The changing transmission mechanism of New Zealand monetary policy

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This is the second of two *Bulletin* articles on the transmission mechanism of New Zealand monetary policy. In the first article (Drew and Sethi 2007), we described this mechanism, detailing the process by which changes in the Reserve Bank's primary monetary policy instrument, the Official Cash Rate (OCR), eventually influence the general level of prices. This article examines how certain aspects of the transmission mechanism have changed over time. Assessing these changes is especially topical given that, in the estimation of some commentators, the most recent period of monetary tightening has witnessed policy that has been less effective at dampening inflation than previously. We briefly review the case for these claims and catalogue evidence from several sources to show that the overall impact of monetary policy on activity and inflation has not obviously weakened, and that some intermediate links in the mechanism may have, in fact, strengthened over the past decade.

1 Introduction

In Drew and Sethi (2007), we described the process by which changes in the Reserve Bank's primary monetary policy instrument, the Official Cash Rate (OCR), eventually influence the general level of prices. In this article, our focus turns to assessing how this process, known as the transmission mechanism of monetary policy, may have changed over time. This is an especially topical exercise given that the present economic cycle and monetary response have exhibited characteristics that have led to some concern about the efficacy of New Zealand monetary policy.

Specifically, we look at several intermediate links in the mechanism, assessing possible changes in either the strength of response of one variable to changes in another, or in the timing with which this response occurs. Consistent with the approach in Drew and Sethi (2007), we organise the discussion in this article around a stylised representation of the transmission mechanism (Figure 1). In Drew and Sethi (2007), we identified 17 intermediate links in a detailed representation of the mechanism, such as "from the OCR

to wholesale short-term interest rates" and "from effective mortgage rates to house prices". In this article, the flow chart is somewhat less comprehensive, featuring fewer links because gaps in available research or data permit conclusions on only a subset of the intermediate links identified in our first article.

In figure 1, links that are deemed to have become stronger over time are mapped in solid lines, weaker ones in dotted lines, and those that have remained largely unchanged in dashed lines. Green lines continue to represent the interest rate channel of the transmission mechanism, blue lines denote the effect of changes in the exchange rate, and red lines refer to effects related to inflation expectations. The numbers next to the links provide easy reference to points in the discussion below.

For each of the links considered, the evidence presented in this article is based on either (a) available academic or internal Reserve Bank research, or (b) the three economic models used to study the transmission mechanism in Drew *et al.* (2008). These models are summarised in Box 1.[2] Note that the various analyses differ in their data definitions and sample periods, and an element of judgement is necessary when aggregating this evidence. Consequently, we are conservative in our conclusions here, defaulting to the view

[2]   Though the transmission mechanism of New Zealand monetary policy has been widely studied using a range of economic models, there is a paucity of prior research that addresses changes in the mechanism over time.

Figure 1

Changes in the transmission mechanism of New Zealand monetary policy
(elements not examined in this article are not shown)
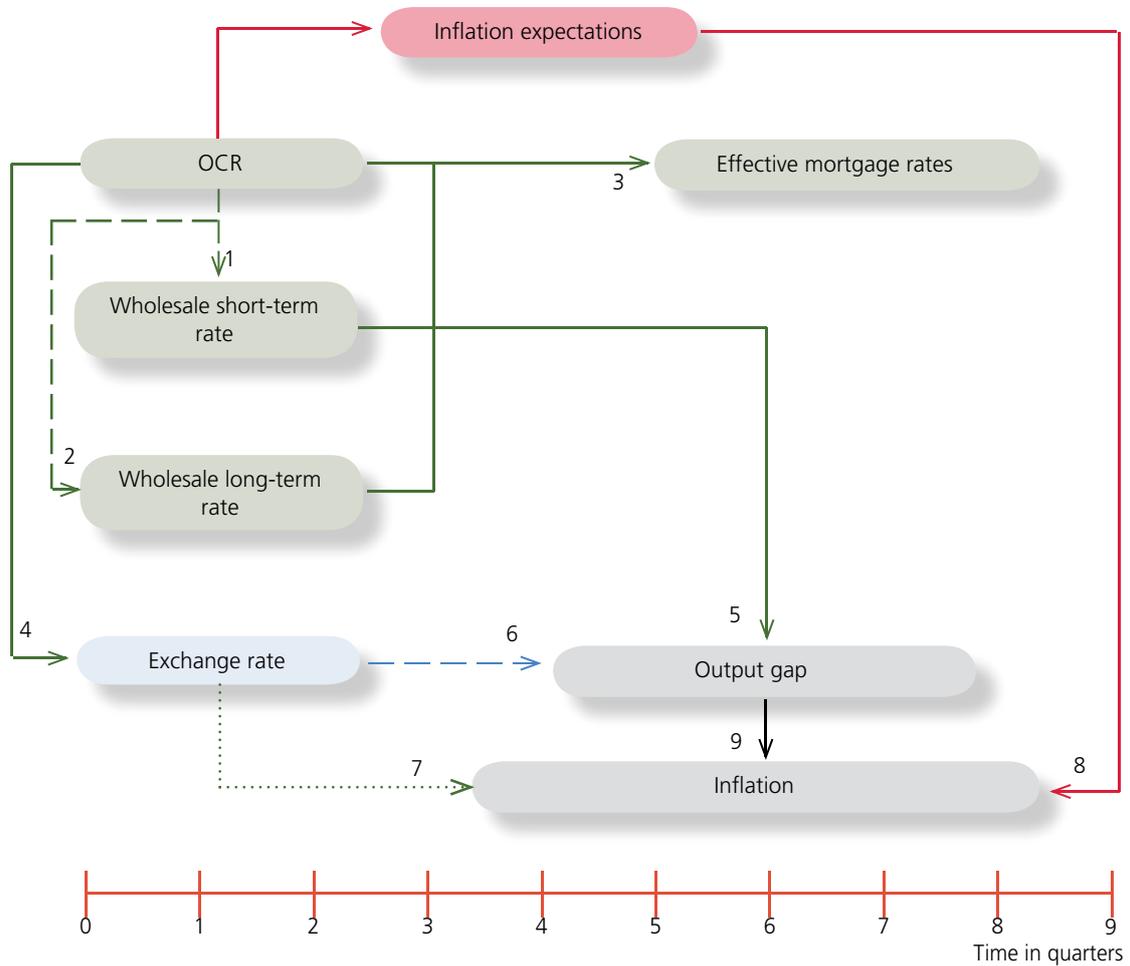
that a link is broadly unchanged over time, unless the bulk of evidence suggests otherwise.

To set the context, we briefly review the transmission mechanism in section 2, together with an overview of the major public causes for concern about the efficacy of recent monetary policy. In section 3, we present evidence on the changing influence of monetary policy on market wholesale and retail interest rates, and on the exchange rate. Section 4 looks at the impact of these financial prices on real activity. Section 5 documents changes in the relationship between aggregate activity and inflation, a link commonly known as the Phillips Curve.

2   A brief review of the transmission mechanism of New Zealand monetary policy

In this section, we review the transmission mechanism using the example of a monetary tightening (an increase in the OCR) that is aimed at dampening projected future inflationary pressure, as in Drew and Sethi (2007). Opposing effects may generally be expected in the event of a decrease in the OCR, though there is likely to be significant variation in timing and magnitude.

An unanticipated increase in the OCR tends to result in increases in other wholesale and retail interest rates for both short- and long-term maturities. These interest rate increases reduce the present values of income streams from a variety of assets such as bonds, equities and real estate,

and lead to lower prices for these assets. Debt servicing costs and rewards to saving increase on the back of higher interest rates, and combine with lower asset values to limit credit available to households and firms. Higher interest rates, being an increase in the 'price' of using money now rather than later, effectively increase the current price of any dollar-denominated expenditure relative to its future cost. Consequently, households and firms face incentives to postpone current consumption and investment, reducing current aggregate demand for goods and services. Finally, if this new level of aggregate demand declines relative to the economy's supply capacities, inflation pressures may be expected to ease.

The second major channel for the transmission of monetary policy is through the exchange rate. An unanticipated increase in the OCR immediately appreciates the New Zealand dollar, as higher domestic interest rates attract foreign capital. In theory, the foreign currency price of New Zealand dollars should be bid-up to a level such that the expected depreciation from that point on is just sufficient to leave an investor indifferent between holding assets denominated in New Zealand dollars and in the foreign currency.

A higher exchange rate implies a lower New Zealand dollar price for foreign-produced goods and services. These lower prices are normally passed on through the supply chain, lowering prices of both intermediate goods and final goods such as those measured in the Consumers Price Index (CPI). A higher exchange rate also renders export-oriented and import-competing firms less competitive, reducing their earnings and again dampening overall domestic activity and inflation pressures.

The final channel through which monetary policy influences prices is through inflation expectations. If households and firms are convinced of a central bank's commitment to an inflation target, and of its ability to meet this target, then they are likely to respond to a change in monetary policy by adjusting their own expectations of future activity and inflation. On anticipating changed economic conditions in the future, they are likely to modify current levels of consumption and investment, and their strategies for setting prices and bargaining for wages.

These three channels – interest rates, exchange rates and inflation expectations – comprise the transmission mechanism of monetary policy. Drew and Sethi (2007) detail the role played by several intermediate variables along each channel.[3]

Major features of the current business cycle, and the role of monetary policy

Since emerging from a brief recession in the late 1990s, New Zealand has enjoyed both the longest and strongest uninterrupted expansion in aggregate economic activity in the post-war period. In recent years, the strong growth has been accompanied by an unemployment rate low by historical and international standards, inflationary pressures stemming from private domestic demand and capacity constraints, and increasing rates of public and private investment. There have been large increases in asset prices, especially for real estate between 2001 and 2007. These domestic drivers of growth have been supported by international factors such as increasing commodity export prices, low costs of capital, and, until relatively recently, a substantial and increasing appetite for risk. The primary response of monetary policy to elevated inflationary pressures is seen in an OCR that is now, at 8.25 percent, 3.25 percent higher than it was at the start of the tightening cycle in March 2004.[4]

Large macroeconomic imbalances have accompanied the expansion in the form of record current account deficits, substantial declines in the household saving rate, an exchange rate that has been widely considered to be exceptionally and unjustifiably overvalued, and a concentration of growth in sectors of the economy relatively sheltered from international competition.

These patterns in New Zealand's recent economic performance have prompted public concern about the role

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[3] Some authors have described a fourth channel in the transmission mechanism relating to credit creation by banks and financial intermediaries in response to changes in monetary policy settings. See Bernanke *et al.* (1999).

[4] Note that real interest rates, measured as the excess of the overnight interbank cash rate over annual CPI inflation, ranged between 3.6 and 3.9 percent between March 2004 and September 2006, and peaked at 6.4 percent in September 2007.

Table 1

The changing transmission mechanism: a summary of findings comparing the strength and timing of intermediate links in the 2000s with the 1990s.

No.	Link	Strength	Timing
1	From monetary policy to short-term wholesale rates	Unchanged	Slightly longer
2	From monetary policy to long-term wholesale rates	Unchanged	Longer
3	From monetary policy to effective mortgage rates	Somewhat stronger	Longer
4	From monetary policy to the exchange rate	Likely stronger	More persistent
5	From interest rates to the output gap	Stronger	Slightly longer
6	From the exchange rate to the output gap	Unchanged	–
7	From the exchange rate to CPI inflation	Weaker	Slightly quicker
8	From inflation expectations to inflation	Stronger	–
9	From the output gap to inflation	Possibly stronger	–

of monetary policy and its recent conduct. Our study of changes in the transmission mechanism specifically addresses two of these concerns. First, changes in the OCR are thought to have provoked disproportionately large changes in the exchange rate in recent years, a claim based principally on the low levels of international risk aversion that have been observed since 2002. There is a risk premium associated with investments in NZD-denominated assets, representing the additional payment required to compensate investors for possible future exchange rate depreciations.[5] With reduced aversion to bearing risk, investors pay less regard to the possibility of future depreciations, and face added incentives to engage in 'carry trades' wherein they borrow in currencies with low financing costs to purchase NZD-denominated assets that offer higher yields.

Some observers have raised another important concern about the recent effects of monetary policy. They perceive that the transmission of monetary policy from changes in the OCR to changes in domestic activity and inflation has weakened as a whole. Several reasons have been proposed in support of this conjecture. For example, low international interest rates and increasing capital markets integration may each have limited the ability of the Reserve Bank to independently influence longer-term domestic interest rates. Also, there has been a growing substitution away from floating rate mortgages to longer-term fixed rate

products, owing both to lower longer-term wholesale rates and to margin compression amongst mortgage lenders on fixed mortgage rates. Some commentary also suggests the Reserve Bank was unable to convince market participants of the underlying strength of inflation pressures in the early part of the current tightening cycle, and consequently changes in the OCR had less influence on longer-term rates than usual.[6]

The remainder of this article presents evidence to show that the overall impact of policy on activity and inflation has not obviously weakened, and in some ways, has strengthened over the past decade relative to the 1990s. Table 1 presents a summary of results discussed below.

There is one important caveat to the exercise: the changing transmission mechanism is likely to be due not just to the changing impact of one intermediate variable on another, but also to the changing nature of the random fluctuations (or shocks) that buffet an economy over time.[7] It can be difficult to perfectly account for the relative contributions to changes in the mechanism from these two causes.

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[5]   Major reasons for this currency risk premium include: the relatively small and relatively undiversified nature of the New Zealand economy, and the persistent macroeconomic imbalances and low national saving rate noted above.

[6]   The other major concern about the recent impact of monetary policy is not addressed in this article. This relates to the observation that, in a cycle where the bulk of inflationary pressure has been sourced in the domestic economy, monetary policy has been poorly targeted, with sectors exposed to the exchange rate bearing the brunt of the burden of reducing inflation.

[7]   For example, some economists attribute the 'Great Moderation' – the period of relatively high growth and low inflation in the US since the mid-1980s – to a sequence of beneficial supply shocks (such as improved productivity from increased use of computers or the rise of China as an efficient manufacturing base) rather than to better monetary management.

Box 1

The economic models in Drew *et al.* (2008)

Many of the conclusions in this paper are based on the findings of Drew *et al.* (2008), a recent Reserve Bank Discussion Paper. Here, we summarise the main features of the three economic models used by the authors to study the transmission mechanism.

The Reserve Bank's Forecasting and Policy System (FPS) has been used as the primary tool for producing the Bank's published forecasts since 1997. It features a dynamic adjustment process that determines how inflation and other variables return to their long-run equilibrium values following an economic shock, and is calibrated to match certain characteristics of the New Zealand business cycle.[8] In turn, the long-run equilibrium is based on a framework of utility-maximising consumers and profit-maximising firms. Although the underlying structure is largely unchanged since the inception of FPS, the dynamic adjustment paths have been heavily adjusted over time. These adjustments, or recalibrations of the model, are prompted by evidence from both sectoral and aggregate-level research, and by judgement on changes in economic structure, and on the propagation of economic shocks. As such, the comparison of different calibrations of FPS over time offers a very convenient synthesis of the Reserve Bank's changing views on various macroeconomic relationships.

The second model used to study the transmission mechanism in Drew *et al.* is a vector auto-regression, or VAR. The defining characteristic of a standard VAR is that it presupposes little formal theory for specifying relationships between variables. Instead, it is assumed that the future path for a variable depends simply on its own history and that of other variables in the model.[9] The VAR in Drew *et al.* features core macroeconomic variables such as inflation, output, interest and exchange rates, and others such as indices of climatic conditions.

The third model considered in Drew *et al.* is small, featuring only five variables. This 'New Keynesian' model is a variant of a type widely used in academic research for assessing monetary policy, as it captures many features of the macroeconomic data in a reasonably parsimonious manner. The relationships between variables are motivated by general equilibrium (or whole-economy) theory, and are internally consistent, allowing the authors to form tentative conclusions about why the transmission mechanism may have changed over time. New Keynesian models can feature one or more different sources of inflexibility that cause variables to adjust slowly in response to an economic shock, and motivate an important role for expectations of future inflation and output in determining the dynamic behaviour of the economy.

Assessing change

The three models in Drew *et al.* use different methods to assess changes in the transmission mechanism. Results from FPS rely on comparing properties of the different vintages of the model from 1997, 2002 and 2007. In contrast, the VAR and New Keynesian models are estimated on New Zealand data, and the changing intensities of the relationships between variables are captured in the changing magnitudes of the estimated parameters in the model equations. Specifically, the VAR uses the method of rolling regressions wherein the model is initially estimated on data from 1989 (September quarter) to 1996 (June quarter). Data from additional quarters until the end of the available sample are successively added, and the model is re-estimated on each successively larger sub-sample. Though rolling regressions yield continuous estimates of changes in economic relationships, these estimates can be volatile, as they are sensitive to individual observations that may or may not be in a given sub-sample. More importantly, the method is backward-looking in that it relies solely on past observations and ignores the information content of future data in estimating a model at a given point in time.

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[8]   See Black *et al.* (1997) for detail on the structure of the FPS.

[9]   The precise assumed dependencies between variables will vary from one VAR model to another. Some extensions, known as structural VARs, motivate contemporaneous relationships from economic theory. See Hamilton (1994) for more on these models.

A technique known as the Kalman filter provides an elegant solution to the problem of estimating relationships that may change over time. It yields smooth estimates of parameter changes, makes use of the full available sample of data, and is relatively insensitive to individual observations.[10] Drew *et al.* use this method to estimate their New Keynesian model.

Accordingly, we base our conclusions on evidence from multiple sources, including from economic models that make different assumptions about the structure of the New Zealand economy and the nature of these shocks.

3 Changes in monetary policy and the effect on financial prices

Following an actual or expected change in the OCR, financial asset prices, such as interest and exchange rates, are first to respond. It is important that these prices respond suitably as they, in turn, affect other asset prices, and real activity and inflation at later stages in the monetary transmission process. As a recent example, rapidly increasing house prices contributed to strong growth in household consumption in the five years to the end of 2007, and were considered to be important contributors to inflationary pressure over the period. As such, in a series of *Monetary Policy Statements* beginning in December 2005, the Reserve Bank was increasingly pointed in noting that a slowdown in house price growth was needed to weaken the case for further interest rate increases. In this section, we look at whether the effect of OCR increases on wholesale and mortgage interest rates was smaller over this period than previously observed, and so failed to contribute to an easing of the rapid increase in house prices in a timely fashion. We also consider the changing impact of monetary policy on the exchange rate.

Interest rates

1 2 Schmidt-Hebbel (2006) looks at monetary policy transmission in New Zealand over the period 1990 to 2005. He focuses on a sub-sample from 1998 to 2005 to determine whether monetary policy and its effects display similar characteristics in this period as in the full sample. In response to a change in monetary policy, Schmidt-Hebbel finds that though monetary policy has significant bearing on 10-year government bond rates in both the full- and the sub-sample, the differences between the samples are small.

Recent 'event analysis' at the RBNZ suggests that since the start of the decade, changes in the OCR have had a significant impact on wholesale interest rates.[11] A hypothetical monetary policy surprise of 1 percent is estimated to prompt one-year forward swap rates to increase by 0.9 percent for settlement one year ahead and by 0.3 percent for settlement five years

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[10] Originally devised for applications such as tracking spacecraft in the 1960s, the Kalman filter is widely used in engineering, aeronautics and communications. Since the mid-1990s, it has also become an essential tool in economic research for retrieving information from noisy or even partially missing data, for estimating economic models, and for smoothing time series by incorporating information from past as well as future data.

[11] See Drew and Karagedikli (2008) and Karagedikli and Siklos (2008). An event analysis, which attempts to isolate the impact of the surprise component of an economic event, is thought to be a more robust way of identifying the impact of monetary policy and other economic developments on financial market prices than the traditional time-series approaches above, and has become an increasingly popular tool in international research.

[12] Swaps are financial instruments that allow counterparties to manage risk, usually by achieving a better match between their assets and liabilities. A forward swap is an instrument that is negotiated at the present juncture, for settlement at a point in the future, and which matures several periods further into the future. The interest rates on these instruments are benchmark wholesale interest rates.

ahead.[12] Event analysis studies require very high frequency data; the required intra-day daily data used in the Bank's research is only available from around 2001. However, in formal robustness checks, the authors of these studies do not find evidence of instabilities in their regressions, as might have been the case if the impact of monetary policy had changed materially since 2001.

For additional perspective over a longer period, we estimate some simple regressions linking changes in monetary policy and short- and long-term wholesale interest rates. As these regressions are estimated over a long sample from 1992, we use changes in interest rates on 90-day bank bills as a proxy for changes in monetary policy settings.[13] Generally, we find that volatility in wholesale interest rates has decreased since about 2000, and that there has been no systematic decline in the total impact of changes in monetary policy on these interest rates. However, comparing estimates from the past five years with those from 1992 to 2002, it appears that more distant changes in monetary policy settings have exercised greater influence on long-term wholesale interest rates relative to more recent changes. In other words, changes in policy settings now take a little longer to flow through to these wholesale interest rates.

3 Liu *et al.* (2007) estimate the degree and speed of response of retail interest rates to changes in policy-controlled rates between 1994 and 2004. They find that, following the introduction of the OCR in 1999, floating interest rates on mortgages and deposits respond more strongly to changes in monetary policy, while fixed interest rates do so more slowly and by less. Tripe *et al.* (2005) also examine the impact of the introduction of the OCR, and reach a similar conclusion that the long-term impact of wholesale rates on floating mortgage rates increased in the post-OCR period, while the impact on fixed mortgage rates decreased slightly. Pais (2007) reaches different conclusions

using weekly data, finding that both floating and fixed mortgage interest rates adjust fully in the long run, but that floating rates do so very slowly.

Between 2005 and 2007, the share of outstanding mortgages on floating interest rate terms declined from 42 percent to 30 percent. Meanwhile, the value of outstanding mortgages on contracts fixed for two years or more increased from 11 percent to 32 percent. There seems to be little doubt that the present cycle witnessed a change in preferences for mortgage borrowing towards the fixed-rate contracts, causing the effective mortgage rate to increase more slowly in response to tighter monetary policy.

The overall assessment from this evidence is ambiguous: it seems that the response of wholesale and mortgage interest rates is more or less unchanged in recent years when compared to the 1990s, but that this response occurs more slowly.

Exchange rates

4 Drew *et al.* (2008) study changes in the transmission mechanism using FPS, the Reserve Bank's core model for producing macroeconomic forecasts. As witnessed by changing FPS calibrations, Drew *et al.* report that the Reserve Bank perceives the exchange rate response to a change in monetary policy to have been stronger and more persistent in 2007 than in 2002 or 1997. This is seen in figure 2, which documents impulse response functions from the three vintages of FPS – that is, the figure maps the changing response of the exchange rate to a unit increase (an impulse) in monetary-policy-controlled interest rates.

Two smaller models considered by Drew *et al.* offer conflicting evidence on changes in this relationship, with the VAR finding support for an unchanged link, and the New Keynesian model suggesting that the impact of a policy tightening on the exchange rate declined over the 1990s, but has increased since 2002.[14] Exchange rate behaviour is notoriously difficult to pin down accurately, and we are inclined to favour evidence from the changing

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[13]   The dependent variable in the regressions is the monthly change in the interest rate on one-year forward swaps for settlement one year ahead (a proxy for short-term wholesale interest rates), and the comparably transformed interest rate on one-year forward swaps for settlement five years ahead (as a proxy for long-term) wholesale interest rates. The regressions are estimated using a Kalman filter with time-varying parameters, and simple diagnostics indicate that the residuals are well behaved.

[14]   Results from the events analysis research cited earlier indicate that an (unanticipated) 1 percent increase in the OCR leads to a 3.5 percent increase in the NZD-USD exchange rate.

FPS calibrations, which aggregates information from a wide range of internal Bank research and from staff judgement as the economy evolves.

Figure 2
According to FPS, the response of the exchange rate to changes in monetary-policy-controlled interest rates has increased over time.
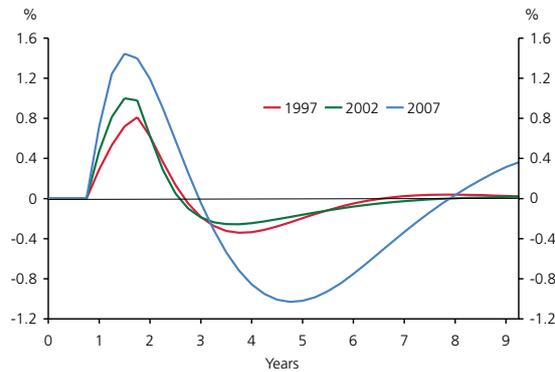
## 4   The changing impact on real activity

As wholesale and retail interest rates increase in response to tighter monetary policy, they prompt households and firms into reassessing their consumption and investment decisions, reducing aggregate demand. In this section, we look at how links from the exchange rate to real activity and from wholesale and retail interest rates to real activity have changed over time.

5 Studying the characteristics of a medium-sized model of the New Zealand economy, Schmidt-Hebbel (2006) finds that the output gap – a measure of excess demand – declines in response to higher short-term interest rates. Interestingly, this decline is small and not statistically different from zero when the model is estimated on a sample from 1992 to 2005, but does become larger and statistically significant when the sample is restricted to the period 1998-2005.

From figure 3, we see that successive recalibrations of FPS have increased the restraint that interest rates exercise on aggregate demand, with much of the increase coming from greater sensitivity of business investment to interest rates. The two smaller models in Drew *et al.* are again in

some disagreement on changes in this relationship, with the VAR suggesting that the response of the output gap is mildly weaker, and the New Keynesian model favouring the interpretation that the impact of interest rates on output growth is significant across the entire sample period (between 1992 and 2007), but strongest towards the end both in terms of the initial response and the persistence of this response.[15]

Figure 3
According to FPS, the impact of interest rates on output has become somewhat stronger and a little delayed over time.
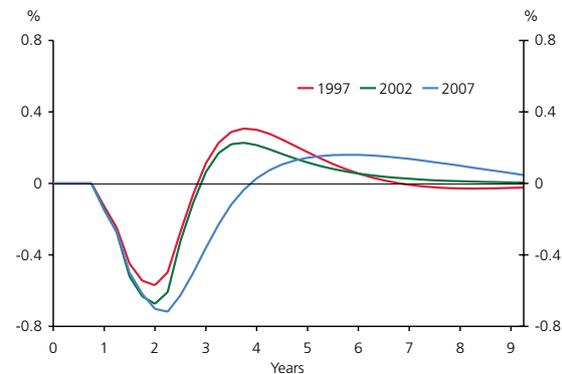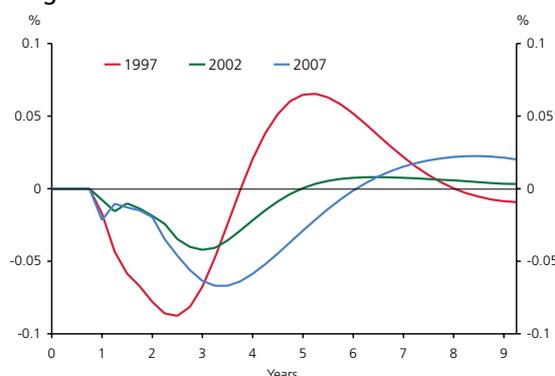

6 Comparing FPS calibrations over time, Drew *et al.* report that a temporary exchange rate appreciation was thought to have had a large and rapid impact on export and import demand in 1997, causing overall demand pressures to decline quickly too. In the 2002 vintage of FPS, these effects are muted and delayed, becoming somewhat stronger again, though further delayed, in 2007 (as seen in figure 4). On the other hand, estimates from the two smaller models suggest that the output response to changes in the exchange rate has been small across the entire sample. Though the effect is estimated to be small by both models, they do differ in that the VAR model indicates that a stronger exchange rate actually generates a very mild positive impact in output from about 2001, while the New Keynesian model reports a more conventional negative response, and one that becomes only marginally stronger over time.

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[15] According to this model, a 1 percent increase in the real interest rate now reduces the output gap by around 0.4 percent in the long-term.

Figure 4

FPS suggests output now responds more slowly to changes in the exchange rate than previously. The effect is small and is mostly unchanged in magnitude since 1997.

Figure 5

FPS suggests pass-through of the exchange rate to CPI inflation declined between 1997 and 2002, remaining largely unchanged since.

5   The changing Phillips curve

The Reserve Bank's view of the inflation process can be represented by a Phillips curve – inflation arises when aggregate output increases beyond an economy's supply capacities. Modern versions of the Phillips curve also postulate an important role for expectations of future inflation in determining current inflation.[16] More elaborate formulations include dependencies on exchange rates, oil and commodity prices, and trading partner inflation.

7 FPS recalibrations suggest that the total impact of the exchange rate on CPI inflation, also called exchange rate pass-through, declined between 1997 and 2002, and has remained largely unchanged since. This total impact can be decomposed into two sub-effects: the impact of the exchange rate on import prices and the subsequent pass-through from import prices to CPI inflation. Comparing the responses of CPI and non-tradable inflation from FPS, it appears that the latter effect has been dominant. For example, the CPI inflation responses are fairly similar in the 2002 and 2007 vintages of FPS, yet non-tradable inflation troughs lower in the 2007 vintage. Hence, the second sub-effect, from import prices to CPI inflation, is likely to have been the dominant contributor to the overall decline in pass-through.
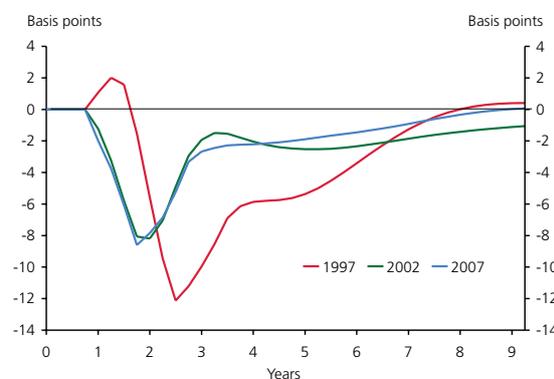
Figure 6 documents some estimates of long-run responses, and essentially captures the changing magnitude of the coefficients in the Phillips curve. These long-run responses are calculated conditional on the assumption that there is no change in monetary policy settings that aims to offset these effects. We see that the New Keynesian model also reports lower overall pass-through for the most part, except in very recent years when it finds for increased pass-through (panel (b) of figure 6). According to this model, in the absence of a monetary policy response, a 10 percent depreciation in the exchange rate today eventually leads to a long-term increase in inflation of around 0.6 percent, compared with an increase of 1.2 percent in the early 1990s.[17]

8 Another major conclusion that we can draw from the New Keynesian model in Drew *et al.* is that inflation became increasingly forward-looking over the sample period. The decline in inflation persistence was steady over the 1990s and has levelled off since 2001. Overall, these results are fairly consistent with FPS recalibrations, and, all else equal, imply an increase in the effectiveness of monetary policy.

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[16] Given that true expectations cannot be observed, modern Phillips curves can be cast in several different forms. Some include past inflation as a proxy for expected inflation, others include survey measures and many macroeconomic models assume that households and firms form rational expectations that fully incorporate all available information.

[17] Researchers report the stylised facts that countries with credible anti-inflationary policies experience lower pass-through to CPI inflation, that pass-through is associated with lower inflation expectations, and that it increases with volatility in inflation and exchange rates (see Campa and Goldberg (2002) and Engel (2002)). Possible microeconomic reasons for declining pass-through include: a change toward invoicing trade in goods and services in New Zealand dollars; increased shares of distribution costs in the price of imports, which provide for greater opportunities for margin compression; a changing mix of goods and services imported into New Zealand over time; and increasing use of sophisticated exchange rate hedging arrangements.

Figure 6
The changing Phillips curve
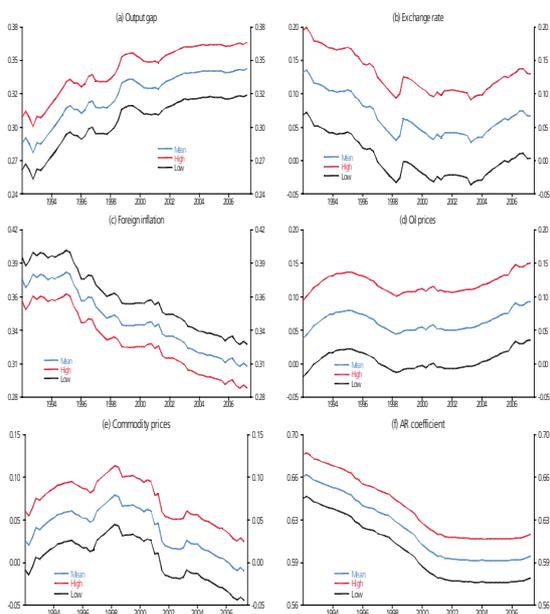
Note: In the New Keynesian model in Drew *et al.*, inflation is specified as a function of the variables in this figure, and we see the changing long-run impact on CPI inflation (assuming that there is no monetary policy response) of (a) the output gap, (b) the exchange rate, (c) trading partner inflation, (d) oil prices, and (e) commodity prices. Panel (f) shows the coefficient on lagged inflation.

9 The model also indicates that the relationship between excess demand and inflation became a little stronger over the 1990s and has stabilised since 2002. Assuming no further response from monetary policy, a 1 percent decrease in the output gap today eventually leads to a decrease in inflation of around 0.35 percent. The rise in this long-term effect is due to an increasing coefficient on the output gap in the Phillips curve, which has been tempered somewhat by the decline in inflation persistence.

In summary, the most important development in the Phillips curve over the past 15 years appears to be the increasing importance of expectations in determining current inflation. To translate this observation into a well-known 'lesson' for monetary policy: though the increasingly dominant role of expectations means that policy can accomplish more with smaller changes to interest rates, it remains crucial to ensure that these expectations remain well anchored to the inflation target.

6   Conclusion

Some concern has been raised about the effectiveness of recent monetary policy in relation to its influence on the exchange rate, and with respect to the overall impact on activity and inflation. On the basis of evidence presented in this article, especially that from the analysis of three different models of the New Zealand economy, we find that there has been no discernible change in the overall influence of monetary policy on inflation in the present economic cycle. However, we find some evidence of changes over time in the strength and timing of the various relationships that are intermediate in the transmission of the OCR to inflation.

First, changes in monetary-policy-linked interest rates are reflected in wholesale interest rates to at least the same degree as in the 1990s, though perhaps with increased delay. Second, even though the exchange rate is estimated to respond more to changes in monetary policy settings, it is also estimated to have become a somewhat less consequential determinant of output and inflation in itself. In other words, much larger changes in the exchange rate are now required to effect a given change in output and inflation, and it appears that monetary policy settings are indeed prompting these larger changes in the exchange rate. Meanwhile, the inflation process has become more forward-looking, with expectations of future inflation becoming more important in determining current inflation.

In summary, we conclude that there has been some re-weighting in the relative burden of macroeconomic adjustment borne by the different channels of the transmission mechanism. Transmission through interest rates remains vital and effective, but eventuates with longer lags. The exchange rate channel has become more important over time: the exchange rate itself responds to a greater degree but, for a given unit of change, generates smaller responses in output and inflation than previously. Overall, the transmission mechanism remains effective, and monetary policy continues to eventually influence the general level of prices.

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