Using financial market information in monetary policy: some examples from New Zealand

Clinton Watkins

Introduction[88]

Central bankers have long recognised that financial markets contain useful information for macroeconomic surveillance and the conduct of monetary policy. Financial markets provide a valuable window for timely information on (domestic and global) economic and financial conditions. This is due to the vast amount of information aggregated by markets, to their forward looking nature, and to the fact that future asset returns are sensitive to economic conditions. Central bankers also pay close regard to financial markets because certain key markets are important initial linkages in the monetary policy transmission mechanism in many economies.

Market information can be incorporated into monetary policy-making in a variety of ways. This paper outlines some key elements of the Reserve Bank of New Zealand's (RBNZ) approach to incorporating financial market information into monetary policy. It begins by looking at the type of questions we wish to answer using financial market information, our framework for market surveillance and how that fits into the RBNZ's structure.

The subsequent sections focus on some practical examples of our market analysis. During the current policy cycle, the behaviour of retail borrowers has changed in response to changes in the shape of the yield curve, which has in turn altered the characteristics of monetary policy transmission. In New Zealand (NZ), it is critical to understand pricing and forward policy rate expectations and to ensure that policy works through the yield curve so that the behaviour of borrowers will be affected. The paper looks at the influence of policy on the yield curve and transmission to retail borrowing, our analysis of forward policy expectations embedded in the yield curve, and a tactical survey of traders on policy expectations and reactions to policy announcements. Finally, the paper discusses how market information is incorporated into the macroeconomic modelling process.

1.   Market information and monetary policy

The primary objectives of the RBNZ are to implement monetary policy and to maintain financial stability by (i) operating monetary policy so as to maintain price stability, and (ii) promoting a sound and efficient financial system. Financial market surveillance is integral to achieving both of these objectives, although this paper focuses on using financial market information to pursue the first objective.[89] Accordingly, different types of monetary policy oriented questions that we wish to answer using financial market information can be thought of in terms of short-, medium- and long-term horizons.

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[89] Market analysis for both monetary policy and financial stability purposes is conducted within the same section of the RBNZ.

- In the short term, we are interested in the policy expectations that are currently priced into financial asset prices and the yield curve by market participants, and how these expectations evolve with the economic dataflow, market relevant events and the other financial market variables.

- In the medium term, it is beneficial to know why financial market participants are trading, how market participants will react to policy announcements, what the influence of policy will be on markets, and whether there are persistent frictions or distortions present in markets that mean financial market variables deviate to some extent from reflecting "fundamentals".

- In the longer term, we are interested in the transmission of monetary policy through the relevant wholesale and retail financial markets, as well as the existence of systematic relationships amongst financial market variables, and between financial market and macroeconomic variables.

Overall, financial market information can be thought of as:

- information obtained from markets directly, and from market participants through liaison;

- asset price and yield moves, flows and transactions;

- risk taking and hedging behaviour;

- characteristics of financial instruments, market and institutional structure; and,

- underlying views on macroeconomic and financial conditions.

The market surveillance framework used by the RBNZ, and how this fits into the monetary policy process, is discussed below.

2.   The market surveillance framework

What is market surveillance at the RBNZ?

Like many central banks, we view market information or intelligence as a synthesis of both desk-based research and direct contact with market participants. Information obtained from these two broad sources is analysed through a variety of financial and economic frameworks to assist with interpreting financial market developments. Interpretation is an important element of the market surveillance process. The Financial Markets Research (FMR) team at the RBNZ not only summarises and reports on market developments; its main function is to interpret these developments in terms of financial or economic frameworks that the Bank's economists and decision-maker[90] can relate to macroeconomic modelling at the Bank, and use to pursue the Bank's policy goal. At the RBNZ, incorporating financial market information into monetary policy involves (i) extracting and interpreting market information, (ii) using this interpretation of markets in policy development, and (iii) using this interpretation in communicating policy to markets (see the diagram below).

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[90]   Under the Reserve Bank Act, the RBNZ Governor is the single decision-maker. For monetary policy, the Governor is supported by the Monetary Policy Committee and the Official Cash Rate Advisory Group.
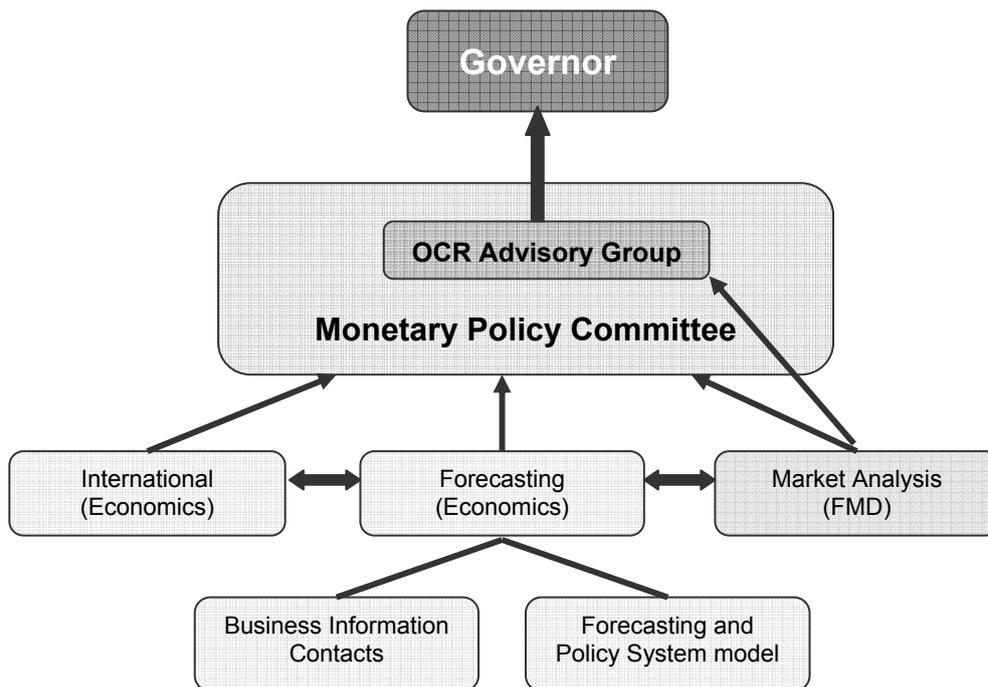
Incorporating financial market information into monetary policy
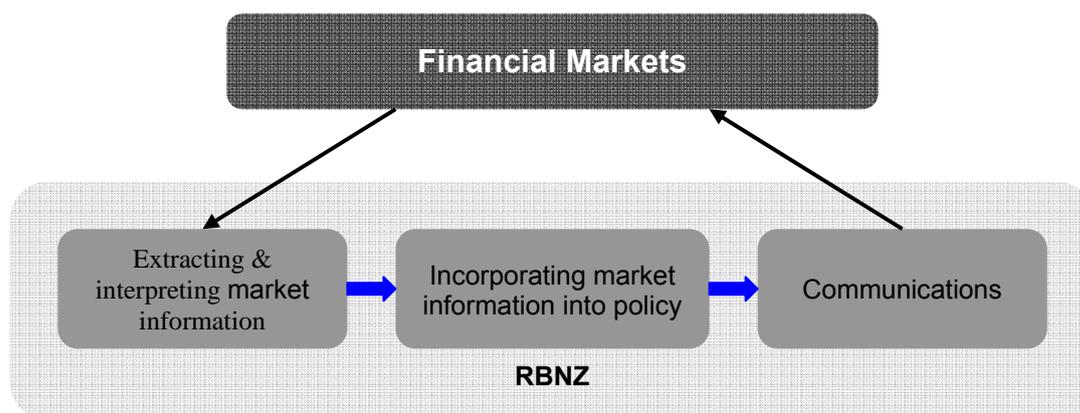
Market information in the monetary policy process

The diagram below depicts a stylised RBNZ monetary policy process. The process is focused around the Bank's Forecasting and Policy System (FPS) model, which provides a framework for analysis of the domestic economy, projections, and discussion of developments at meetings of the Monetary Policy Committee (MPC). The model is operated by the Forecasting team in the Economics Department, who also provide detailed economic analysis on various aspects of the domestic economy. The Market Analysis team provides information directly to the MPC as well as to the other teams involved in the policy process. This information will be discussed below in detail. Other components feeding into the process include "*Business Information Contacts*", which is a programme of liaising with firms on economic developments, and international economic forecasts. The MPC deliberates on the economic and financial market information, modelling and projections. Individual members of the Official Cash Rate Advisory Group (OCRAG), as a sub-committee of the MPC, provide written recommendations to the Governor on policy. The group collectively provides advice on communicating the policy decision.

Where market analysis fits into the policy process

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Gathering information for market surveillance

The RBNZ has had a dedicated Financial Markets Research team since the mid-1990s, situated within the Bank's Financial Markets Department (FMD). The team draws in information from four main sources: (i) open data sources and financial market databases, (ii) direct contact and liaison with market participants, (iii) surveys conducted by the Bank, and (iv) internal information flows from other sections of the RBNZ.

External financial market databases provide access to real-time market price and yield information across a vast array of markets. The Bank has an internal "Market Watch" financial market data system that captures "tick" observations. At present, the system captures data on about 950 financial prices (and other variables such as volumes) from both domestic and global markets. This data is regularly checked for completeness and accuracy. The database provides access to high frequency, hourly and daily snapshots of these variables via a spreadsheet-based query system available throughout the Bank. It provides the main data source for the Market Analysis team's quantitative tools, reports and "chart packs". The diagram below shows the system architecture for the Market Watch database.

Architecture of the Market Watch database
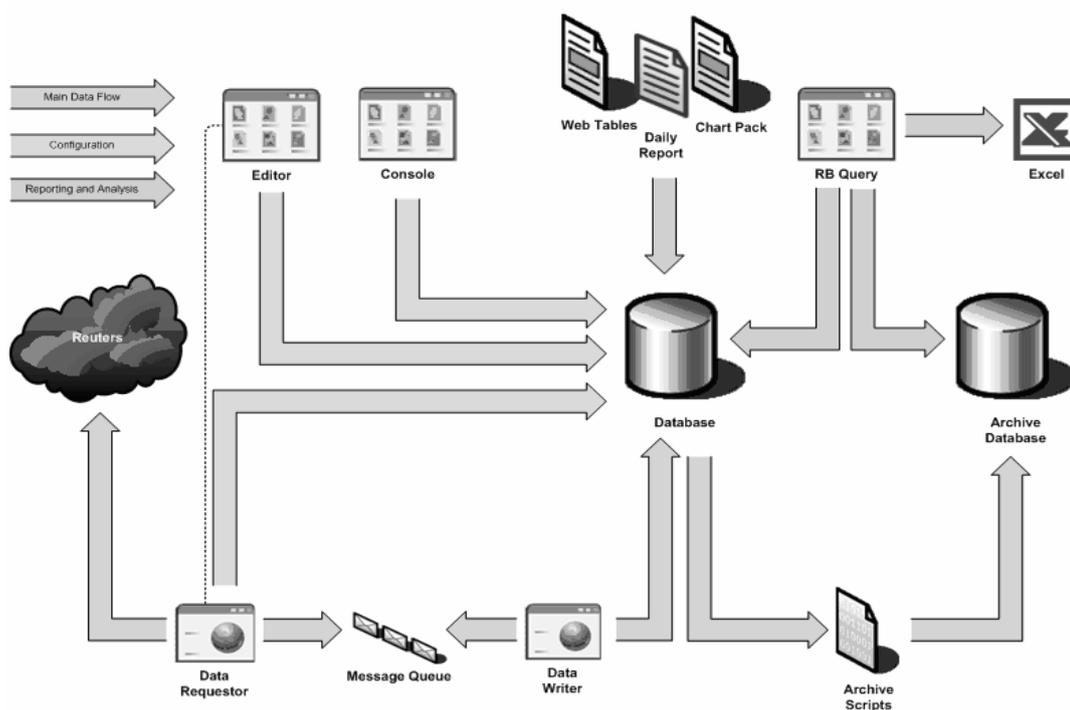
A range of quantitative tools are regularly used to analyse market developments, including: short-term policy rate outlook models; models for analysing cash market pressures; tools that provide information on the transmission mechanism and various yield curves; and tools to estimate options implied distributions on foreign exchange rates and other variables. The tool building process is ongoing to keep up with developments in financial economics technology, and the evolving structure of markets. Developing these tools relies on in-house, commercial or investment bank, academic, and central bank research. Some of these tools replicate methods used by market participants to understand market developments or analyse trades. This helps analysts at the RBNZ to interpret traders' views and trading rationales. In the following sections, some of our quantitative tools will be discussed.

Market liaison is conducted through day-to-day telephone contact, periodic surveys, visits to local and overseas dealing rooms, and formal meetings with both domestic and offshore market participants. Day-to-day market liaison efforts focus on contact with traders and asset managers in the important transmission mechanism markets, and some peripheral markets. To a lesser degree, we engage market strategists and economists in discussion. More time and effort is put into speaking with traders because the Market Analysis team aims to understand the functioning of markets, and to the extent we can, what is driving investment flows. We believe an important means of understanding market developments, particularly those involving changes in views, dynamics or structure, is to speak directly with those actively transacting in the markets of interest. We also meet on a regular basis with higher level financial market and treasury staff in the domestic banks.

A priority of the Financial Markets Research team is to develop and maintain close and strong relationships with a broad network of market contacts covering the key domestic and main global markets of relevance to domestic monetary policy and financial stability.[91] While

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[91] Global benchmark interest rate, currency, commodity and equity prices are monitored. Domestic markets closely related to the transmission mechanism include money markets (overnight index swaps, physical bank bills, bank bill futures, forward interest rate agreements), wholesale capital markets (interest rate swaps), government and corporate bonds (including those issued by offshore corporates called Kauri bonds), offshore issuance of NZ dollar denominated securities (Uridashi bonds, Eurokiwi bonds), foreign exchange (spot,

desk-based research on market data is very useful, surveillance based purely on this approach has disadvantages. For instance, many market indicators move in reaction to data or an event, rather than leading it. Market price deviations from values consistent with fundamentals usually give little guidance on the timing of correction. Further, data on some sectors, such as hedge funds' leverage and strategies, is sporadic and poor. The shortcomings of purely desk-based research reinforce the importance of effective strategies for gathering market intelligence through direct contact with market participants.

There are risks that information gained through direct contact could be biased or distorted. We use a relationship management approach to mitigate these risks (as do the Bank of England and the US Federal Reserve). By maintaining long-standing relationships with market participants, the information provided can be "handicapped" according to the reliability of the source over time. Moreover, we place a great deal of importance on fostering internal information flows amongst the various groups interacting with financial markets, both those trading with market participants, and those liaising more generally. Maintaining a broad spectrum of market information sources lessens the risk that a biased or distorted information source might colour the Bank's interpretation of market developments.

The Market Analysis team is co-situated with the Bank's dealers who transact with domestic markets for liquidity management purposes (the Domestic Markets (DM) team), and the dealers who manage the Bank's foreign reserves by transacting in foreign exchange and offshore fixed income markets (the Foreign Reserves Management (FRM) team). The analysts sit in a "dealing room" environment. The co-location of the market analysts with the RBNZ market operations traders promotes information flows from the wide range of market participants with which the Bank has a trading relationship.

Working closely with the DM team provides the market analysts with access to information on liquidity management operations (foreign exchange swaps, basis swaps, open market repurchases and reverse repurchases), influences on the settlement cash level (government flows, settlement cash forecast, commercial bank cash holdings), and use of the Bank's standing facilities (Overnight Reverse Repurchase Facility, Bond Lending Facility, Repurchase Facility). Information flows from the FRM team primarily cover a wide range of currency market developments, as well as providing a window on currency market participant views on the domestic and international economies. The Market Analysis team also operates a "Market Test Portfolio". This is a small portfolio that allows the team to trade in a limited number of fixed income securities (physical and futures). Trading in markets assists the process of understanding market microstructure, developing transactional knowledge, and building relationships with financial market counterparties.

Information flows from other parts of the Bank are also useful in market analysis and interpretation, particularly areas such as those involved with wholesale payment systems and banking supervision. For instance, being the operator of the wholesale settlement and depository systems, we have access to a wealth of detailed transactional information.[92] Various parts of the Bank conduct surveys of financial institutions and market participants. RBNZ financial market turnover, pricing and holdings surveys are an important source of information for the Financial Markets Research team. These include daily foreign exchange turnover and bond turnover, wholesale and retail interest rates, and monthly non-resident bond holdings. Ongoing efforts aim to improve information flows across the RBNZ, particularly from these areas.

The Market Analysis team is located in a separate department to that in which macroeconomic analysis takes place, although there is substantial communication between

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options, forwards), and mortgage interest rates (a key retail interest rate market). For financial stability purposes, an even broader range of markets are analysed.

[92]   Although some legal issues and system technology constraints currently limit the extent to which this data can be accessed for analysis.

the two areas. One benefit that results from this separation is that it encourages the market analysts to provide a market-based interpretation of economic data and developments, and contestable advice into the monetary policy process. Often, market information is cast as a market-based counterview to economic modelling in the policy process.

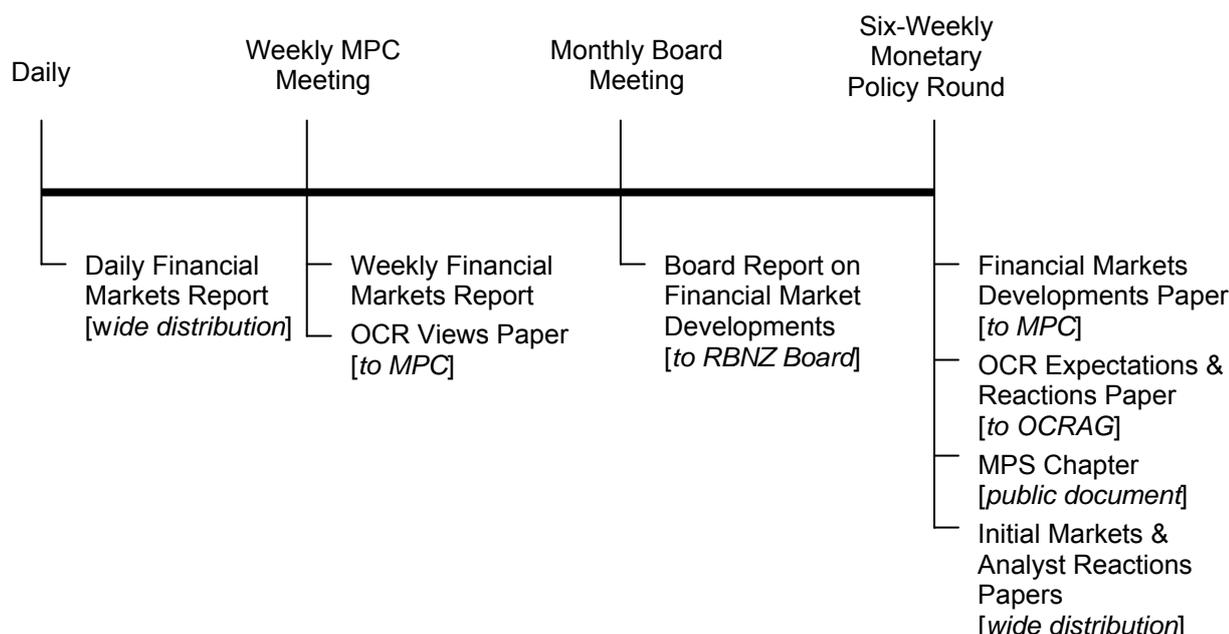The diagram below shows the main information sources used in market analysis and interpretation at the RBNZ.

Market surveillance information sources
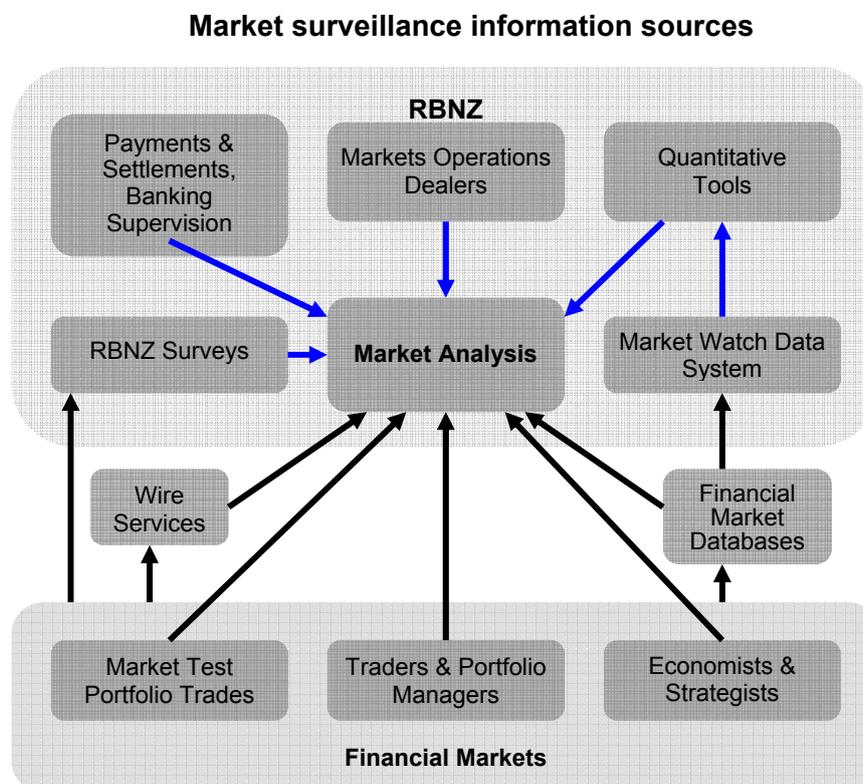
Market surveillance contributions to the monetary policy process

The Market Analysis team's primary client is the MPC. To service this committee, the team has developed several key outputs. These include: a daily report on developments in domestic and offshore markets distributed widely within the bank; weekly MPC reports on financial market developments, and analyst (OCR) views; a financial markets development paper and a market expectations and reactions survey for each of the 6-weekly monetary policy rounds; and a chapter for the quarterly Monetary Policy Statement (MPS). A monthly paper is written for the Reserve Bank Board[93] to provide appropriate financial markets background for Board Members in their assessment of the Bank's policy performance. Research is conducted for other key committees of the Bank as well as the MPC.

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[93]   The Board of the Reserve Bank performs an oversight and governance function; it does not advise on or have any input into monetary policy decision-making. In contrast to the MPC, which consists of internal staffers (with two external observers), the Board Members are selected from outside the Bank by the Minister of Finance.

Market analysis reporting in the monetary policy process

Daily	Weekly MPC Meeting	Monthly Board Meeting	Six-Weekly Monetary Policy Round
Daily Financial Markets Report [*wide distribution*]	Weekly Financial Markets Report

OCR Views Paper [*to MPC*] | Board Report on Financial Market Developments [*to RBNZ Board*] | Financial Markets Developments Paper [*to MPC*]

OCR Expectations & Reactions Paper [*to OCRAG*]

MPS Chapter [*public document*]

Initial Markets & Analyst Reactions Papers [*wide distribution*] |

The following sections provide an overview of some of the financial market analysis that contributes to the financial market surveillance outputs. The next section provides an example of how a recent inversion in the yield curve affected retail borrower behaviour, lengthening the lags involved in monetary policy transmission. This highlights the critical importance for NZ of understanding forward policy expectations over a long horizon.

3.   Monetary policy transmission through mortgage interest rates

Inflation pressures in NZ over recent years have been fuelled by significant increases in borrowing by households. This has happened, surprisingly, during a period in which monetary policy has been tightened significantly. Faced with this apparently counter-intuitive phenomenon, Governor Bollard posed the following question to the Financial Markets Research team:

> "*I have been raising the Official Cash Rate but it doesn't appear to be having much impact on the interest rates that borrowers are paying. What is going on?*".

Retail interest rates on residential mortgage debt are an important component of the transmission mechanism of monetary policy in NZ[94] for several reasons. For example: (i) around one third of NZ households hold mortgages;[95] (ii) 8 percent of households own an investment property and these tend to be highly geared with mortgage financing; and (iii) small businesses often rely on the proprietor's residential mortgage for business investment funding.

The average interest rate paid on outstanding residential mortgage debt (the "effective mortgage rate") has risen at a relatively slow pace during the current tightening cycle, particularly over the first two years (2004 to 2006; see the chart below). While the OCR

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[94]   For a detailed discussion, see Drew, A and R Sethi (2007), "The transmission mechanism of New Zealand monetary policy", *Reserve Bank of New Zealand Bulletin*, 70(2).

[95]   Scobie, G, T Le and J Gibson (2007), "Housing in the Household Portfolio and Implications of Retirement Saving: Some Initial Findings from SOFIE", *New Zealand Treasury Working Paper*, 07/04.

should affect the level of mortgage interest rates, there are a number of other important factors that also influence the impact of the policy rate on the effective mortgage rate.

**The effective mortgage rate and the OCR**
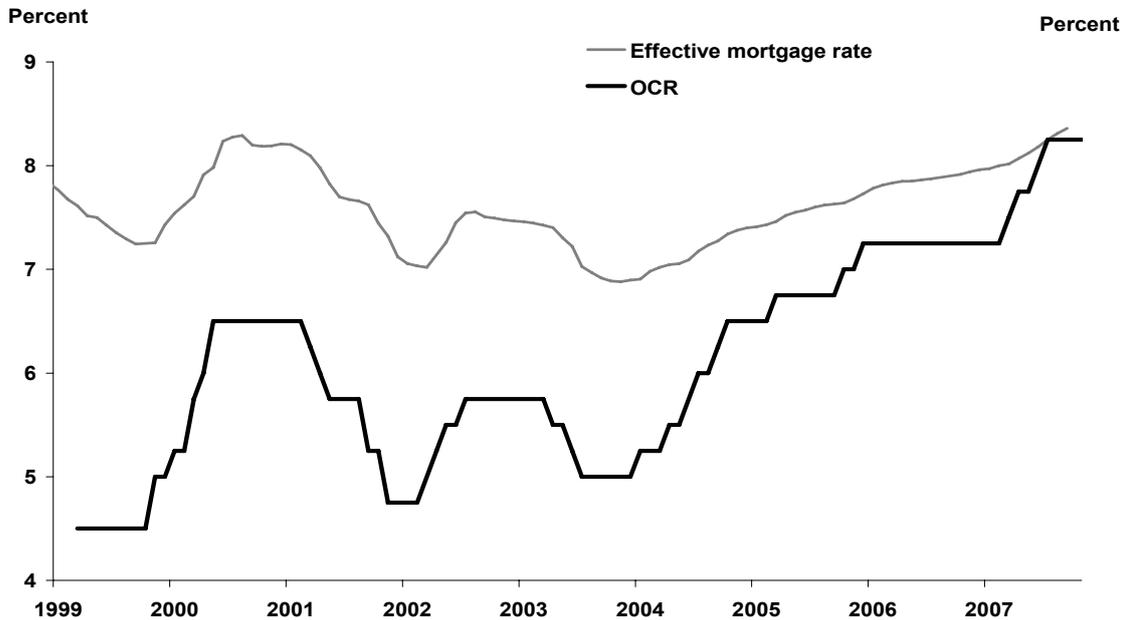
Mortgages in NZ are written on either short-term interest rates or fixed borrowing rates. Pricing of short-term (or "floating") rate mortgages depends on the 90-day bank bill yield, a rate that reflects near-term monetary policy expectations. As the chart below indicates, the channel from the OCR through floating borrowing rates appears to have worked effectively over the current tightening cycle.

The effective floating mortgage rate
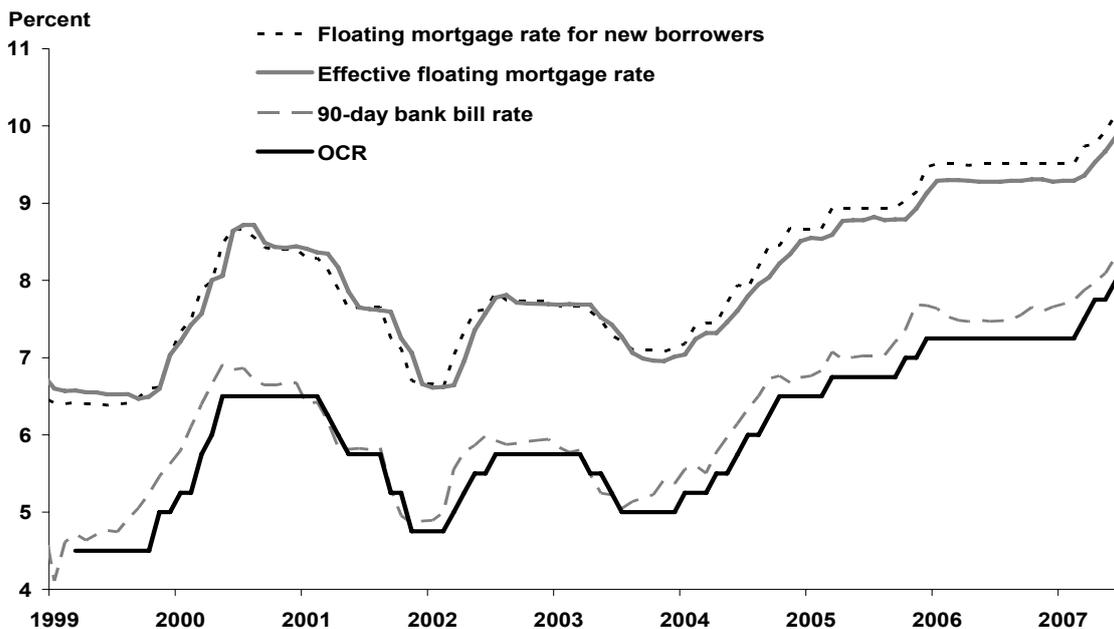
However, both new and existing borrowers have moved from floating to fixed borrowing rates[96] (see the chart below). The relationship between the OCR and effective fixed mortgage interest rates is relatively weak compared to the relationship with the effective rate for floating rate mortgages. The growing proportion of fixed rate mortgages, particularly those with a maturity of more than one year, has increased the lags involved in the transmission of monetary policy. This is because there will be a period of time between a tightening in monetary policy and the point at which existing fixed rate mortgages mature, and new mortgages are negotiated. These lags have been one factor behind the subdued response of the effective mortgage rate to the OCR since 2004.

Fixed and floating mortgage tranches
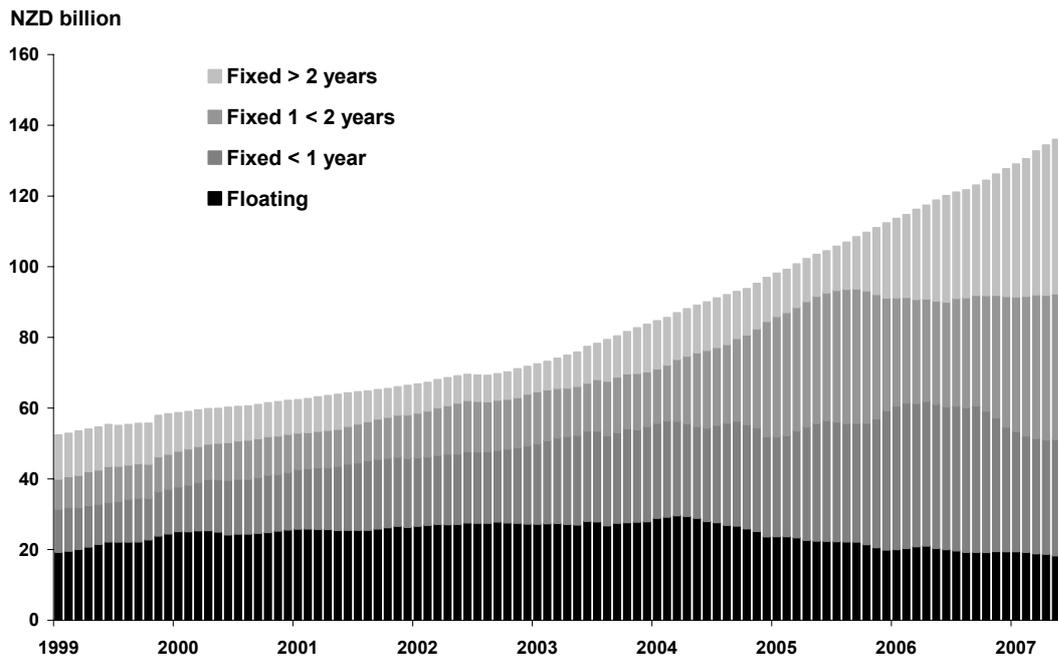
The reason that borrowers have been attracted to fixed rate mortgages during the current tightening cycle is that interest rates for fixed rate mortgage debt have been low relative to floating mortgage rates (see the chart below). During previous tightening cycles, fixed mortgage rates have generally been higher than floating mortgage rates, so the current cycle is relatively unusual.

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[96] The duration of the NZ mortgage portfolio is relatively short when compared with US mortgage debt, but longer than Australian mortgage debt. In contrast with the US, NZ mortgages typically do not have any embedded optionality to refinance at a lower rate if interest rates fall.

Floating and fixed mortgage rates
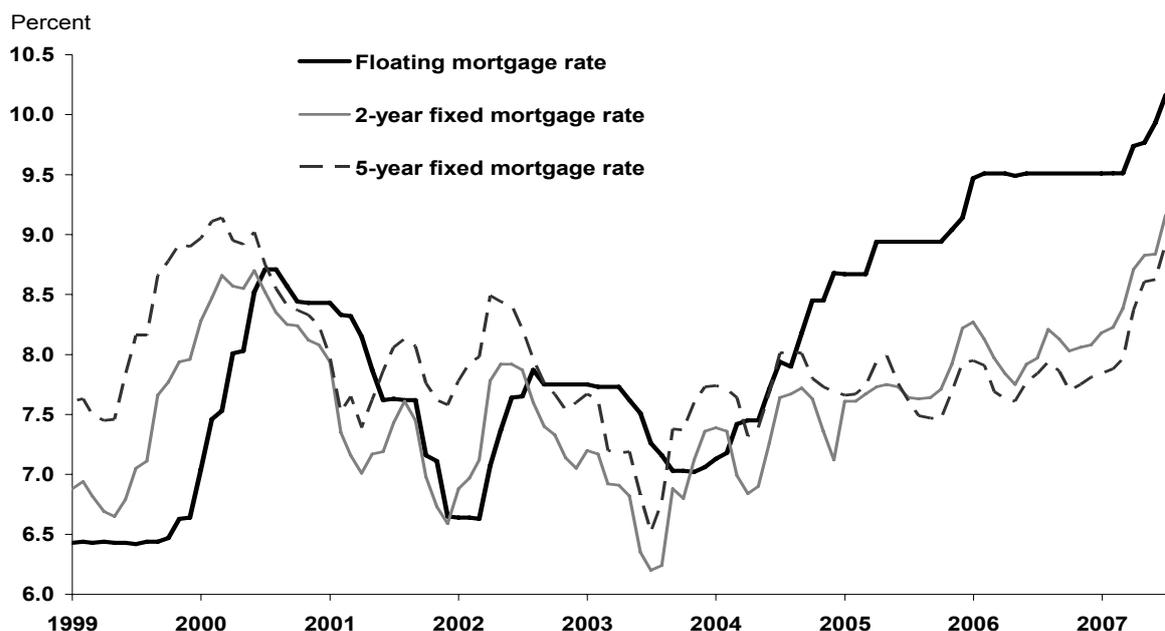
Mortgage lending banks manage the interest rate risk involved in providing fixed rate mortgages through the domestic interest rate swaps market.[97] Accordingly, funding costs for fixed rate mortgages depend on the level of interest rate swap rates. Bank bills and interest rate swaps make up what we consider to be the benchmark commercial bank liability yield curve in NZ.

In a stylised sense, the short-term end of the NZ yield curve responds predominantly to cyclical factors, that is, monetary policy and market expectations of future monetary policy based on market participants' views of the domestic macroeconomy. Changes in longer-term interest rates are influenced by structural factors, and for a small open economy like NZ, these structural factors largely reflect longer-term expectations of global growth and inflation developments, as reflected in long-term global interest rates.[98]
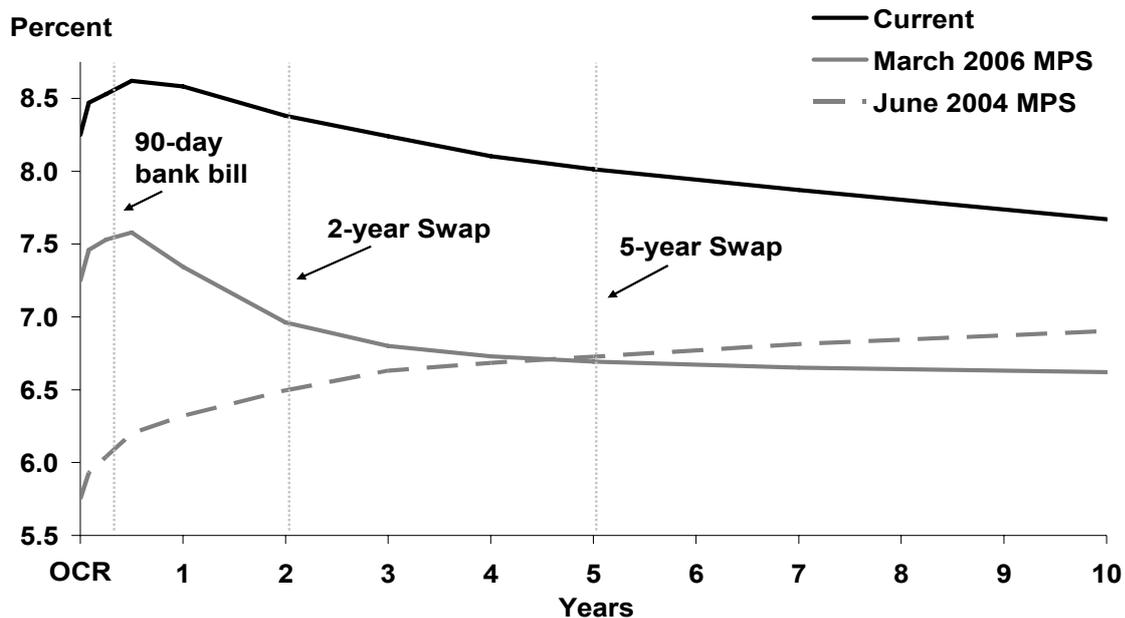
Despite significant tightening since January 2004 (325 basis points to date), longer-term interest rates have remained anchored at relatively low levels for much of the cycle. The chart below shows the yield curve at selected points during the tightening cycle – on the June 2004 and March 2006 MPS announcement dates, and the current curve. Funding costs for 2- to 5-year mortgages became substantially lower than costs for floating rate mortgages between 2004 and early 2007.

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[97] The majority of commercial bank funding is raised at a maturity of less than 90 days. The mismatch between short-maturity liabilities and longer-maturity assets (the fixed rate mortgages) raises an interest rate re-pricing risk for the banks. This risk is managed through the interest rate swaps market. To hedge fixed rate mortgages, banks pay a stream of fixed interest rate flows and receive a stream of floating (90-day) interest rate flows.

[98] Of course long-term interest rates are seen as expectations of future short-term interest rates (expectations hypothesis). Long-horizon future short-term rates are strongly influenced by the evolution of the global macroeconomy.

The yield curve inverted and became more curved during 2005/06

Commercial bank liability yield curve

Percent

Current
March 2006 MPS
June 2004 MPS

90-day
bank bill

2-year Swap

5-year Swap

8.5
8.0
7.5
7.0
6.5
6.0
5.5

OCR   1   2   3   4   5   6   7   8   9   10
Years

Long-term NZ interest rates remained at low levels, anchored by low global long-term rates.[99] The combination of anchored long-term interest rates and higher short-term interest rates saw the yield curve invert (become negatively sloped) rapidly. The yield curve also became more downward curved around mid-term maturities (2- to 5-year rates). Two reasons behind the increased downward curvature were relatively large issuance volumes of 2- to 5-year NZ dollar denominated securities in offshore markets,[100] and a degree of pessimism amongst offshore investors on NZ growth prospects. As the chart below indicates, the degree of inversion and downward curvature of the yield curve is extreme here relative to the previous two policy cycles.

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[99] Bollard, A (2006), *Easy Money: Global Liquidity and its Impact on New Zealand*, Reserve Bank of New Zealand.

[100] These comprise Uridashi bonds, which are NZ dollar denominated bonds issued by offshore entities in Japan, mostly to retail investors but also to some institutional investors, and Eurokiwi bonds, which are NZ dollar denominated bonds issued by offshore entities to institutional investors in the euro markets. In issuing these bonds, interest rate risks are hedged by receiving a fixed interest rate and paying a floating interest rate in the swaps market, putting downward pressure on the commercial bank liability curve. The amount of outstanding Uridashi and Eurokiwi bond issuance is more than double the level of government bonds on issue (NZD 56.3 billion versus NZD 24.6 billion).

**Shape of the yield curve during the current
tightening cycle has been unusual**

Slope and curvature estimates from a quadratic model
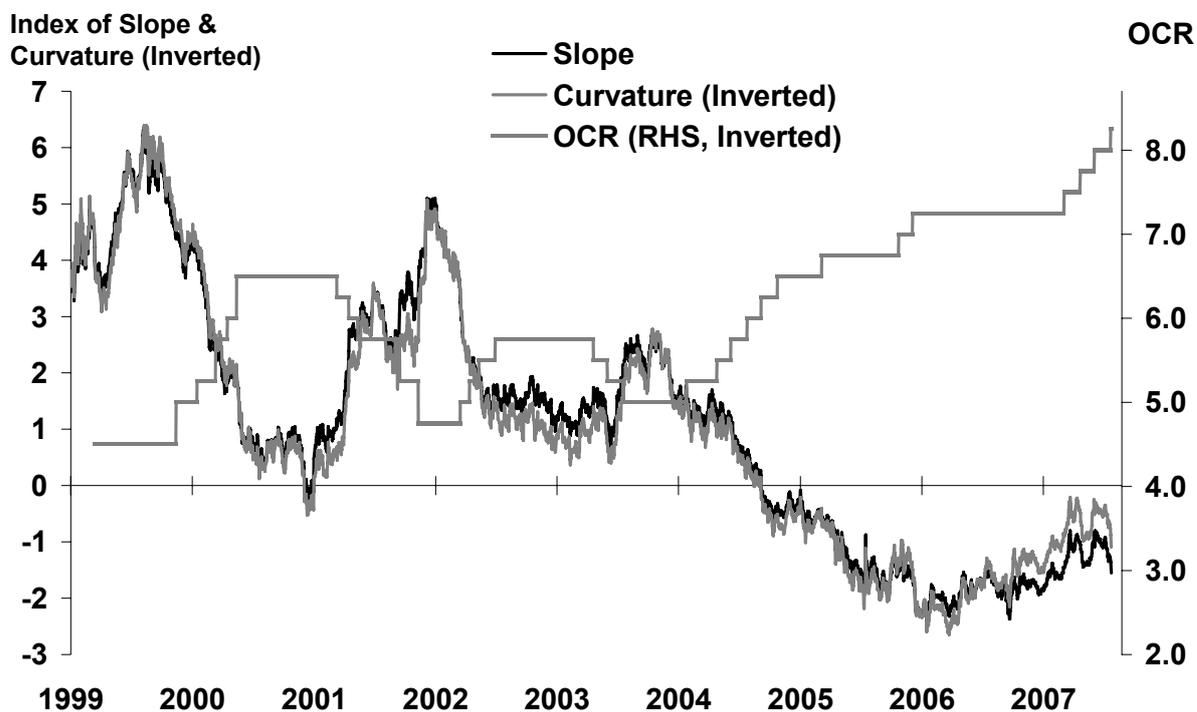
Despite the muted reaction of longer-term interest rates to increases in the OCR, tightening did flow through the exchange rate channel as the NZ dollar appreciated in line with relative short-term interest rate expectations[101] (see the chart below).

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[101] Relative interest rate expectations are defined as the difference between NZ money market futures yields and a Trade Weighted Index (TWI) weighted average of US, UK, eurozone, Japanese and Australian money market futures yields.

**The NZ dollar Trade Weighted Index
and relative interest rate expectations**
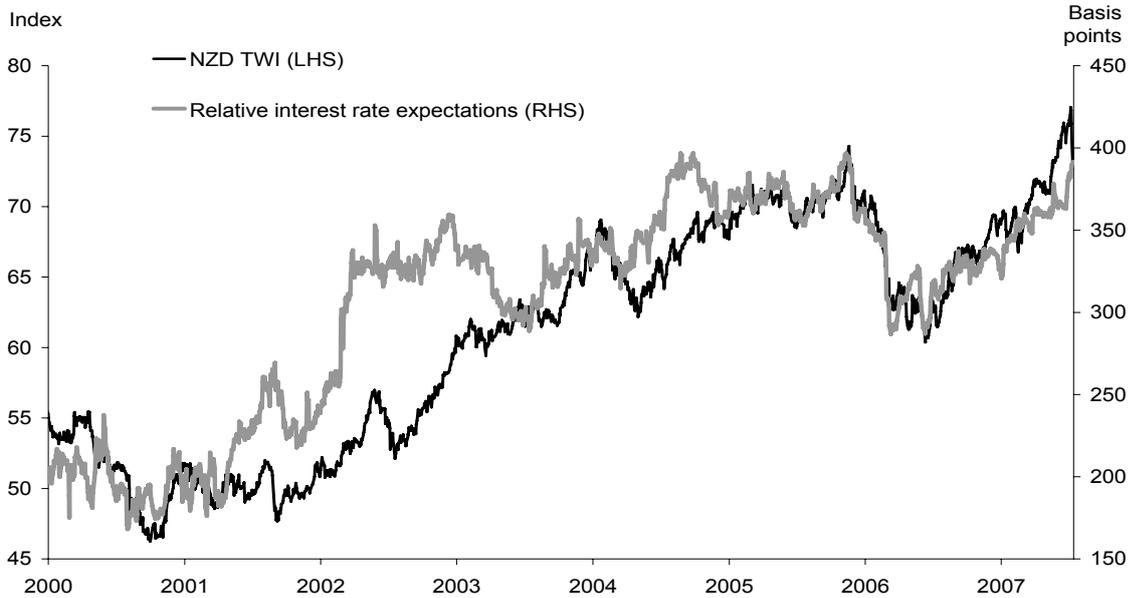
Financial conditions in NZ, and the behaviour of the domestic yield curve, have been heavily influenced by relatively easy policy conditions in the major global economies for much of the current tightening cycle. This illustrates the extent to which the policy mix in NZ depends on global policy conditions and the impacts on financial conditions in NZ when domestic monetary policy is out of synchronisation with policy in the major global economies. The four broad alternative mixes of financial conditions are shown in the diagram below, with the situation currently faced represented by the lower right quadrant.

The NZ policy mix depends on overseas policy
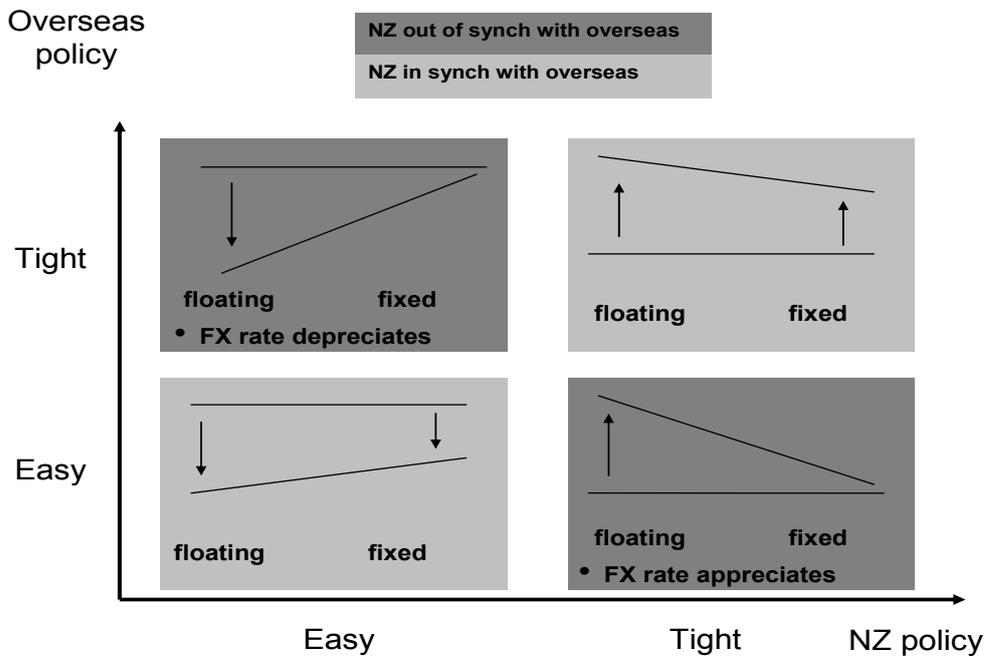
Note: off-diagonal "out of synch" effects are not symmetric.

Another factor exerting a downward influence on fixed-term mortgage interest rates during the current tightening cycle has been strong competitive behaviour amongst the domestic

commercial banks. Competition for market share in fixed rate mortgages has led to compressed lending margins (this is illustrated with regard to 2-year rates in the chart below). This helped mortgage rates stay closer to the level of wholesale interest rates than would have otherwise been the case.

Margins on 2-year fixed mortgages
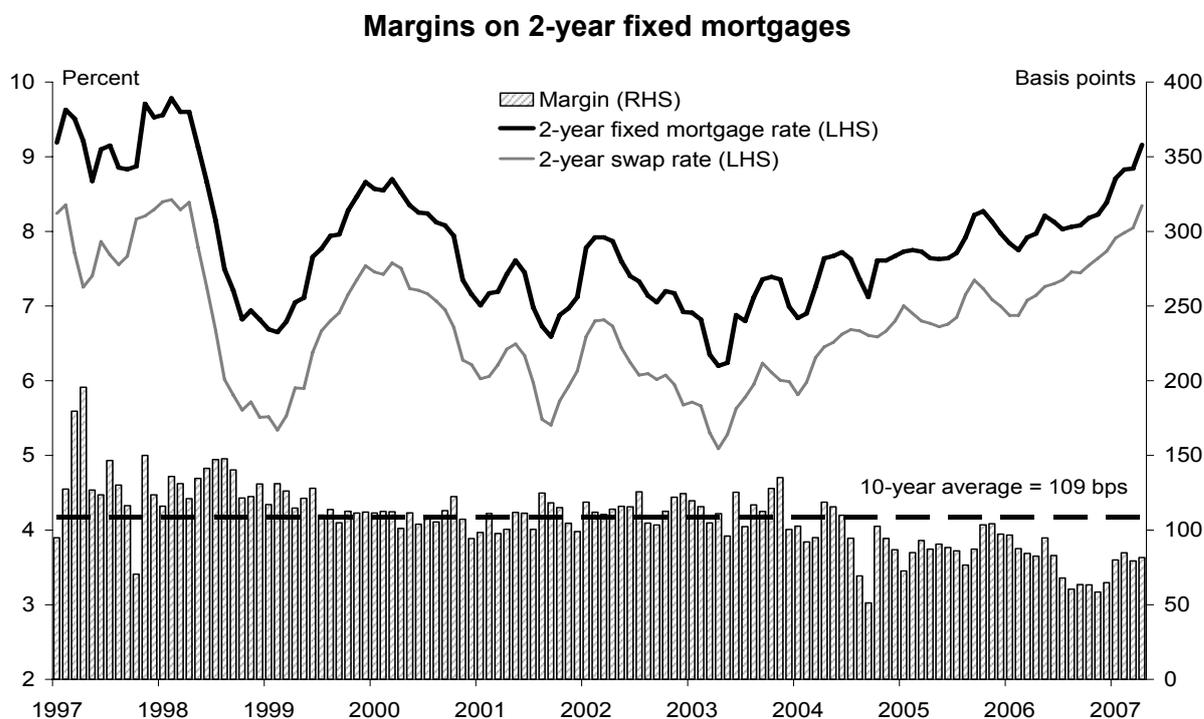
Our experience with recent developments in the transmission of the OCR to retail borrowing rates suggests three lessons for policy-making in NZ:

- The changing behaviour of borrowers in response to the shape of the yield curve has meant the Bank has had to pull longer and harder on the policy lever to achieve a material tightening in financial conditions. With a greater proportion of fixed rate mortgages, there may be considerable lags involved in delivering relief to the economy during an easing cycle. Lags involved in the transmission of the OCR to the effective mortgage rate now depend on the schedule of mortgage re-pricing; that is, when tranches of fixed rate mortgages mature and are re-negotiated at a new interest rate.[102]

- Expectations are arguably as important as, if not more important than, actual policy moves in managing the shape of the yield curve. The next two sections cover some examples of how we analyse future expectations, using both quantitative and qualitative tools.

- Though the lags in the transmission of policy through the interest rate channel have been longer than in previous cycles, the Bank has had substantial impact on borrowing costs, and in particular the effective mortgage rate. As existing and new borrowers take on mortgages at higher interest rates, the effective mortgage rate is likely to continue to increase, which suggests there is further interest rate pressure in the pipeline.[103]

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[102] Researchers at the RBNZ are working on incorporating a "mortgage agent" into a new Dynamic Stochastic General Equilibrium macroeconomic model.

[103] Recent pipeline interest rate pressures are fully discussed in the June 2007 *Monetary Policy Statement* (MPS), pages 20 to 22.

4.   Interpreting implied policy rate expectations

Understanding market expectations of future policy is important for any central bank. In NZ, understanding money market policy expectations and how they are transmitted through the yield curve to longer-term capital markets is critical to effective monetary policy, as illustrated in the previous section. Affecting the economy through the interest rate channel requires the management of market expectations so as to influence interest rates beyond the 2-year horizon to as great an extent as possible, given the exogenous impact of global interest rates.

Money market expectations of future policy in NZ can be estimated for around 12 months ahead, and are most accurately measured over the next three or four decisions, given that money markets are most liquid over this horizon. At the RBNZ, we estimate policy expectations using both Overnight Indexed Swaps (OIS) and bank bill futures. OIS expectations models are our preferred method given that rates in the OIS market give a "cleaner" read on markets' expectations regarding the policy rate itself. This is because of the smaller term premium embedded in OIS yields relative to other money market instruments.[104] The OIS instrument is a relative newcomer to NZ markets, having been first traded in 2002, but volumes and liquidity have rapidly expanded in this market over the last five years.[105] In terms of monetary operations, the OIS market is used to derive the reference rates from which Domestic Market operations are conducted.
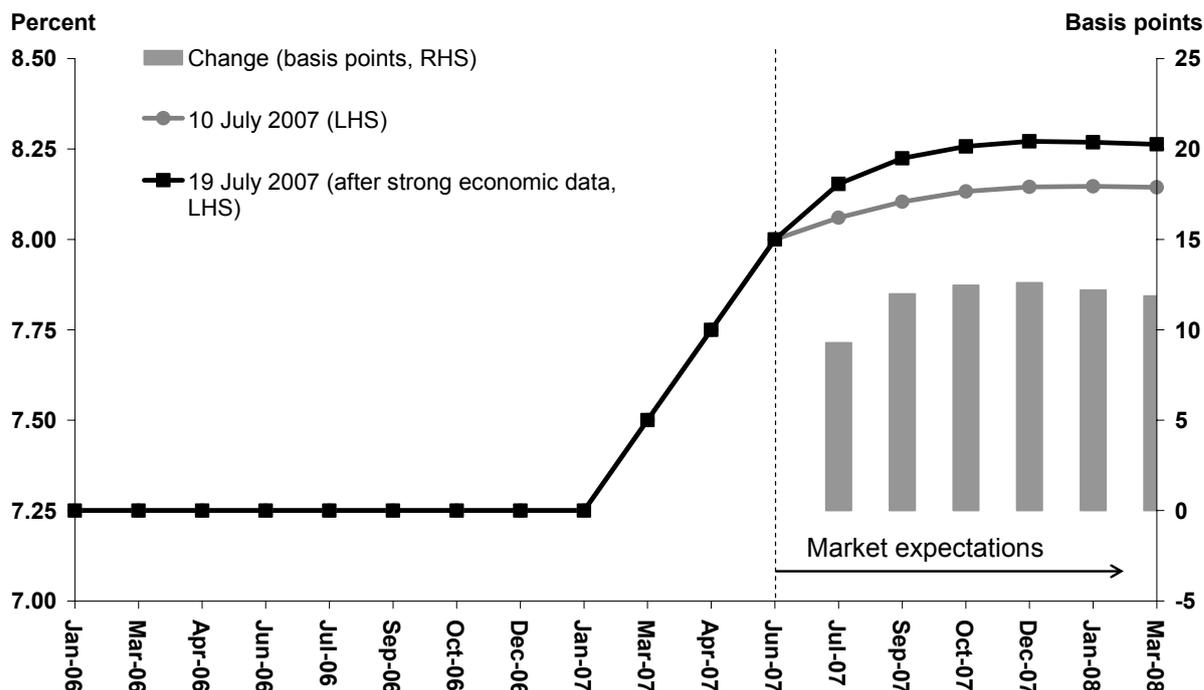
The chart below illustrates an example of OIS implied market expectations before and after recent stronger than expected economic (retail sales and CPI) data. At the time, markets had moved from pricing in a 30 percent chance of a 25 basis point rate rise in July, to pricing in a 70 percent chance. Further out, markets had fully priced in an 8.25 percent OCR by September.

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[104] For further information on OIS markets see Choy, WK (2003), "Introducing overnight indexed swaps", *Reserve Bank of New Zealand Bulletin.*

[105] Deep and liquid OIS markets exist in a number of countries. We regularly estimate OIS policy rate expectations models for NZ and several other economies including the US, the eurozone, Japan, the UK, Canada and Australia. Overseas policy expectations are used to build our interpretation of how markets view monetary policy and macroeconomic developments in these economies, and our assessment of future global interest rate movements.

Market expectations of the Official Cash Rate

Based on OIS rates, without a term premium

Percent   **Basis points**

- Change (basis points, RHS)
- 10 July 2007 (LHS)
- 19 July 2007 (after strong economic data, LHS)

Market expectations →

Regarding near-term policy expectations, our market intelligence aims to understand the reasons why markets move on a particular piece of economic data (or other event), and what the distribution of market expectations, or the risks, around current market pricing are. In the example above, market contacts pointed to a strong rise in non-tradable inflation as likely to have been of particular concern to the Bank. Risks had shifted toward the likelihood of an OCR increase in July, and over the following days, as markets digested the stronger data, market sentiment became more skewed toward a rate increase. Individual market participant views tended to be broadly similar, suggesting a reasonably narrow distribution of expectations around market pricing.

However, money market models of implied expectations in NZ are generally only useful over a horizon of up to 12 months. We use implied forward rates from models of the full yield curve, those of Nelson and Siegel (NS), and Svensson,[106] to analyse longer-term market expectations. While there is a plethora of complex models, NS is more parsimonious, and imposes a lower requirement on data. This is important for modelling the NZ commercial bank liability curve as there are relatively few data points on the yield curve with which to estimate the model.[107]
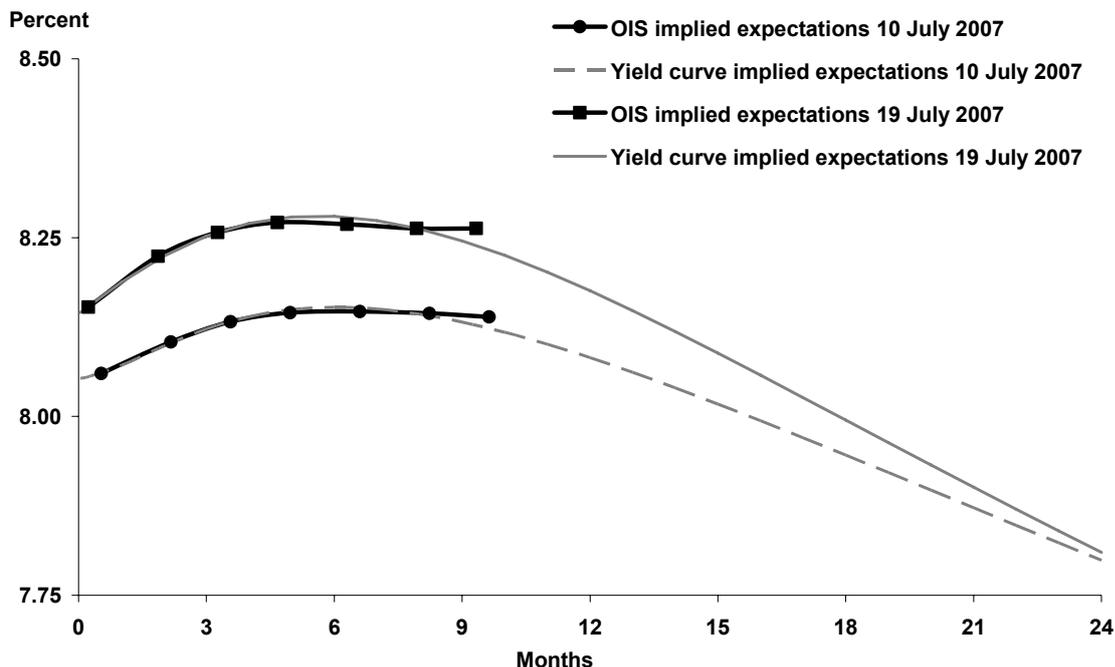
The chart below shows that interest rate expectations implied by the NS model increased over most of the 2-year horizon ahead in response to the stronger than expected data mentioned above. Expectations regarding the length of time before the chance of a rate reduction also lengthened.

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[106] See Nelson, CR and AF Siegel (1985), "Parsimonious modelling of yield curves for US Treasury bills", *NBER Working Paper Series*, no 1594, and Svensson, LEO (1994), "Estimating and interpreting forward interest rates: Sweden 1992-4", *NBER Working Paper Series*, no 4871.

[107] Using the commercial bank liability curve to estimate the yield curve means that a risk premium must be subtracted from the implied overnight forward curve so that this can be interpreted as a policy rate expectation curve.

Yield curve implied Official Cash Rate expectations

Using OIS and the NS model with an estimated risk adjustment

Percent

- OIS implied expectations 10 July 2007
- Yield curve implied expectations 10 July 2007
- OIS implied expectations 19 July 2007
- Yield curve implied expectations 19 July 2007

Months

Models such as NS describe the yield curve in terms of three broad components – slope, curvature and long-run (or asymptotic) level. Recent research in the macro-finance literature suggests that most of the information in yield curves can be summarised by models that represent the curve using these three factors.[108] For market intelligence purposes, these three factors are useful and intuitive given that trades commonly made by market participants are based on views around level, slope and curvature.

Another way of considering a distribution of expectations around implied market pricing is to look at survey data on analyst forecasts (see the chart below). These forecasts can differ substantially from market pricing, so they are usually compared and contrasted with market pricing. In the example below, both the median of analyst forecasts and market prices were revised up substantially following the stronger data.

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[108] There is a growing literature in this area in which yield curve models are joined with small macroeconomic models. See, for example, Ang, A and M Piazzesi (2003), "A No-Arbitrage Vector Autoregression of Term Structure Dynamics with Macroeconomic and Latent Variables", *Journal of Monetary Economics*, 50, 745–787.

The range of analyst forecasts for the Official Cash Rate

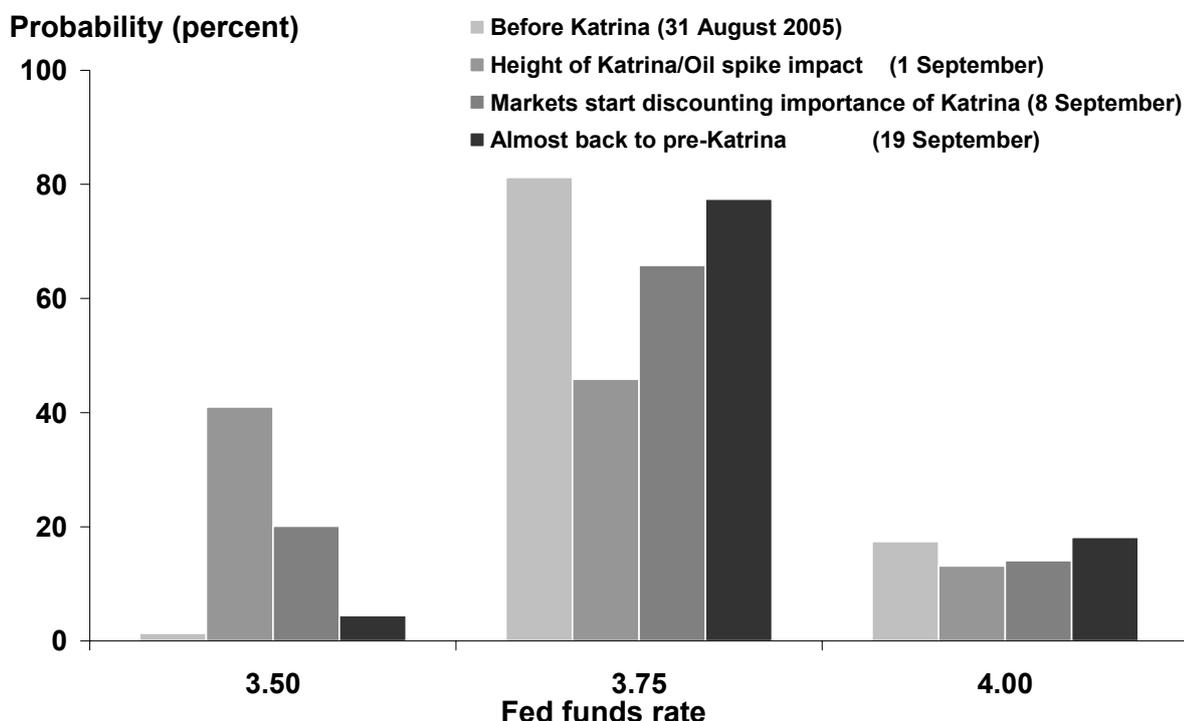Reuters survey of analysts and market prices, 6 December 2007
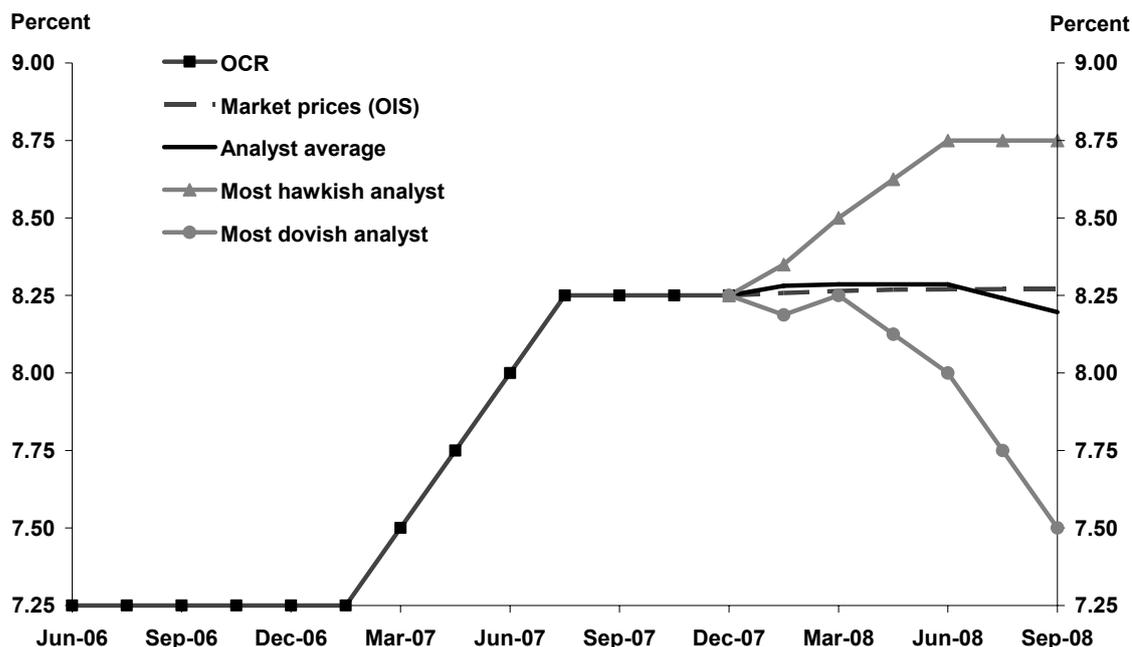
In markets where exchange-traded options on money market instruments exist, it may be possible to estimate a distribution of market expectations for upcoming policy decisions direct from options prices. An example is expectations regarding US Federal Reserve policy.[109] A distribution of future policy expectations is particularly useful for understanding market pricing when there is substantial uncertainty in markets over the future course of policy, or market expectations are skewed. Of course, the mean of the distribution should equal the point estimates implied by models of expectations that use OIS or futures rates. The example below shows an estimate of the distribution of Fed funds futures before and after Hurricane Katrina and the associated oil price spike that created uncertainty in market expectations of future Fed policy. We regularly use a variety of expectations models, including the Fed funds options model shown below, to assist in building a market-based interpretation of economic developments in several of the major global economies.

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[109] A model proposed recently by researchers at the Federal Reserve Bank of Cleveland provides a tractable method of extracting a distribution of expectations on future Fed funds decisions using the prices of options on Fed funds futures. See Carlson, JB, BR Craig and WR Melick (2005), "Recovering Market Expectations of FOMC Rate Changes with Options on Federal Funds Futures", *Working Paper 05/07*, Federal Reserve Bank of Cleveland.

**Fed funds rate, September FOMC –
distribution of market expectations**

Implied by the prices of options on the
September 05 Fed funds futures contract

Probability (percent)

■ Before Katrina (31 August 2005)
■ Height of Katrina/Oil spike impact   (1 September)
■ Markets start discounting importance of Katrina (8 September)
■ Almost back to pre-Katrina   (19 September)

Fed funds rate

5.   Market expectations and reactions survey

Ahead of each policy announcement,[110] we conduct a tactical survey of traders on the market's expectations regarding the policy announcement, and likely reactions to market-generated hypothetical scenarios around the policy decision and accompanying statement. These scenarios are based on what markets see as "least market reaction", "plausible dovish", and "plausible hawkish" policy announcements.

The purpose of the survey is twofold: (i) to inform the Bank on how to frame and communicate policy in a way that will be credible to markets, accurately convey the Bank's policy assessment, and achieve desired market pricing around the policy outlook; and (ii) to guide the Bank as to what market pricing the announcement can and cannot achieve.

The market-generated hypothetical scenarios are not intended to be prescriptive, but are intended to be informative in the policy development and communication process. As Blinder[111] notes, "*Should central bankers listen to the markets? Yes, in the sense that we should all listen to news broadcasts; but not in the sense that children should listen to their mothers*". Armed with an understanding of the distribution of views around current market pricing, the Bank can interpret how markets are likely to react to the "news" component of the policy announcement. If the announcement is likely to surprise the market, the survey

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[110] OCR decisions in March, June, September and December are accompanied by a press conference and a Monetary Policy Statement that includes a brief policy assessment and four chapters of commentary, analysis and projections. OCR Reviews in January, April, July and October are released as an interest rate decision and brief policy assessment only, by newswire.

[111] Blinder, AS (2006), "Monetary policy today: sixteen questions and about twelve answers", *Central Banks in the 21st Century*, Bank of Spain.

provides the information on which to base an interpretation of by how much and in what direction interest rates and the NZ dollar will move.

The survey itself is conducted by telephone[112] or email, and focuses on four areas:

- What OCR expectation is priced in by the market for the next and future OCR announcement dates?

- What OCR decision and statement would generate the least market reaction, and if some market reaction is unavoidable under that scenario, what would it be?

- What OCR decision and statement would constitute a plausible hawkish scenario under which market interest rates would increase? How would interest rates react across the yield curve, and how would currency markets react?

- What OCR decision and statement would constitute a plausible dovish scenario under which market interest rates would decrease? How would interest rates react across the yield curve, and how would currency markets react?

Under each hypothetical scenario, we distil how markets expect the Bank to: (i) view recent economic data; (ii) express its key concerns going forward; and (iii) express its policy outlook. In doing so, we also build a profile of what kind of participants are active in NZ interest rate and currency markets, of their views and positioning, and of whether market views across types of participant are concentrated, broadly dispersed or polarised. The table below provides a hypothetical example of the qualitative survey results.[113]

**Stylised example: how traders characterise
a hawkish, least market reaction, and dovish announcement**

| Hawkish	Least market reaction	Dovish
Raise the OCR by 25 basis points and suggest that "further tightening is *likely*".	**Raise the OCR by 25 basis points and suggest that "further tightening *cannot be ruled out*".**	**Leave the OCR unchanged, and note that "while some upside risks remain, recent increases in the OCR are likely to dampen domestic demand sufficiently".**
Here we provide phrases which traders would expect to see in a statement consistent with the hawkish scenario, and which would trigger market interest rates to increase in line with the estimates in the next chart.	**Here we provide phrases which traders would expect to see in a statement consistent with the least market reaction scenario, having the impact on interest rates in line with the estimates in the next chart.**	**Here we provide phrases which traders would expect to see in a statement consistent with the dovish scenario, and which would trigger a decrease in market interest rates in line with the estimates in the next chart.**

We also interpret traders' quantitative estimates of currency, money and capital markets' reactions to the three hypothetical policy scenarios, and represent these graphically (see the chart below). Combined with traders' perceived likelihood of these scenarios, these estimates give the Bank a distribution of views around current market pricing.

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[112] Respondent institutions are selected to provide a representative sample of significant or price-making participants in the money markets (primarily bank bill futures and OIS), and the wholesale capital market (interest rate swaps). The survey is aimed at ascertaining traders' views of the expectations in these markets, and as such, respondent individuals are usually either traders or asset managers with direct participation in the markets of interest. To incorporate the views of currency market participants, NZ dollar traders are also included.

[113] To foster open communication with traders, individual responses to the survey are confidential, and are not included in the report prepared on the survey results.

**A stylised version of traders' impression of the
likely market reaction to the OCR scenarios**[114]

OCR expectations based on OIS rates, without a term premium

Policy announcement dates
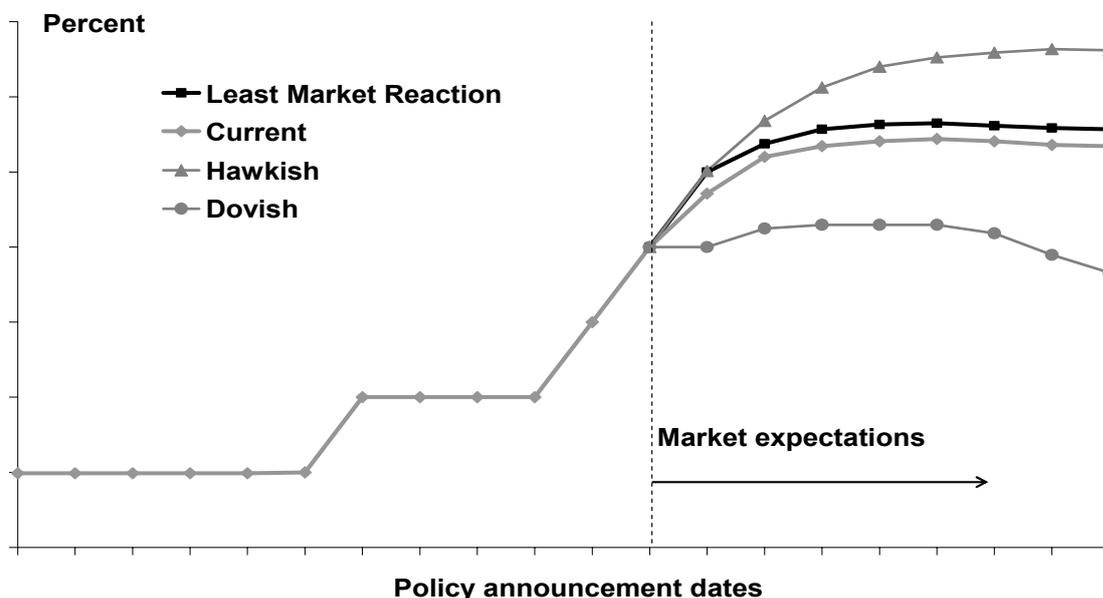
Of course, there are potentially significant communications risks inherent in conducting the survey and having detailed discussions with market participants in close proximity to an interest rate decision. These risks are mitigated in several ways. We interview experienced market professionals with whom we maintain long-standing relationships. These respondents are well informed on the context and purpose of the survey, and the questions we ask the respondents follow the same four key areas in each survey.

# 6.   Incorporating market information into macroeconomic modelling

Standard macroeconomic models used for monetary policy analysis incorporate quantitative financial market variables – usually a short-term and a long-term interest rate, an exchange rate, economically important commodity prices and a domestic equity market index. Some models incorporate implied quantitative information such as policy rate expectations or risk premia. Given the richness of quantitative and qualitative information that can potentially be obtained from financial markets, standard macroeconomic models incorporate only a limited amount directly. However, the process around the use of monetary policy models in central banks often incorporates a great deal of financial market information.

In the model used at the RBNZ, key financial market variables include the 90-day bank bill rate, the yield on 5-year interest rate swaps, the NZ Trade Weighted Index (TWI, representing the exchange rate), foreign interest rates, and several commodity prices. Most of these variables are largely exogenous to the model, the exception being the 90-day interest rate projection. The RBNZ model differs from most models used by central banks, which take the path of short-term interest rates as exogenous, as a constant, or as implied by money market interest rates.

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[114] This is a stylised mock-up of the chart in which we provide quantitative estimates of the market reactions to each scenario, and does not resemble the outcome of an actual survey, or the RBNZ OCR.

Our 90-day interest rate projection for three years forward is disclosed to markets in the MPS, and reflects the interest rate path needed to maintain inflation within the target band over the policy horizon, based on the information available and the Bank's current views of the economic and inflation outlook. The interest rate track can be market moving information if the projection differs from market expectations, to the extent that traders interpret the projection as suggestive of the Bank's policy bias. During the policy process, the 90-day interest rate projection is compared with market interest rates and policy expectations. This provides an understanding of how the model deviates from current market pricing, and a measure of how the MPS may surprise markets. Following the MPS release, we observe the market reaction to interpret the extent to which market pricing has been influenced by the announcement, and the degree of consistency between market prices and the projected short-term interest rate. The chart below shows the 90-day interest rate projection compared with the bank bill futures pricing immediately following the policy announcement for each December MPS from 1998 to 2006.

Market pricing and the projected 90-day interest rate
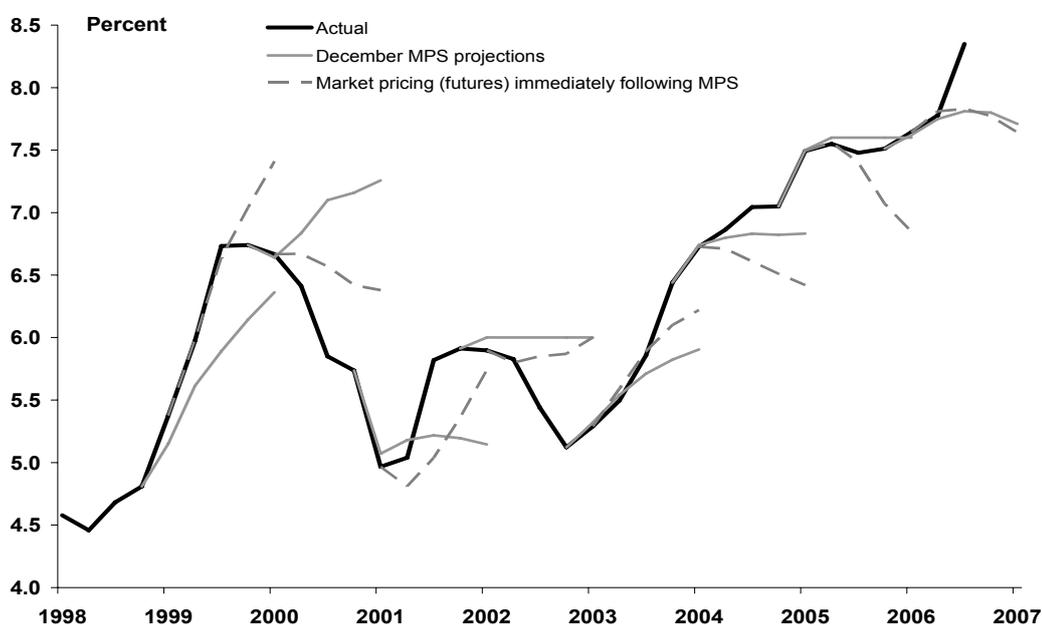
We also use the endogenous interest rate projections within the model to quantify the relative impact on inflation pressures emanating from new economic information received since the previous forecast round. This serves as a useful tool for focusing the MPC's discussion on the most significant developments. The market reaction to these surprises, that is the change in implied policy rate expectations, provides a cross-check against the model's interpretation of the marginal effect of each piece of data on the policy and inflation outlook.

An important exogenous variable in the model is the trade-weighted exchange rate. Although the specification of the future TWI path is a technical assumption, it often garners much attention from market participants. Accordingly, it is important to understand this assumption in the context of market expectations. We compare the assumed path of the TWI with analyst expectations (see the chart below).

Analyst forecasts of the TWI and the June MPS assumption
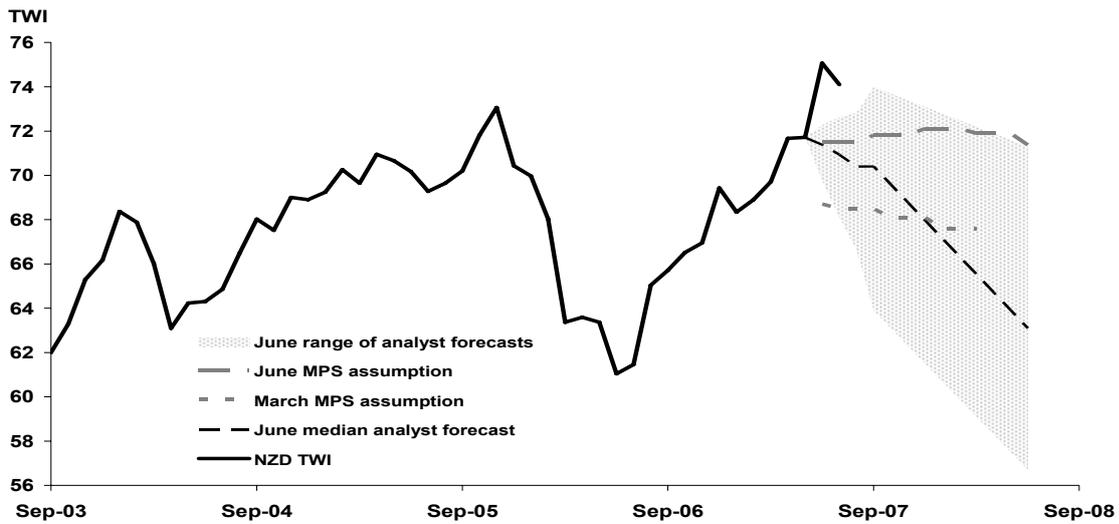
Another way to evaluate our foreign exchange rate assumption is to compare it with options implied market expectations. Unfortunately we cannot do this for the TWI itself, as the index is not actively traded in over-the-counter options markets. However, we can analyse options implied market expectations of the largest component of the TWI, the NZ dollar/US dollar exchange rate. We estimate risk neutral probability density functions[115] as a guide to the distribution of currency expectations around current spot and forward exchange rates.[116] The chart below shows the probability of a 10 percent appreciation or depreciation in three months time relative to the three month forward NZD/USD exchange rate.

Probability of a 10 percent move in the NZD/USD exchange rate in 3 months
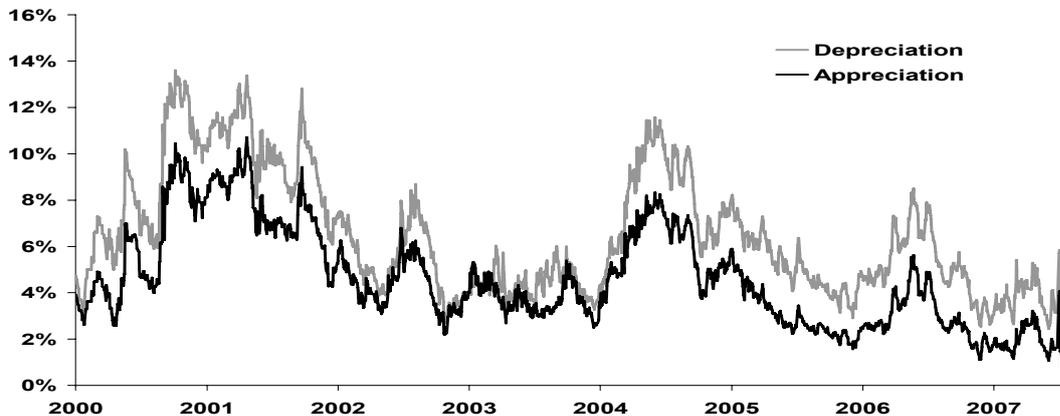
Beyond the financial market variables that enter the RBNZ model directly, financial market information is used to: (i) set the context within which the modelling of global and domestic

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[115] Risk neutral probability distributions are considered consistent with observed market prices under the assumption that market agents are risk neutral. Risk aversion means that the options implied distributions deviate from the "true" probability distribution that market participants attach to different outcomes of the underlying asset's price because options implied expectations also reflect risk-taking preferences.

[116] Noting that forward foreign exchange rates reflect interest rate differentials between the two currencies, and given persistently positive NZ-US interest rate differentials, the NZD/USD forward rate is likely to be biased toward depreciation relative to "true" expectations.

macroeconomic conditions is discussed at MPC meetings; (ii) guide and cross-check the assumptions made in macroeconomic modelling; (iii) cross-check the projections derived from the model; (iv) highlight and guide the evaluation of discrepancies between the projections and market expectations; and (v) guide understanding of the risks around the projections. As Hildebrand notes, "*Financial variables may contain information that can contribute to the projection or they may raise questions about the projection*".[117] While assumptions and projections may not necessarily be intended to reflect market or analyst expectations, discrepancies between market expectations and model variables are examined closely in the monetary policy process.

Conclusion

While there is a great deal that can be achieved with desk-based financial market research, we believe market intelligence involving direct contact with market participants through strong long-term relationships adds an invaluable dimension to our analysis. In our experience, the benefits of a dedicated team of market analysts with direct market contact lie in the ability to incorporate well structured analysis and interpretation of market developments, via rigorous economic and financial frameworks, into monetary policy formulation.

A constant challenge in market surveillance is to ensure analysis remains focused on gaining strong insights into the activity and functioning of markets. We need to discover and communicate the essence and motivation of flows and positioning undertaken by the various market players, as opposed to merely reporting market movements and reaction to economic releases. We continue to broaden and deepen our experience in this area, mainly by extending and strengthening our relationships with market participants; further developing our quantitative tools for analysing yield curves, market expectations of policy rates and other economic/financial variables, and risk premia; adding to our information resources by extending market surveys and obtaining more information via the settlement and depository systems we operate; and improving information flows from other parts of the Bank.

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[117] Hildebrand, Philipp M (2006), *Monetary Policy and Financial Markets*, Swiss National Bank.