The sample period begins in the late 1980s and ends midway through 2008 before the collapse of Lehman Brothers rattled financial markets the world over. Central to our analysis is the occurrence of a substantive change in the operating procedure of the Reserve Bank of New Zealand in March 1999. At the time, the Reserve Bank realized the need to switch from a quantity-based to a price-based operating procedure in an effort to make the conduct of monetary policy more efficient, transparent, and predictable. By international standards the volatility of market interest rates had become unacceptably high under the quantity-based operating scheme and therefore compromised the Reserve Bank's ability to communicate its intentions effectively to financial market participants. We show that the switch to the Official Cash Rate (OCR) system made market interest rates more predictable. More importantly, we find more evidence in support of the expectations hypothesis in the OCR period. The ability of the term spread to predict changes in the short term interest rate improved markedly after the adoption of the OCR system. Robustness checks of our econometric findings reveal further that refinements to the operating framework such as the release of biannual Financial Stability Reports have improved the central bank's communication strategy with the financial market. This is evidenced by the estimated coefficient of the180-day/90-day term spread moving closer to the value implied by the EH since the introduction of the Financial Stability Report in October 2004. Our findings thus confirm the connection between the operating procedure, which affects the predictability of interest rates, and the empirical validity of the expectations hypothesis.[2]

The rest of the paper is organized as follows. Section II presents the gist of the expectations hypothesis. Section III describes the operating procedure before and after March 1999.

[2] In an earlier study of the expectations hypothesis covering only the pre-OCR period, Guthrie, Wright and Yu (1999) report that the theory describes the behavior of interest rates in New Zealand reasonably well, at least in comparison with the United States. They conjecture that the success of the expectations hypothesis in New Zealand is a direct consequence of the Reserve Bank's manipulation of short-term interest rates over the 1989-1998 period. Because short term interest rates were far more predictable in New Zealand compared to the United States, the expectations hypothesis describes the behavior of short-term interest rates better in New Zealand than in the United States. This is essentially the argument advanced by Mankiw and Miron (1986), Rudebusch (1995), and McCallum (2005).

Section IV presents the empirical findings and the results of a series of robustness checks. Section V concludes.

II. The Basic Model

This section briefly reviews the expectations hypothesis of term structure in a simple two-period model. Let r_t and R_t be the one-period and two-period bank bill rate, respectively. The expectations hypothesis posits that

$$R_t = \theta + \frac{1}{2}(r_t + E_t r_{t+1}) \ , \tag{1}$$

where E_t defines the expectation formed at time t. Equation (1) describes the arbitrage-free condition that the return from investing in a two-period bill equals the expected return from investing sequentially in two one-period bills, plus a constant term premium θ. Rewrite Equation (1) as

$$E_t r_{t+1} - r_t = -2\theta + 2(R_t - r_t) \ . \tag{2}$$

The term spread between the long rate and the short rate should reflect the market's prediction about future movements in short-term interest rates. Assuming that market forecasts are correct on average, the future short rate equals the sum of the expectation and a forecast error:

$$r_{t+1} = E_t r_{t+1} + v_{t+1} \, , \tag{3}$$

where v_{t+1} is orthogonal to information available at time t.

To set up the conventional test of the expectations theory, substitute (3) into (2) and parameterize the equation as

$$r_{t+1} - r_t = \alpha + \beta(R_t - r_t) + v_{t+1} \, . \tag{4}$$

Attention in the literature focuses primarily on the coefficient on the term spread. For the expectations theory to hold, point estimates of β should not be significantly different from two. The null and alternative hypotheses underlying the test are:

H_0: $\beta = 2$ and H_A: $\beta \neq 2$ (5)

We examine the predictive ability of the term spread using yields on New Zealand bank bills. Bank bills are backed by or issued by commercial banks to raise funds in the wholesale money market. They usually have a term to maturity of 30, 60, 90, or 180 days. 90-day bank bills are a major source of funding for home mortgages and working capital. The simple two-period framework allows us to consider two cases. The first case treats the 30-day bank bill rate as the short rate and the 60-day bank bill rate as the long rate. The second case treats the 90-day bank bill rate, which is by far the most watched interest rate in the money market, as the short rate and the 180-day as the long rate.

Given the critical importance of a central bank's operating procedure in determining the validity of the expectations hypothesis in empirical tests, we describe in the next section the distinctive features of the two operating procedures which the Reserve Bank of New Zealand has followed since the 1980s.

III. Operating Procedures

A. The Cash Settlement Balances (CSB) System

The complete overhaul of the monetary policy framework in New Zealand preceded the adoption of the Reserve Bank Act of 1989 by about three years. The hallmark of the operating procedure by which monetary policy was implemented from 1986 until March 17th, 1999 was an announced target for the supply of cash settlement balances (free reserves in circulation at the end of the business day). By its very nature the focus of this operating procedure rested squarely on ensuring that the quantity of actual cash settlement balances in circulation was roughly in line with the announced target after accounting for all inflows into and outflows from the government account. To meet the target for cash settlement balances, the Reserve Bank carried out open market operations on a daily basis.

If conditions warranted a change in monetary policy, the Reserve Bank sought to steer market interest rates in the desired direction. To achieve this outcome, the Reserve Bank could either change the supply of or affect the demand for cash settlement balances. By changing the target for cash settlement balances outright, the Bank was in a position to affect commercial banks' access to cash settlement balances, A larger (smaller) supply of settlement balances would lead to lower (higher) overnight interest rates and flow on to other short-term interest rates. The Reserve Bank issued its own short-term securities to affect liquidity in the financial sector. By varying the supply of these bills, the Reserve Bank sought to influence the demand for cash settlement balances.[3] For instance, a reduction in the supply of Reserve Bank bills was to make commercial banks bid more aggressively for cash settlement balances in the inter-bank market, thereby pushing up short-term interest rates. The two remaining tools to affect monetary conditions through the demand for cash settlement balances were the discount margin and the payment of interest on cash settlement balances held on deposit at the Reserve Bank. By increasing the discount margin, the Reserve Bank made it more costly for commercial banks to acquire access to cash settlement balances via the sale of Reserve Bank bills. Hence the commercial banks would again bid more vigorously for cash settlement balances in the inter-bank market, thereby pushing up short-term interest rates. Raising the yield on balances on deposit with the Reserve Bank lowered the opportunity cost of holding cash settlement balances and induced commercial banks to step up their demand for additional cash balances. Interestingly, the yield on these balances was 65 percent of the yield on seven-day bank bills (similar to bank-backed commercial paper), a market-determined interest rate![4]

This operating procedure proved to be wanting in several respects. First and foremost, the quantity-based CSB system failed to translate enunciated changes in the stance of monetary policy to predictable changes in short-term market interest rates. Financial market participants found it exceedingly difficult to map an announced change in the target, say a reduction of the target by NZ$ 5 million, into the desired change in the most important short term interest rate, the 90-day bank bill rate. Was it to bring about a 25 basis point change? Or even a 50 basis point change?[5] Because of the absence of a tight link between changes in the target for CSB and market interest rates, the Reserve Bank had to communicate its policy intentions by way of statements on monetary conditions. Thus monetary policy was factually implemented by commenting on whether current market interest rates and the exchange rate were at levels commensurate with achieving price stability. For a while, every Wednesday the Reserve Bank gave an assessment on the appropriateness of monetary conditions. To

[3] These bills were auctioned off twice a week in tenders of NZ$ 70 million each and had a term to maturity of 63 days. Bills with less than 28 days to maturity could be redeemed for cash settlement balances without penalty.
[4] Starting in December 1991, the deposit rate was changed to the yield on seven-day bank bills less 300 basis points.
[5] The final change of target for cash settlement balances occurred in August 1995, three and a half years prior to the introduction of the Official Cash Rate. The Reserve Bank realized early on that the CSB target operating procedure was beset with systemic problems. For instance, given the small size of the financial markets and the limited supply of Reserve Bank bills in circulation, there was an incentive for commercial banks to hoard them in an attempt to control the cash market. This led to sizeable periodic differences between the overnight cash rate and the 90-day bank bill rate.

facilitate communication with financial market participants, the Reserve Bank adopted in the mid-1990s a monetary conditions index which served as an operating target in the implementation of monetary policy.

Due to the opaque way monetary policy was implemented under the CSB system the volatility of short-term interest rates in New Zealand was exceedingly high by international standards. Table 1 shows the average absolute daily change in the 90-day bank bill rate in New Zealand was nearly six times higher than in the United States, nearly 4 times higher than in Britain, more than 2.5 times higher than in Australia and more than 1.5 times higher than in Canada. Towards the end of the decade when monetary policy signals were transmitted via the monetary conditions index, fluctuations in the 90-day bank bill rate in New Zealand even worsened while they decreased by more than 50 percent in Canada, the United Kingdom, and the United States. A marked increase in the volatility of the value of the domestic currency vis-à-vis the US Dollar, the Japanese Yen, and the German Mark complicated matters further during the Asian Currency crisis in 1997 and thereafter.[6] At the time the Reserve Bank realized that it could not do much about the ups and downs of the value of the domestic currency in the foreign exchange markets. Foreign exchange market intervention was ruled out as a policy prescription. Faced with this situation, the Reserve Bank concluded that a complete revamp of its operating procedure was necessary to lessen the volatility of short-term interest rates in the domestic financial market.

B. The Official Cash Rate System

As early as 1996 the Reserve Bank realized the need for switching to a price-based operating procedure. However, the decision to guide market expectations about the course of future monetary policy with the help of a monetary conditions index delayed the introduction of the Official Cash Rate system by a little more than two years. On February 8th, 1999 the Reserve Bank announced that effective March 17th the implementation of monetary policy in New Zealand would revolve around the Official Cash Rate. The Reserve Bank sets the Official Cash Rate and reviews its setting six times a year. In essence, the OCR serves two purposes. First, it acts as a clear and precise signal for the current stance of monetary policy. In that capacity it acts as the benchmark for short-term interest rates in New Zealand. Second, the

[6] The standard deviation of changes in the daily exchange rate of the NZ Dollar to the US Dollar over the July 1996-1999 period increased to 0.0040 from 0.0029 during the 1994- June 1996 period. The standard deviation of changes the NZ Dollar/Japanese Yen exchange rate increased from 0.4563 in the 1994-June 1996 period to 0.6172 in the July 1996 –Jan 1999 period. For the NZ Dollar/German Mark exchange rate, the standard deviation increased from 0.0069 to 0.0086 over the same periods.

OCR is the instrumental lever in operating the Reserve Bank's standing facilities. In its original conception, the OCR forms the mid-point of a channel for the overnight cash rate in the interbank lending market.[7] The Reserve Bank offers to lend (on demand against suitable collateral) at a rate of 25 basis points above the announced OCR and agrees to accept deposits at a rate of 25 basis points below the OCR. These two interest rates mark the ceiling and floor of the corridor within which the overnight cash rate fluctuates. Open-market operations were initially the primary tool that the Reserve Bank used to smooth liquidity flows in and out of the financial sector. They have become less important in more recent times in the wake of attempts by the Reserve Bank to improve the operational efficiency of the OCR system. Strains had arisen because of dwindling amounts of outstanding Treasury debt, which serves as collateral in open-market operations. To counteract the problem, the Reserve Bank decided to increase substantially the volume of cash balances in circulation. In addition, the Reserve Bank increasingly relies on foreign exchange swaps to affect liquidity conditions in the financial market.

The OCR system has the advantage that it is transparent, efficient, and easy to understand. By setting an interest rate, the Reserve Bank sends a clear signal to the market about the desired level of interest rates at the short end of the maturity spectrum of the yield curve. The OCR system allows expectations about the future course of monetary policy to affect current interest rates. This is a marked improvement over the CSB system with its diffuse policy signals. Because there was more uncertainty about the future course of monetary policy under the CSB system, the Reserve Bank was also far more activist in that it had to ensure that actual monetary conditions conformed to desired monetary conditions.

[7] In June 2006 the Reserve Bank made a few modifications to the OCR system. Under the new arrangement, the OCR forms the floor of a 50 basis-point corridor. The cost of borrowing funds from the bank has increased to OCR +50 basis points and funds deposited at RBNZ draw interest at the Official Cash Rate. For further details on the changes introduced see Frazer (2004), Guender and Rimer (2008), and Nield (2006).

IV. The Expectations Hypothesis under the Two Operating Procedures during the Low Inflation Period[8]

The impending adoption of the Official Cash Rate system, announced on February 8th 1999, marks a clearly identifiable *exogenous* break in the operating procedure of the Reserve Bank of New Zealand. Consequently, we deem it appropriate in our empirical analysis to distinguish between two sub-sample periods, the CSB system (1989:01-1999:02) and the OCR system (1993:03-2008:06).[9] The split in the sample is demarcated by the vertical line in Figure 1, which shows the behavior of yields on bank bills with terms to maturity from 30 days to 180 days over the whole sample period.

A. Behavior of Interest Rates

The Reserve Bank predicted that the adoption of the OCR system would lead to a substantial fall in interest rate volatility and hence to a more predictable course for monetary policy. In a statement released to financial markets on February 8th, 1999, senior Reserve Bank economists wrote: "[However], 90-day volatility is expected to fall [further] under the Cash Rate system. A less volatile 90-day rate, with most significant changes reflecting expectations about future monetary policy, will provide a clearer signal to investors and consumers making financial decisions," (Archer, Brookes, and Reddell, p.57). Casual inspection of Figure 1 reveals that the volatility of all four nominal interest rates does indeed appear to have declined during the OCR period.

Precise information about the extent of volatility appears in Table 2 which records the behavior of the 30-day, 60-day, 90-day, and 180-day bank bill rates in New Zealand over the whole sample period (1989:01-2008:06), the CSB period (1989:01-1999:02), and the OCR period (1999:03-2008:06). It is evident that the standard deviation of changes in market interest rates fell across the board during the OCR period. Bills with a maturity of up to 90 days experienced the most dramatic reduction in volatility. The standard deviations of 30-day, 60-day and 90-day bank bill rates decreased by more than 55 percent. The decrease in volatility during the OCR period was somewhat less for the 180-day bank bill rate at nearly

[8] CPI inflation in New Zealand fell from 9 percent in 1988 to 4 percent in 1989. Hence we chose January 1989 as the beginning of the low-inflation period. The beginning of the sample period precedes the enactment of the Reserve Bank Act by almost a year. By January 1989, New Zealand had embarked on a steady course for monetary policy that emphasized the maintenance of price stability. In April of the preceding year, the Minister of Finance had declared "that in future monetary policy would be targeted at price stability," (p. 252 in *Monetary Policy and the Financial System*). The Reserve Bank Act which officially defines price stability as the overriding goal of monetary policy was enacted in December 1989 and took effect on February 1st, 1990.

[9] Some practitioners would prefer to rely on stability tests such as the Quandt-Andrews test to locate a breakpoint. We address this issue in Section IV.C of the paper.

30 percent. Thus, the Reserve Bank's prediction of a substantial decrease in fluctuations of market interest rates under the Official Cash Rate system is borne out by the data. Notice that there are no dramatic differences in the variability of changes in the bank bill rates during the OCR period.

To test whether the predictability of interest rates depended on the operating procedure, we carry out a univariate forecasting exercise. The observed change in the short-term interest rate in period *t+1* is regressed on its current period change and the current period change in the long-term interest rate. The forecasting equations are estimated for the whole sample period as well as for the CSB sub-sample period and the OCR sub-sample period. The results of this exercise are reported in Table 3 for the 30-day/60-day rate scenario and in Table 4 for the 90-day/180-day scenario.

Inspection of the first two columns in both tables reveals that the forecasting equation explains movements in the short term interest rate much better during the OCR period than before. In Table 3, the adjusted R^2 rises almost seven-fold, from 0.08 during the CSB sub-sample period to 0.53 during the OCR sub-sample period. Somewhat less dramatic improvements in the forecasting ability of the regression occur in the 90-day/180-day set-up. In Table 4, the adjusted R^2 increases markedly, almost doubling from 0.24 in the CSB sub-sample period to 0.43 in the OCR sub-sample period.[10] All in all, these findings suggest that changes in the short-term interest rate became far more predictable during the OCR system.

It is a moot question what would have happened to the volatility of market interest rates had the CSB operating regime remained in place in New Zealand. Two recent studies investigate the effect of improvements in *existing* interest rate-based operating frameworks rather than the adoption of a *new* framework on the volatility of interest rates. Studying policymaking at the Federal Reserve and the ECB, Colarossi and Zaghini (2009) attest to the changes in the operational procedures in limiting or eliminating altogether the extent to which overnight interest rate volatility is transmitted along the yield curve in money and bond markets. Similarly, Nautz and Schmidt (2009) find that since 1994 the Fed has gained better control over the federal funds rate by streamlining its operating procedure and improving its communication strategy with financial market participants. For the reasons described in

[10] A similar picture emerges if one, first, decomposes the change in the observed interest rate (Δr_t)into the change explained by the regression $(E\Delta r_t)$ and the unexplained change $((\Delta r_t - E\Delta r_t)$ and, second, compares the associated standard deviations across the subsample periods. For instance, in the 30-day/60-day set up, the standard deviation of $E\Delta r_t$relative to the standard deviation of $\Delta r_t$is 0.0415/0.1323=0.3137 during the OCR period and 0.0161/0.4943=0.0325 during the CSB period Further details on the breakdown of total variation in short-term interest rates are available upon request from the corresponding author.

Section III.A it is highly doubtful that the Reserve Bank would have made similar efficiency gains had it decided to stick with the CSB operating regime.

B. Test of the Expectations Hypothesis on New Zealand Data

If Mankiw and Miron's claim that the success of the expectations hypothesis hinges critically on the predictability of short-term interest rates is correct, then one would expect the theory to receive more support in New Zealand during the OCR sub-sample period. After all, due to the shift from the CSB system to the OCR system, interest rates across the board became more predictable. More broadly, the switch to the OCR system heralded in a new phase in the implementation of monetary policy in New Zealand. Transparency, efficiency, and effective communication with financial markets were now emphasized more heavily than in the past.[11]

Tables 5 and 6 report the empirical findings for estimating equation (4). Table 5 shows the coefficient estimates of the regression and the associated test statistics for the 60-day/ 30-day term spread for the whole sample period and the two sub-sample periods. While the coefficient estimate on the term spread is positive and statistically significant at the one percent level in all three regressions estimated, only the coefficient estimated for the OCR sub-sample period is close to the hypothesized value of 2.[12] Indeed, a Wald test fails to reject the hypothesis that the estimated coefficient equals two for the OCR sub-sample period but not for the CSB sub-sample period. The p-value of the test is 0.315 for the former and 0.05 for the latter. It is also evident that the 60-day/30-day term spread has far greater predictive content for the short rate during the OCR period than the CSB period or the whole sample period. The predictive power of the estimated regression rises more than eightfold, from 0.06 in the CSB sub-sample period to 0.53 in the OCR sub-sample period when short-term interest rate variability was substantially lower than before the change in the operating procedure.[13]

The findings for the 180-day/90-day term spread appear in Table 6. Using bills with longer terms to maturity changes the results somewhat. The term spread has no predictive content for changes in the 90-day bank bill rate during the CSB sub-sample period. The adjusted R^2 of 0.03 is abjectly low. In sharp contrast, the term spread predicts changes in the 90-day bank

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[11] One innovation, the publication of the path of future 90-day rates, started in 1997 in the lead-up to the switch to the OCR system.

[12] Attention focuses on the estimate of the slope coefficient.

[13] These results are thus immune to the criticism that the expectations hypothesis appears to be valid only in times of high variability of short-term interest rates, a point made by Kool and Thornton (2004) in the context of the Mankiw and Miron (1986) study of the behavior of short term interest rates prior to the founding of the Fed.

bill rate rather well in the OCR sub-sample period. The adjusted R^2 rises more than tenfold. However, the coefficient estimate of 0.79, while statistically significant at the one percent level, is much smaller than the hypothesized value of 2.

C. Sensitivity Analysis

To check the robustness of our findings, we carried out a series of tests. Specifically, we examined the results reported in Tables 5 and 6 along four dimensions: predictive ability of lagged spreads, endogenous breakpoints in the regression equation, sensitivity of the reported results to the slope of the yield curve, and improved central bank communication.[14] In what follows, we briefly describe the nature of each test and the associated outcome.

Predictive Ability of Lagged Term Spreads During the OCR Period

The first robustness check consists of adding lagged term spreads to the test equation. Evidence showing that such lags improve the predictive ability of the amended regression equation during the OCR sub-sample period is inconsistent with the simple expectations hypothesis being tested. However, no such evidence exists. For both the 60-day/30-day and the 180-day/90-day case, Wald tests on the sum of the coefficients of the lagged term spreads adding up to zero yield Chi-square statistics that fail to reject the null hypothesis. In both regressions the p-value is 0.15 and the coefficient on the current term spread remains close to the original estimate.[15]

Endogenous Breakpoints in the Sample

At the beginning of this section, we split the whole sample period into two subperiods, arguing that the switch from the quantity-based to the price-based operating system in March 1999 constitutes a clearly identifiable exogenous breakpoint. An alternative way to proceed consists of allowing the data to determine breaks in the regression equation. A widely used

[14] Some would argue that the nature of the business cycle has changed dramatically over the past two decades and could have therefore contributed to the success of the expectations hypothesis in more recent times. We looked at key macroeconomic indicators during the CSB balances period and the OCR period. It is true that the OCR period saw lower levels of and less volatility in CPI inflation, real output growth, and the unemployment rate in New Zealand. At the same time, the size of and swings in household debt and the current account deficit increased considerably during the OCR period; the volatility of real exchange rate changes nearly doubled; the house price to income ratio increased by almost 50 percent. The lack of a clear-cut systematic pattern in the behavior of these variables weakens the argument that the economic climate has become more benign.

[15] We tested two specifications of the regression equation, one with the first and the second lag of the respective term spread as additional regressors, and the other with lags one through four. All specifications tested yielded the same result: the sum of the coefficients on the lagged term spreads is statistically insignificant from zero at conventional significance levels. These additional findings are available upon request from the corresponding author.

test that detects breakpoints endogenously is the Quandt-Andrews test. Applied to the case at hand, this test identifies 1993:01 as a breakpoint in the 60-day/30-day regression equation over the1989:01-2008:06 sample period (p-value of test = 0.09).[16] Arguably, such breakpoint tests can produce misleading results. Closer examination of the 60-day/30-day term spread reveals that at the beginning of January 1993 the Reserve Bank tightened monetary policy in response to a sharp depreciation of the NZ Dollar. As a result, the spread turned sharply negative in January. By early February, the Reserve Bank had reversed its monetary policy action due to a marked drop in CPI inflation. Thus, an endogenous albeit temporary tightening of monetary policy is misconstrued by the Quandt-Andrews test as a breakpoint.

Inverted vs. Positively Sloped Yield Curves

Following Kool and Thornton (2004), we next examine whether the support of the expectations hypothesis is confined to periods when the yield curve is inverted. Our results for the 30-day/60-day horizon suggest that this is not the case. According to the top panel of Table 7, the predictive power of the term spread in the OCR period is greater when the yield curve is positively sloped ($Adj.\ R^2 = 0.39$) than when it is negatively sloped (($Adj.\ R^2 = 0.11$). In addition, the coefficient on the term spread is considerably closer to the hypothesized value of *2* when the yield curve is positively sloped (*1.7044*) than when it is inverted (*1.4889*). Both coefficients are statistically significant at the 1 percent level. For the 180-day/90-day horizon, the predictive content of the yield spread is also better when the yield curve is upward sloping ($Adj.\ R^2 = 0.25$) than when it is inverted ($Adj.\ R^2 = 0.13$). While the coefficient on negative term spread observations is nearly twice the size of the coefficient on positive term spread observations both coefficients are highly statistically significant irrespective of the slope of the yield curve.

Improved Central Bank Communication with Financial Markets

Central bank watchers opine that central banks have changed the way in which they communicate their intentions to financial markets. Rather than being secretive and deliberately nebulous as in the past, central banks have made genuine efforts to become transparent, clear, and efficient in their dealings with financial market participants. These improvements range from specifying their objectives and strategies to announcing policy

[16] No breakpoint is detected in the 180-day/90-day case. The breakpoint tests are based on a trimming of 15 percent.

decisions and signaling the future path of the policy instrument.[17] The Reserve Bank of New Zealand has been in the forefront of this movement. As an example, the Bank has published a Financial Stability Report since October 2004.[18] The purpose of this report is to monitor the health of the domestic financial sector and to examine trends in international financial markets. The report, which is published twice a year, provides the Bank with a mouthpiece to comment on developments in the banking sector and the capital market. At the same time, the report offers the Bank the opportunity to inform financial market participants about the ways in which it plans to deal with events that threaten to undermine or destabilize the financial sector. The Financial Stability report can thus be thought of as a communication device through which the Reserve Bank shares its views on current and future developments in the financial sector with the public.

To assess whether the publication of the biannual Financial Stability Report has made a difference to the key parameter in the test equation during the OCR period, we created two dummy variables and added them to the regression equation. The first variable, denoted by DU_t, takes the value *1* for all months since the introduction of the Financial Stability Report in October 2004 and *0* for the period prior. This specification of the test equation asks whether the release of the Financial Stability Report from October 2004 onward permanently changed the coefficient on the slope of the yield curve. The results of this test appear in Table 8 and confirm that the coefficient on the interaction term is positive and statistically significant at the 5 percent level for the 180-day/90-day case. With the release of the report the coefficient on the slope of the yield curve moved much closer to the hypothesized value of 2. The predictive ability of the amended regression equation improves marginally, too. In contrast, the results for the 60-day/30-case indicate that the introduction of the report in October 2004 did not affect the size of the coefficient on the term spread.

The other dummy variable, denoted $DU2_t$, measures the impact effect of the release of the Financial Stability Report on the estimated coefficient on the term spread. The dummy variable takes the value *1* for the month when the report was released and *0* otherwise. Table 9 shows that the release of the report appears to have exerted a sizeable positive and statistically significant effect on the coefficient on the 60-day/30-day term spread but not on the coefficient on the 180-day/90-day spread.

[17] Blinder et. al (2008) survey the literature on this topic. They argue that deliberate effective communication strategies have been developed by central banks only over the past 10-15 years.
[18] The Reserve Bank has also published a quarterly Monetary Policy Statement since December 1996. A few months later in June 1997 it began to publish projections of the 90-day bank bill rate.

It is thus debatable whether the publication of the Financial Stability Report has led short-term market interest rates to conform more systematically to the predictions of the expectations hypothesis. The strongest case exists for the 180-day/90-day term equation. The release of the Financial Stability Report from October 2004 onward has resulted in the size of the coefficient being substantially closer to *2* and an improvement of the predictive ability of the 180-day/90-day spread. In this regard the publication of the Financial Stability Report can be thought of as an improvement in the Reserve Bank's communication strategy.

V. Conclusion

This paper has examined the expectations hypothesis of the term structure of interest rates at the short end of the maturity spectrum in New Zealand. Our inquiry focuses on a recent episode in New Zealand financial history characterized by low inflation and relative calm in financial markets. During the 1989-2008 period the Reserve Bank of New Zealand followed initially a quantity-based operating procedure which gave way to a price-based regime in March 1999. We show that the change in the operating regime affected the predictability of short-term interest rates and the extent to which these interest rates conformed to the predictions of the expectations hypothesis.

Solid evidence backing the validity of the expectations hypothesis in New Zealand exists at the very short end of the maturity spectrum (30-day/60-day) from March 1999 onward when the Reserve Bank introduced the OCR regime. For financial instruments with a somewhat longer term to maturity (90-day/180-day), the expectations hypothesis fares better once account is taken of the improved communication strategy employed by the Reserve Bank since October 2004 when it began to publish a biannual Financial Stability Report.

Our results lend credence to the view that the operating procedure of a central bank influences in no small measure whether the behavior of interest rates is consistent with the expectations hypothesis. In New Zealand, the predictive content of the term spread improves markedly in the wake of the switch from a quantity-based to a price-based operating procedure in March 1999. The OCR system has made it easier for market participants to understand the day-to-day conduct of monetary policy. As a result, market interest rates have become more predictable, thereby contributing to the success of the expectations hypothesis in explaining the behavior of yields on short-dated financial instruments in New Zealand.

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Table 1: Average Daily Change in Short-Term Interest Rates (Basis Points)

90-day rate			
	1994-1999 (Jan)	1994-1996 (June)	1996 (July)-1999 (Jan)
New Zealand	8	6.7	9.3
Australia	3	3.4	2.6
Canada	4.5	6.5	2.6
United Kingdom	2.1	2.9	1.4
United States	1.4	2.0	0.9

Taken from Archer, Brookes, and Reddell (1999).

Table 2: Standard Deviations of Changes in New Zealand Bank Bill Rates

	1989:1 -1999:02	1999:03 - 2008:06	1989:1 - 2008:06
30-day rate	0.4953	0.1323	0.3720
60-day rate	0.4510	0.1340	0.3418
90-day rate	0.4240	0.1376	0.3299
180-day rate*	0.4223	0.1510	0.3124

Note:

1. Monthly 30-day, 60-day, and 90-day rates were retrieved from the Reserve Bank of New Zealand website. * 180-day rates are available only from January 1991onward and were supplied by the Reserve Bank.
2. The raw yield i_t on bank bills is converted into a compounded yield by the following formula: $r_t = \log\left(1 + \frac{i_t}{100}\right)100$.

TABLE 3: Forecasting Equation

$$r_{t+1} - r_t = \alpha + \sum_{j=0}^{n} \beta_{1j}(r_{t-j} - r_{t-1-j}) + \sum_{k=0}^{m} \beta_{2k}(R_{t-k} - R_{t-1-k}) + z_{t+1}$$

R_t = 60-day rate r_t = 30-day rate

PERIOD	1989:01 - 1999:02	1999:03 - 2008:06	1989:01 - 2008:06
Constant	-0.0400 (0.0418)	0.0084 (0.0078)	-0.0102 (0.0213)
$r_t - r_{t-1}$	-1.2681* (0.6468)	-1.1854*** (0.2788)	-1.2304** (0.5112)
$r_{t-1} - r_{t-2}$	-0.6578 (0.4322)	-0.7781** (0.3585)	-0.6816** (0.3283)
$r_{t-2} - r_{t-3}$	-0.4229 (0.5612)	-0.2490 (0.2220)	-0.4618 (0.4542)
$R_t - R_{t-1}$	1.7007** (0.7329)	1.6731*** (0.2788)	1.6737*** (0.5696)
$R_{t-1} - R_{t-2}$	0.5367 (0.4848)	0.7591** (0.2994)	0.5804 (0.3625)
$R_{t-2} - R_{t-3}$	0.5379 (0.6263)	0.4994* (0.2661)	0.6016 (0.5018)
Adjusted R^2	0.08	0.53	0.14
s.e.	0.4782	0.0908	0.3464
LM test (*p*-value)	0.1531	0.2634	0.0155

Notes: 1. The number of monthly observations for the CSB, OCR and whole sample period are 120, 112, and 232, respectively.

2. *, ** and *** denote significance at 10%, 5% and 1% level, respectively.

3. Standard errors of the coefficient estimates are reported in parentheses. s.e. = standard error of the regression.

4. All regression results are based on continuously compounded interest rates. Let the raw interest data be *i*. Then $r = \ln(1+ i/100) \times 100$.

5. Standard errors are corrected for autocorrelations using the Newey –West procedure (1987).

TABLE 4: Forecasting Equation

$$r_{t+1} - r_t = \alpha + \sum_{j=0}^{n} \beta_{1j}(r_{t-j} - r_{t-1-j}) + \sum_{k=0}^{m} \beta_{2k}(R_{t-k} - R_{t-1-k}) + z_{t+1}$$

R_t = 180-day rate r_t = 90-day rate

PERIOD	1991:01 - 1999:02	1999:03 - 2008:06	1991:01 - 2008:06
Constant	-0.0234 (0.0384)	0.0112 (0.0101)	-0.0039 (0.0183)
$r_t - r_{t-1}$	-0.9893* (0.5809)	-0.2386 (0.1812)	-0.6666* (0.4019)
$r_{t-1} - r_{t-2}$	1.1524* (0.6743)	-0.4541** (0.2161)	0.5095 (0.4573)
$r_{t-2} - r_{t-3}$	-1.4399** (0.5530)	0.0715 (0.2397)	-0.9142** (0.3659)
$R_t - R_{t-1}$	1.5850** (0.6140)	0.6954*** (0.1991)	1.2083*** (0.4107)
$R_{t-1} - R_{t-2}$	-1.4918** (0.7293)	0.4377** (0.2121)	-0.7323 (0.4618)
$R_{t-2} - R_{t-3}$	1.7533*** (0.6116)	0.1322 (0.2417)	1.1676*** (0.3930)
Adjusted R^2	0.24	0.43	0.26
s.e.	0.3931	0.1041	0.2786
LM test (*p*-value)	0.4598	0.5998	0.1769

Note: see previous table.

TABLE 5: The Term Spread Equation

$$r_{t+1} - r_t = \alpha + \beta(R_t - r_t) + v_{t+1}$$

R_t = 60-day rate r_t = 30-day rate

PERIOD	1989:01 - 1999:02	1999:03 - 2008:06	1989:01 - 2008:06
Constant	-0.0946* (0.0544)	-0.04*** (0.0117)	-0.0607** (0.0304)
$R_t - r_t$	1.219*** (0.4262)	1.83*** (0.1644)	1.395*** (0.3104)
Adjusted R^2	0.05	0.53	0.09
D.W.	1.39	1.40	1.35
s.e.	0.4817	0.0904	0.3548

Notes:

1. The number of monthly observations for the CSB-, OCR- and whole sample period are 122, 112 and 234, respectively.
2. *, ** and *** denote significance at 10%, 5% and 1% level, respectively
3. Standard errors of the coefficient estimates are reported in parentheses.
4. Standard errors are corrected for autocorrelation using the Newey-West (1987) procedure.
5. All regression results are based on continuously compounded interest rates. Let the raw interest data be i. Then r = ln (1+ i/100) x 100.

TABLE 6: The Term Spread Equation

$$r_{t+1} - r_t = \alpha + \beta(R_t - r_t) + v_{t+1}$$

R_t = 180-day rate r_t = 90-day rate

PERIOD	1991:01 - 1999:2	1999:03 - 2008:06	1991:01 – 2008:06
Constant	-0.0815 (0.0582)	-0.0334** (0.0146)	-0.0552* (0.0312)
$R_t - r_t$	0.6224 (0.3966)	0.7856*** (0.0923)	0.7537*** (0.1961)
Adjusted R^2	0.03	0.40	0.08
D.W.	1.19	1.29	1.18
s.e.	0.4402	0.1065	0.3103

Notes:

1. The number of monthly observations for the CSB-, OCR- and whole sample period are 98, 112 and 210, respectively. See also notes to previous table.

Table 7: The Effects of Positive vs Negative Term Spreads during the OCR Period (1999:03-2008:06): $r_{t+1} - r_t = \alpha + \beta(R_t - r_t) + v_{t+1}$

R_t = 60-day rate r_t = 30-day rate	$R_t - r_t > 0$	$R_t - r_t < 0$
Constant	-0.0278** (0.0137)	-0.0558 (0.0366)
$R_t - r_t$	1.7044*** (0.2032)	1.4889*** (0.5530)
Adjusted R^2	0.39	0.11
D.W.	1.52	1.67
s.e.	0.0908	0.1193
N	93	19
R_t = 180-day rate r_t = 90-day rate	$R_t - r_t > 0$	$R_t - r_t < 0$
Constant	-0.0075 (0.0151)	-0.0487 (0.0396)
$R_t - r_t$	0.6259*** (0.0958)	1.1136*** (0.3379)
Adjusted R^2	0.25	0.13
D.W.	1.45	1.53
s.e.	0.1018	0.1200
N	92	20

TABLE 8: The Effect of Improved Communication during the OCR Period (1999:03-2008:06)

$$r_{t+1} - r_t = \alpha + \beta(R_t - r_t) + \gamma DU_t(R_t - r_t) + v_{t+1}$$

	R_t = 60-day rate r_t = 30-day rate	R_t = 180-day rate r_t = 90-day rate
Constant	-0.0355*** (0.0130)	-0.0497*** (0.0160)
$R_t - r_t$	1.8422*** (0.1656)	0.7927*** (0.0798)
$DU_t*(R_t - r_t)$	-0.0854 (0.4889)	0.6754** (0.3094)
Adjusted R^2	0.53	0.43
D.W.	1.41	1.38
s.e.	0.0908	0.1041

Notes:

1. The sample period consists of 112 monthly observations.
2. The dummy variable DU_t is defined as follows:

   $DU_t=1$ for period 2004:10 – 2008:06 $DU_t=0$ for period 1999:03 – 2004:09.

TABLE 9: The Effect of Improved Communication during the OCR Period (1999:03-2008:06): Measuring the Impact Effect of the Financial Stability Report

$$r_{t+1} - r_t = \alpha + \beta(R_t - r_t) + \gamma DU_t(R_t - r_t) + v_{t+1}$$

	R_t = 60-day rate r_t = 30-day rate	R_t = 180-day rate r_t = 90-day rate
Constant	-0.0382*** (0.0120)	-0.0363*** (0.0146)
$R_t - r_t$	1.8181*** (0.1629)	0.7850*** (0.0898)
$DU2_t$*($R_t - r_t$)	0.6670** (0.3235)	0.6423 (0.4326)
Adjusted R^2	0.53	0.40
D.W.	1.37	1.31
s.e.	0.0903	0.1062

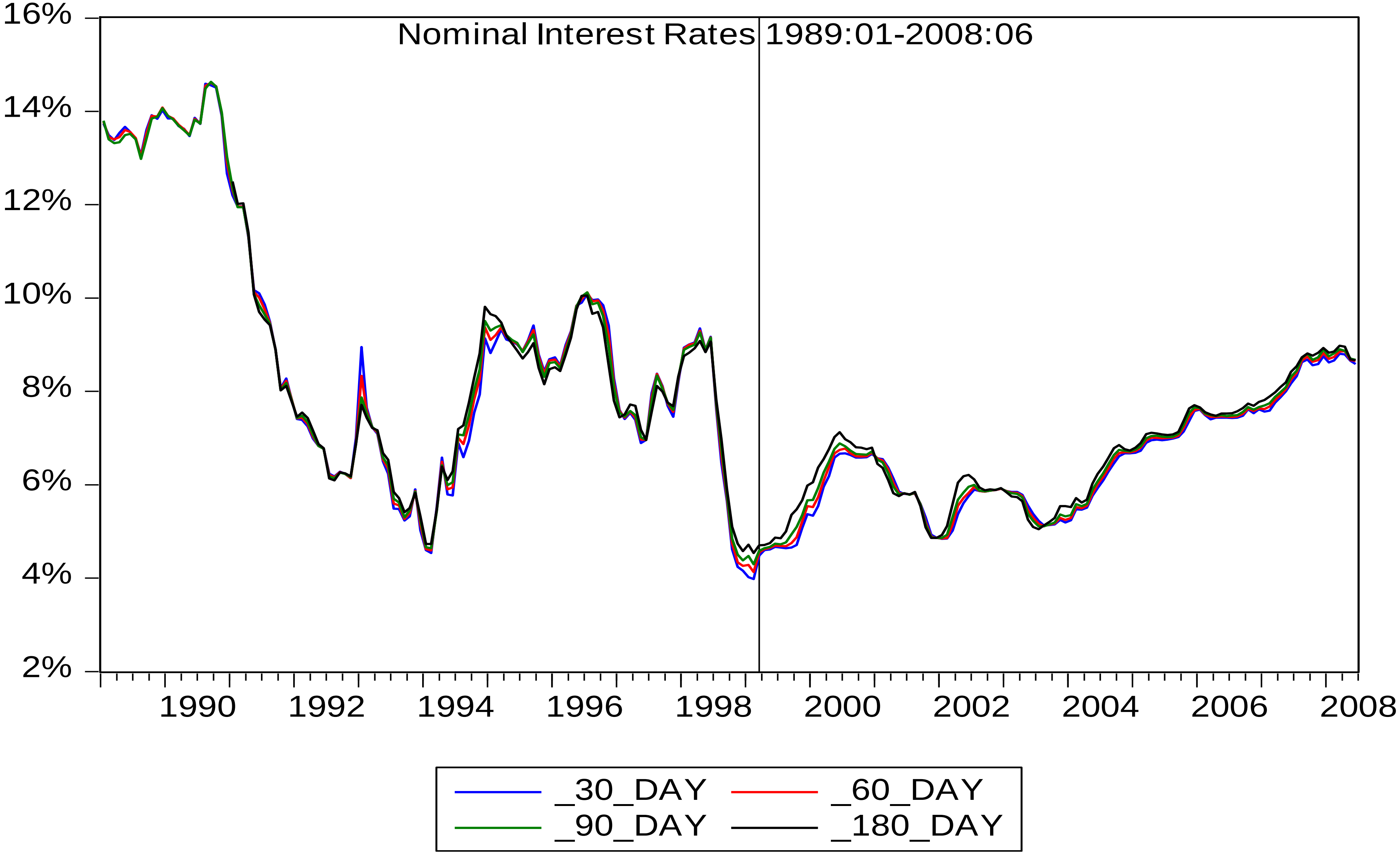
Notes:

1. The sample period consists of 112 monthly observations.
2. The dummy variable $DU2_t$ is defined as follows:

   $DU2_t=1$ for October 2004, May 2005, November 2005, May 2006, November 2006, May 2007, November 2007, May 2008.

   $DU2_t=0$ otherwise.

Figure 1



Nominal Interest Rates 1989:01-2008:06
16%
14%
12%
10%
8%
6%
4%
2%
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
_30_DAY
_60_DAY
_90_DAY
_180_DAY