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A happy “halfway-house”? Medium term inflation targeting in New Zealand*

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Abstract

The 2002 Policy Targets Agreement (PTA) between the Reserve Bank of New Zealand and the government asks the Reserve Bank to target inflation “over the medium term” rather than over an annual target. This medium term objective shifts inflation targeting towards a “half-way house” between inflation targeting and price level targeting. Extending the inflation averaging horizon to the medium term improves the inflation-output tradeoff by influencing inflation expectations. But how long should the medium term be? Characterizing the New Zealand economy with a small new-Keynesian model, we show that the happiest halfway house is located around a two or three year averaging horizon which leads to mild, but non-trivial, improvements in the efficiency of monetary policy.

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1 Introduction

Many central banks target inflation, seeking stability and low volatility in the rate of change in the price level. Most inflation targeting central banks aim to stabilize inflation around a low (0-3 percent) annual rate.

Inflation targeting has been preferred to price level targeting which seeks stability and low variation in the price level. Under price level targeting, periods of positive inflation must be followed by periods of deflation to maintain stability in the price level whereas inflation targeting does not require offsetting bygone shocks to the price level. Price level targeting can produce better macroeconomic outcomes than inflation targeting. (Svensson 1999b) shows that if the government delegates a price level target, this results in lower short-run inflation volatility compared to inflation targeting.¹

Of course, the choice of regime is not binary. The government could ask the central bank to target a medium term average of inflation over several quarters. Under medium term inflation targeting, periods of above target inflation must be followed by periods of below target inflation if the medium term inflation target is to be maintained. Medium term inflation targeting represents a middle ground between price and inflation targeting. Indeed, strict inflation targeting approaches price level targeting when the central bank targets inflation averaged over a large number of periods.

The gains from optimal delegation are a function of the underlying model of the economy and in particular, the role for forward-looking agents (Dennis and Söderström 2005; Nessén and Vestin 2005). Nessén and Vestin (2005) show that gains accrue from medium term inflation targeting in a model with forward and backward looking arguments. The question of how long the medium term should be depends on the empirical model of the economy. The objective of this paper is to identify the optimal averaging horizon for a small open economy

¹Minford and Peel (2003) argue price level targeting improves output stability without the assumption that monetary policy is conducted under discretion.

inflation targeter, and to quantify the benefits of pursuing medium term inflation targeting.

The model is applied to New Zealand, which proves a pertinent test case for several reasons. First, New Zealand’s legislative framework prescribes instrument but not goal independence to the central bank, closely matching the notion of optimal delegation within the literature. The 2002 Policy Targets Agreement (PTA) between the Reserve Bank of New Zealand (RBNZ) and the government, asks the central bank to target inflation “over the medium term” – precisely the policy we examine in this paper. Finally, New Zealand adopted explicit inflation targeting in February 1990 and thus also offers the longest run of data available, relative to other explicit inflation targeters.

Section 2 details New Zealand’s monetary policy framework. Section 3 details the model and the dynamics of key variances across alternative inflation averaging horizons. Section 4 presents the results of optimal delegation experiments. Concluding comments are provided in section 5.

2 New Zealand’s Monetary Policy Framework

2.1 Optimal Delegation

The legislative framework at the core of New Zealand’s inflation targeting regime establishes instrument but not goal independence for the central bank. The government’s problem is to delegate the optimal set of objectives — encapsulated in the PTA — that the RBNZ is required by law to achieve.²

²The Governor can be fired if these objectives are not met.

The *central bank’s problem* is to set the interest rate to minimise the intertemporal loss function. This can be represented:

$$\min_{u_t} E_0 \sum_{t=0}^{\infty} \beta^t L_t^{cb} \quad (1)$$

E_0 is the expectation operator at time $t = 0$, β is the discount factor, and u_t is the monetary policy instrument, most typically the interest rate. The period loss function L_t^{cb} is a quadratic loss function that penalizes deviations of key macroeconomic variables from targets which can be represented:

$$L_t^{cb} = y_t' Q^{cb} y_t + u_t' R^{cb} u_t \quad (2)$$

where u_t is the instrument and y_t are the state variables. The Policy Targets Agreement captures a subset of state variables.³

The *government’s problem* is to minimise society’s loss function by choosing the variables and parameters of the period loss function to pass to the central bank. This can be represented as the following:

$$\min_{Q^{cb}, R^{cb}} L_t^s = y_t' Q^s y_t + u_t' R^s u_t \quad (3)$$

In the seminal delegation paper, Rogoff (1985) used this formulation to show that the government should appoint a relatively inflation-conservative Governor. Other researchers have exploited other forms of delegated loss functions. For example, Jensen (2002) exploits nominal income targeting and Walsh (2003) uses a loss function that includes the change in the output gap to improve the inflation-output tradeoff

³Note that the PTA is expressed in terms of volatilities of macroeconomic variables and not objectives in the levels such as full employment. The quadratic function approximates volatility with the variances of key macroeconomic variables.

by inducing policy inertia. Lees (2003) shows that there exist substantial gains from optimal delegation for the New Zealand economy. In our paper we examine a particular form of delegation — medium term inflation targeting.

2.2 Multiple objectives

Although the current PTA contains multiple stabilisation objectives, earlier PTAs specified strict inflation targeting with little consideration of output stabilisation objectives. Bernanke, Laubach, Mishkin, and Posen (1999) note that in the early period, multiple objectives were seen as weakening the transparency and accountability of the Reserve Bank. Archer (1997) states that the policy rule in place before March 1995:

“...prohibits monetary policy from active consideration of output and employment as objectives in their own right.”

However, the 2002 PTA explicitly adopted multiple stabilisation objectives:

“In pursuing its price stability objective, the Bank shall implement monetary policy in a sustainable, consistent and transparent manner and *shall seek to avoid unnecessary instability in output, interest rates and the exchange rate.*”

with emphasis added. To capture these stabilisation objectives, we append equation (3) to include arguments that contain output and interest rate stabilisation. Although Nessén (2002) finds an equivalence between targeting inflation over a longer horizon and more output stabilization, Vestin (2005) shows a price level target is beneficial and not conditional on the weight on output stabilisation. (We ignore

exchange rate stabilisation which is treated in Lees 2003.) Society’s loss function thus contains the following arguments:

$$L_t^s = \bar{\pi}_t^2 + \lambda_1 \tilde{y}_t^2 + \lambda_2 i_t^2 \quad (4)$$

where \tilde{y}_t is the output gap, i_t is the nominal interest rate and $\bar{\pi}_t$ is annual inflation. Note that the loss associated with the interest rate and output gap variances is expressed relative to the variance in annual inflation.⁴

Rather than specify a precise numerical representation of the loss function, results are traced out under four loss function representations: (i) the baseline case, where $L_t^s = \bar{\pi}_t^2 + \tilde{y}_t^2 + 0.25i_t^2$; (ii) an activism case, where $L_t^s = \bar{\pi}_t^2 + \tilde{y}_t^2 + 0.01i_t^2$; (iii) less output stabilisation, where $L_t^s = \bar{\pi}_t^2 + 0.5\tilde{y}_t^2 + 0.25i_t^2$; and (iv) inflation conservatism, where relatively less weight is attached to output stabilisation and interest rate stabilisation, $L_t^s = \bar{\pi}_t^2 + 0.5\tilde{y}_t^2 + 0.01i_t^2$.

2.3 Medium term inflation targeting

New Zealand’s inflation targeting structure has evolved to targeting inflation over a medium term average of inflation. While earlier PTAs (March 1990, December 1990, 1992, 1996, 1997, 1999) specified an annual target for inflation, the 2002 PTA states:⁵

“...the policy target shall be to keep future CPI inflation outcomes between 1 per cent and 3 per cent *on average over the medium term.*”

⁴The PTA stipulates that the policy target should be over future inflation outcomes. The forward-looking intertemporal loss function in equation (1) is consistent with the obligations inherent in the PTA and also with the broader literature.

⁵The Policy Target Agreements are available at <http://www.rbnz.govt.nz/monpol/pta>.

with emphasis added. However, the medium term is not defined within the Policy Targets Agreement.

One interpretation of a medium term inflation target implies that the central bank can no longer let inflation ‘bygones-be-bygones’, but must condition policy on recent inflation outcomes. Grimes (2000), considers a five year averaging target and explains:

“...an averaging target such as this is also a ‘half-way house’ towards a move to price level targeting: if inflation is 4% in the first year of the new term, then it must average less than 2.75% for the remaining four years (for a 0-3% average target range).”⁶

Such an average inflation targeting loss function can be expressed:

$$L_t^{cb} = \bar{\pi}_{j,t}^2 + \lambda_1 \tilde{y}_t^2 + \lambda_2 i_t^2 \quad (5)$$

where $\bar{\pi}_{j,t}$ is average inflation:

$$\bar{\pi}_{j,t} \equiv \frac{1}{j} \sum_{s=0}^{j-1} \pi_{t-s} \quad (6)$$

The subscript j on the inflation rate denotes the averaging horizon that is implemented for inflation. Each t represents a quarter, so an annual inflation measure sets $j = 4$. Note that equation (5) balances not letting ‘bygones-be-bygones’ with output and interest rate stabilisation objectives. We seek the optimal j for the government to delegate to the central bank for a range of stabilisation objectives. But first, we lay out the constraint on the central bank’s behaviour — the model of the economy.

⁶The Svensson (2001) report subsequently recommended adopting an explicit medium-term target for annual inflation.

3 The Model

3.1 Theoretical model

Our goal is to evaluate the impact on the economy of materially different, alternative monetary policy regimes. In light of the Lucas critique, one needs a model with a structure that is policy-invariant to credibly evaluate changes in the policy regime.

We note that the core structural elements of recent new-Keynesian models are: (i) a forward-looking component in the aggregate demand equation derived from the consumption Euler equation (McCallum and Nelson 1999); (ii) forward-looking behaviour in the Phillips curve equation, derived either from wage-contracting behaviour on the part of firms and workers (Batini and Haldane 1999 or Fuhrer 1997), or from firms’ price mark-up behaviour (Galí and Gertler 1999) and (iii) an uncovered interest rate parity condition based on no opportunities for arbitrage in foreign exchange markets.

However, purely forward-looking models match the data poorly. Instead, habit formation on the part of consumers (see Abel 1990 or Fuhrer 2000) and backward-looking behaviour on the part of firms and workers (see Roberts 1997) can be introduced into structural models to generate persistence in output and inflation to match the data.

The theoretical model given below is a hybrid model that contains both forward- and backward-looking elements. In addition, we appeal to some inertia in decision making on the part of agents (Svensson 2000), such that interest rates affect inflation with a two period lag via the standard channel.

Although the parameters in the model are not deep parameters derived explicitly from optimising agents, the similarity in form to optimising models should yield some immunity to the Lucas critique, given the small magnitude of the policy shift we consider.⁷ The model can thus

⁷Rudebusch (2005) shows the reduced form representation of plausible forward-looking models

be represented:

$$\tilde{y}_t = \beta_1 E_t \tilde{y}_{t+1} + \beta_2 \tilde{y}_{t-1} - \beta_3 r_{t-1} - \beta_4 q_{t-1} + \varepsilon_{\tilde{y}t} \quad (7)$$

$$\pi_t = (1 - \alpha_1)\pi_{t-1} + \alpha_1 E_t \pi_{t+1} + \alpha_2 \tilde{y}_{t-1} + \alpha_2 \Delta q_{t-1} + \varepsilon_{\pi t} \quad (8)$$

$$\Delta q_t = \gamma(r_t - r^w) + \varepsilon_{qt} \quad (9)$$

where q_t is the real exchange rate, r_t is the real interest rate (defined as $i_t - \pi_t$) and r^w is a constant real world interest rate. All the coefficients are positive according to theory.

3.2 Empirical model

The model is estimated over most of the inflation targeting period from 1990Q1 to 2003Q2. The output gap is formed by Hodrick-Prescott (HP) filtering real gross domestic product (production). The *expected* output gap is proxied by applying the HP filter to the expected output gap series from the RBNZ Survey of Expectations series, which asks correspondents, with time $t - 1$ information, their expectation of GDP at time t . Inflation is an adjusted weighted median measure of inflation, while inflation expectations are proxied by the RBNZ Survey of Expectations series which asks correspondents at time $t - 1$ their expectation of the end of quarter CPI. Both the output gap and inflation expectations series are rated forward one period to match the expectation of the variable at time $t + 1$ based on time t information. The nominal interest rate is the 90-day interest rate. The exchange rate is the real trade-weighted index (TWI). All data are demeaned prior to estimation.

The empirical model is estimated by OLS. We assume that the survey data approximates model rational expectations which reduces the identification problems associated with the model given monetary policy

appear policy invariant for the magnitude of changes in policy rule observed in US data. We view the policy changes considered in the paper as smaller than the Volcker disinflation and thus the model with forward-looking terms is likely to be policy invariant.

lags. Associated p -values are presented beneath the coefficient estimates. With one exception, insignificant coefficients are removed.

$$\tilde{y}_t = \underset{(0.000)}{0.878} \tilde{y}_{t-1} - \underset{(0.000)}{0.088} r_{t-1} + \varepsilon_{\tilde{y}t} \quad (10)$$

$$R^2 = 0.766, \quad \sigma_{\varepsilon_{\tilde{y}}} = 0.0081, \quad DW = 1.825$$

$$\pi_t = \underset{(0.002)}{0.457} \pi_{t-1} + \underset{(0.002)}{0.543} E_t \pi_{t+1} + \underset{(0.081)}{0.129} \tilde{y}_{t-1} - \underset{(0.547)}{0.026} \Delta q_{t-1} + \varepsilon_{\pi t} \quad (11)$$

$$R^2 = 0.408, \quad \sigma_{\varepsilon_{\pi}} = 0.0084, \quad DW = 2.076$$

$$\Delta q_t = \underset{(0.022)}{0.430} (r_t - r^w) + \varepsilon_{qt} \quad (12)$$

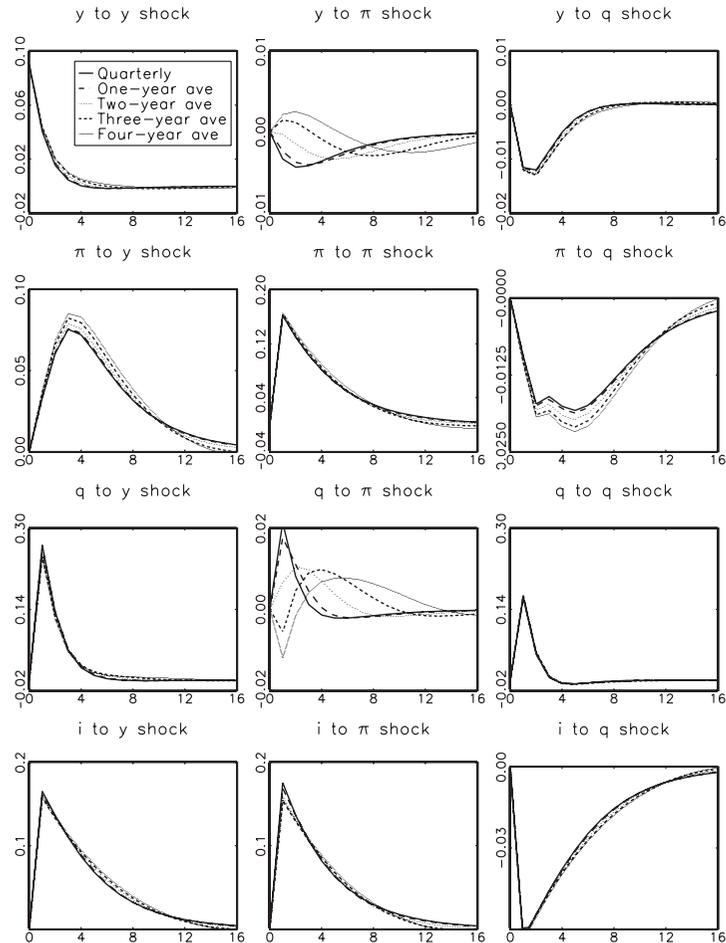
$$R^2 = 0.402, \quad \sigma_{\varepsilon_q} = 0.0280, \quad DW = 1.252$$

Both the real exchange rate and the forward-looking aggregate demand component were insignificant in the aggregate demand equation. Although the change in the real exchange rate is insignificant within the Phillips curve, equation (11), we persist with this representation of the economy and explore alternative exchange rate channels in section 4.3. All other parameters are correctly signed according to theory, although the coefficient on the uncovered interest rate parity equation is relatively low compared with the no-arbitrage condition (i.e. the coefficient should be 1 according to theory). Furthermore, the exchange rate error terms appear autocorrelated.

3.3 Model dynamics

The impulse responses of the output gap, inflation, and the interest rate to positive one standard deviation shocks from inflation, output, and the real exchange rate are presented in figure 1, for a range of averaging horizons.

Figure 1
Impulse Responses: New Zealand 1990q1 to 2003q2



The dynamics are intuitive. Output, inflation, the exchange rate and interest rates increase in response to an output shock; inflation and the interest rate increase in response to an inflation shock; and output, inflation and the interest rate fall in response to a positive shock that leads to an appreciation of the exchange rate. There are some small differences in the dynamics across horizons.

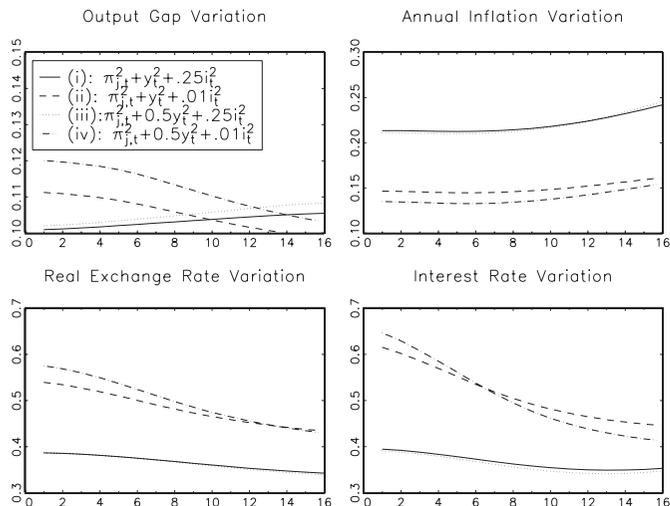
An inflation shock has the largest impact on a period-on-period (i.e. quarterly) measure of inflation. Across longer horizons, the effect of the inflation shock is mitigated across all periods within the averaging horizon. This allows the central bank to implement less aggressive policy, lowering interest rate volatility, and causing output to fall less than with a shorter averaging horizon. However, the extended interest rate path keeps output below trend for longer.

An interesting feature is the similarity of the impulse responses for inflation up to approximately 6 periods following each shock. The impulse response functions only begin to diverge when period-on-period inflation gets close to zero. For a longer averaging horizon, byones are no longer byones; inflation in later periods must be below target to counter the above target inflation in earlier periods. As the averaging horizon is lengthened, an increasing number of past periods are incorporated into the central bank's inflation average. Following periods of above target inflation, there must be a greater degree of below-target inflation, to move average inflation close to target.

3.4 The role of the averaging horizon

The averaging horizon plays a role in determining the standard deviations of the goal variables. These standard deviations are traced out in figure 2 with the averaging horizon on the x-axis. The averaging horizon ranges from period-on-period inflation targeting ($j = 1$), through annual inflation targeting ($j = 4$), and out to a four-year horizon for inflation ($j = 16$). The volatilities differ depending on the central

Figure 2
Volatility across policy horizons



bank's reaction function, which is of course, a direct function of the loss function specified by the government.

Variation in annual inflation increases for all loss functions as the averaging horizon is extended because such variation matters less for the central bank's loss function.⁸ However, variation in *average* inflation falls as the averaging horizon increases.

At shorter averaging horizons ($j < 10$), a greater weight on output stability is associated with higher period inflation volatility. For longer averaging horizons ($j > 10$), greater output stabilisation is associated with lower period inflation volatility. As the weight on output increases, the importance of driving inflation below target is reduced.

⁸It is, however, average inflation that appears in the delegated loss function.

Because the central bank does not need to respond as aggressively relative to single period inflation targeting, variation in the interest rate decreases with increases in the averaging horizon.⁹

Output gap variation depends on the weight attached to interest rate stabilisation. With a low weight on interest rate stabilisation, variation in the output gap increases when the averaging horizon is extended. When the weight on interest rate stabilisation is high, the variance of the output gap decreases at longer averaging horizons. Extending the averaging horizon also leads to decreased volatility in the interest rate. The overall effect of extending the averaging horizon is to increase output gap volatility.

Extending the averaging horizon leads to a reduction in the inflation goal variable, that is, inflation averaged across the averaging horizon. Variation in the goal variables translates into numerical values for the loss that the central bank, incurs. The intertemporal loss values for various loss function specifications are presented in table 1.

Table 1
RBNZ losses under alternative averaging horizons

j -period	$L_t = \bar{\pi}_{j,t}^2 + \lambda_1 \tilde{y}_t^2 + \lambda_2 i_t^2$			
	$\lambda_1 = 1.0, \lambda_2 = 0.25$	$\{1.0, 0.01\}$	$\{0.5, 0.25\}$	$\{0.5, 0.01\}$
1	10.94	5.06	10.28	4.23
4	8.96	3.54	8.29	2.74
8	7.25	2.52	6.55	1.79
12	6.28	1.99	5.57	1.33
16	5.91	1.70	5.27	1.09
Loss reduction	45.9%	66.3%	48.7%	74.1%

NB Loss function weights are presented in brackets at the top of each column.

Table 1 shows that extending the averaging horizon decreases inflation volatility, that is, average inflation will be closer to target. The increase in inflation and interest rate stability outweighs the decrease in output

⁹The exception is when there is a low weight on output stabilisation and the policy horizon is short Nessén (2002).

stability. Removing the weight on interest rate stability produces large decreases in loss.

However, our interest is in evaluating the benefit of average inflation targeting from society’s perspective, not from the perspective of the central bank. We seek to identify the reduction in society’s loss when the government delegates an optimal averaging horizon. The following section addresses this question.

4 Results

Our experiment investigates whether targeting an averaging horizon that is different to society’s can decrease society’s loss under discretion-based policy. Nessén (2002) shows that targeting an averaging horizon longer than society’s horizon has two opposing effects: (i) policy is less aggressive because individual shocks are smoothed over the entire inflation horizon; and (ii) policy is more aggressive because bygones are no longer bygones and the policymaker must have regard for past inflation outcomes.

4.1 Optimal delegation over the averaging horizon

The variances and associated losses for the range of loss function specifications are presented in table 2 below for the baseline model.

Extending the averaging horizon is not particularly effective in reducing the loss that society incurs. Across the four loss functions considered, the maximum gain from extending the averaging horizon is a 3.45 percent reduction in society’s loss. This occurs under the inflation conservative loss function, (where $L_t = \pi_{j,t}^2 + 0.5\tilde{y}_t^2 + 0.01i_t^2$, in the last section of the table) when the averaging horizon is over two years.

Dennis and Söderström (2005) argue the percentage difference in society’s loss has little immediate economic interpretation and advocate

an alternative “inflation equivalent” metric. This metric is the the permanent deviation of inflation from target that would make society indifferent between the welfare measures evaluated (see also Jensen 2002), that is:

$$\hat{\pi} = \sqrt{L_s - L_g}. \quad (13)$$

where L_s is society’s loss when the central bank minimises society’s loss under discretion and L_g is society’s loss when the central bank minimises the loss function delegated by the government under discretion. Under this metric, the inflation equivalent improvement in welfare is 0.351 inflation percentage points or 35.1 inflation basis points.¹⁰ The benefits to society from the government delegating an optimal medium term inflation objective are approximately equal to a permanent deviation of inflation from target of one-third of one percentage point.

When the central bank places a minimal weight on interest rate stability, a two-year average proves the best averaging horizon. With increased preference for interest rate stability ($\lambda_2 = 0.25$) a three year average is the best averaging horizon, but again the percentage gains from moving from lengthening the annual averaging horizon are small.

Our results show a two or three year inflation horizon is optimal and yields some small gains in terms of reducing the volatility of key macroeconomic variables. A shorter averaging horizon does not improve the inflation-output tradeoff identified by Nessén and Vestin (2005). A longer horizon is not useful because the improvement in the inflation-output tradeoff is counterbalanced by a definition of inflation that is increasingly divergent from society’s preferences over annual inflation.

¹⁰

The calculation is $0.35 = \sqrt{3.565 - 3.442}$ to 2 decimal places.

Table 2
Societal Loss Under Optimal Delegation: Baseline Model

j	$\sigma_{\tilde{y}}^2$	σ_{π}^2	σ_i^2	L_t	$\% \Delta L_t$
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$$L_t = \pi_t^2 + 0.5\tilde{y}_t^2 + 0.01i_t^2$$

1	0.013	0.021	1.367	3.69	-3.62
4	0.013	0.021	1.124	3.57	0.00
8	0.013	0.022	0.784	3.44	-3.45
12	0.012	0.024	0.588	3.54	-0.70
16	0.011	0.028	0.485	3.81	6.93

$$L_t = \pi_t^2 + 0.5\tilde{y}_t^2 + 0.25i_t^2$$

1	0.011	0.061	0.245	16.73	1.03
4	0.011	0.061	0.227	16.56	0.00
8	0.012	0.063	0.196	16.29	-1.63
12	0.012	0.068	0.171	16.25	-1.87
16	0.012	0.074	0.155	16.55	-0.06

$$L_t = \pi_t^2 + \tilde{y}_t^2 + 0.01i_t^2$$

1	0.011	0.024	1.377	4.38	2.78
4	0.012	0.024	1.170	4.26	0.00
8	0.011	0.024	0.885	4.13	-2.98
12	0.011	0.026	0.719	4.19	-1.64
16	0.010	0.029	0.628	4.39	3.12

$$L_t = \pi_t^2 + \tilde{y}_t^2 + 0.25i_t^2$$

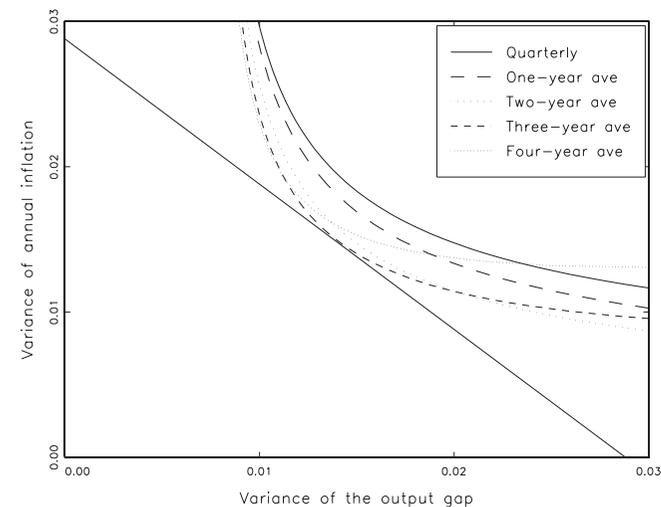
1	0.011	0.061	0.251	17.34	0.93
4	0.011	0.061	0.234	17.18	0.00
8	0.012	0.063	0.204	16.92	-1.51
12	0.012	0.067	0.179	16.87	-1.80
16	0.012	0.073	0.163	17.14	-0.23

NB j is the averaging horizon. Values in bold indicate the lowest value of society's loss given society's loss function.

4.2 A graphical representation

To show the effects of extending the averaging horizon, variance frontiers that chart annual inflation and output gap volatility for different averaging horizons are depicted in figure 3. To reduce the problem to a two dimensional space, a zero weight is placed on interest rate stability (such that the loss function is $L_t = \pi_{4,t}^2 + \lambda_1 \tilde{y}_t^2$) and variances are traced out for a range of weights on output stabilisation.

Figure 3
Variance Frontiers



Note that many of the variance frontiers cross. This is the manifestation of two effects, each of which dominate under different conditions. First, there is the improvement in the inflation-output trade-off as the averaging horizon is extended that Svensson (1999a) shows. Second, inflation averaging horizons longer than one year increase volatility in annual inflation. Therefore, extending the averaging horizon leads to

larger increases in period inflation volatility and also in annual inflation volatility.

As the averaging horizon is extended, the variance frontiers are generally pushed southwest towards the origin, for a broad range of preferences. Policy can frequently be improved by adopting longer averaging horizons, but that choice of horizon varies with the preference for output stabilisation.

To see this, an iso-loss is drawn conditional on a society with equal concern for inflation and output stability. The curve with an averaging horizon of two years is tangential to this iso-loss line, implying that a horizon of two years is optimal when society places equal weight on inflation and output stabilisation. More inflation stabilisation requires a flatter iso-loss line that favours longer averaging horizons.

4.3 Robustness

The empirical model estimated in section 3.2 differs from the theoretical model in a number of nontrivial directions. First, the lag of the real exchange rate is statistically insignificant within the output gap equation. Yet policymakers view the impact of the exchange rate on net exports (and thus output) as a key driver for output in New Zealand. Second, the exchange rate equation returns an estimate of the impact of the real interest rate differential on the real exchange rate of 0.431. Estimating uncovered interest rate parity is not a standard procedure in most small new-Keynesian models because theory suggests a coefficient of one on the real interest rate if the no arbitrage condition holds exactly. Finally, the Durbin-Watson statistic on the exchange rate equation is very low, suggesting serially correlated errors.

These features lead us to consider a first set of changes to the model that are aimed at testing the robustness of the results against a plausible augmented model. Specifically, we restrict the baseline estimated model by: (i) setting the coefficient on the lag of the real exchange

rate in the output gap equation, β_4 , equal to -0.1 ; (ii) imposing uncovered interest rate parity on the exchange rate by setting $\gamma = 1$; and (iii) imposing an autocorrelation coefficient of 0.5 on the exchange rate residuals.

Nessén and Vestin (2005) report that the degree of forward-looking behaviour within the Phillips equation is a key determinant of the optimal averaging horizon. Thus we consider two alternative representations of forward-looking behaviour. The second alternative model places a coefficient of 0.7 on expected inflation (the parameter estimate is 0.543) and the third model uses a coefficient of 0.3 on expected inflation.

The results from these three alternative models are presented in table 3. They confirm that there are small gains from extending the averaging horizon. The largest gain from optimal delegation is a 4.75 percent decrease in society's loss or in inflation equivalent terms, about one-third of one percent point permanent deviation of inflation from target.

This occurs under the augmented exchange rate model and when society is inflation conservative (where $L_t^s = \bar{\pi}_t^2 + 0.5\tilde{y}_t^2 + 0.01i_t^2$). Under this augmented model, a two-year inflation average is always optimal.

The very forward-looking model suggests the optimal averaging horizon is three years for most loss functions, but four years for the baseline loss function (where $L_t^s = \bar{\pi}_t^2 + \tilde{y}_t^2 + 0.25i_t^2$). Asking the central bank to minimise a loss function that contains a rate of inflation averaged over three years generates improvements in society's loss across the range 2.61 percent to 4.01 percent. In inflation equivalent terms, these percentage improvements range from 0.24 to 0.57 percentage points of permanent deviation in inflation from target.

The backward-looking model shows there is no gain to society from passing to the central bank a loss function with an alternative averaging horizon. The best averaging horizon for the central bank is an annual horizon – identical to society's true preferences. When the role of expectations in determining inflation is diminished, the opportunity to make gains for society through optimal delegation is eliminated.

Table 3
Societal Loss Under Alternative Models

j	Augmented model				Forward-looking				Backward-looking			
	$\sigma_{\tilde{y}}^2$	σ_{π}^2	σ_i^2	L_t	$\sigma_{\tilde{y}}^2$	σ_{π}^2	σ_i^2	L_t	$\sigma_{\tilde{y}}^2$	σ_{π}^2	σ_i^2	L_t
$L_t = \pi_t^2 + 0.5\tilde{y}_t^2 + 0.01i_t^2$												
1	.014	.018	.584	2.89	.009	.009	.692	1.89	.033	.046	1.630	7.44
4	.014	.018	.424	2.74	.010	.009	.534	1.81	.034	.046	1.572	7.44
8	.013	.018	.269	2.61	.010	.009	.393	1.75	.035	.046	1.375	7.45
12	.012	.020	.202	2.71	.010	.009	.326	1.75	.035	.048	1.177	7.54
16	.011	.024	.174	2.99	.010	.010	.293	1.78	.035	.051	1.025	7.71
$L_t = \pi_t^2 + 0.5\tilde{y}_t^2 + 0.25i_t^2$												
1	.010	.045	.092	8.54	.015	.032	.094	8.37	.025	.098	.208	24.23
4	.011	.044	.079	8.29	.015	.032	.082	8.24	.025	.098	.205	24.22
8	.011	.045	.061	7.97	.016	.033	.066	8.03	.025	.099	.197	24.23
12	.011	.050	.052	8.21	.018	.035	.053	7.91	.025	.100	.186	24.26
16	.012	.061	.052	9.28	.019	.038	.045	7.93	.026	.102	.176	24.33
$L_t = \pi_t^2 + \tilde{y}_t^2 + 0.01i_t^2$												
1	.012	.021	.543	3.66	.009	.009	.764	2.36	.028	.052	1.616	8.97
4	.012	.021	.427	3.54	.009	.009	.638	2.30	.029	.051	1.565	8.97
8	.011	.021	.312	3.40	.009	.009	.526	2.25	.029	.052	1.408	8.98
12	.010	.023	.258	3.46	.009	.009	.473	2.24	.029	.053	1.253	9.04
16	.010	.026	.232	3.66	.009	.010	.446	2.25	.029	.056	1.131	9.16
$L_t = \pi_t^2 + \tilde{y}_t^2 + 0.25i_t^2$												
1	.010	.046	.096	9.20	.014	.030	.101	8.99	.024	.100	.215	25.40
4	.010	.045	.083	8.96	.015	.030	.089	8.88	.024	.100	.212	25.40
8	.011	.046	.067	8.67	.016	.031	.073	8.69	.024	.100	.203	25.40
12	.011	.050	.058	8.87	.017	.032	.062	8.58	.025	.102	.193	25.43
16	.011	.059	.057	9.72	.018	.034	.055	8.58	.025	.104	.183	25.49

NB Values in bold indicate lowest societal loss (with corresponding averaging horizon in the first column) given the model of the economy and specification of society's loss function.

4.4 An alternative view of the averaging horizon

An alternative approach to exploring the best averaging horizon for an alternative set of societal preferences is to calculate the range of societal preferences for which a given averaging horizon is optimal. For this exercise we restrict attention to output stabilisation only, such that the loss function takes the form $L_t = \pi_{4,t}^2 + \lambda_1 \tilde{y}_t^2$. This loss function is identical to the loss function explored in the graphical representation of variance frontiers in section 4.2. For each averaging horizon, table 4 presents the range of output stabilisation for which each horizon is optimal.

Table 4

Horizon	Model			
	Baseline	Augmented	Forward-looking	Backward-looking
1	-	-	-	-
4	0-0.06	-	-	0.00-8.00
8	0.06-0.88	0.00-0.28	0.00-0.24	8.00- ∞
12	0.88-3.41	0.28-2.31	0.24-0.67	-
16	3.41- ∞	2.31- ∞	0.67- ∞	-

NB. Each cell contains the range of output stabilisation preference (λ_1) for which that horizon (the row entry) is optimal given the model (the column entry). Thus the cell in the first column and fifth row of the table shows that a four year averaging horizon is optimal when the weight on output stabilisation ranges from 3.41- ∞ .

Column 2 of table 4 shows the results for the baseline model. When society is almost entirely concerned with inflation stabilisation, such that the weight on output gap volatility takes a weight ranging from 0 – 0.06, there is no gain to extending the averaging horizon and an annual average is optimal. Across a more plausible range of weights for output stabilisation, 0.06 – 0.88, a two-year average for inflation is optimal; a three-year average for inflation is optimal when the weight

on the output gap is $0.88 - 3.41$ and only under extreme preferences, $\lambda_1 \in [3.41, \infty)$, is a four-year horizon optimal.

Under the restricted model, with an enhanced role for the exchange rate, longer averaging horizons prove optimal. A three year average for inflation is optimal for a wide range of output stabilisation weights, $0.28 - 2.31$. Longer averaging horizons are also preferred under the forward-looking model: with a four-year horizon the optimal horizon for output stabilisation weights of $0.67 - \infty$.

The benefits of directly conditioning on forward-looking expectations are larger when expectations form a key channel in the transmission mechanism. Column four of the table shows that under the forward-looking model, there is always an incentive to implement a longer averaging horizon. Finally, column five shows the results for the backward-looking model. Under this model, the annual averaging horizon is always optimal — there is no optimal delegation incentive with respect to the averaging horizon. Nessén and Vestin (2005) also find the optimal width of the averaging horizon is smaller as the degree of forward-looking behaviour declines within a theoretical model.

5 Conclusion

The 2002 Policy Targets Agreement requires the Reserve Bank to target inflation over the medium term. Targeting a medium term average of inflation shifts inflation targeting towards a “halfway-house” between inflation targeting and price level targeting. This paper assumes the Reserve Bank of New Zealand operates under discretion and seeks the optimal medium term averaging horizon, the location of the “halfway house” the government should delegate to the central bank.

Using a small new-Keynesian model as our baseline representation of the New Zealand economy, we find a two or three year averaging horizon is the optimal definition of the medium term. This is true for

several alternative representation of society’s preferences. Such an averaging horizon produces mild gains; calculations suggest society would be up to 3 percent better off. In inflation equivalent terms society could avoid about one-third of one percentage point in the deviation of inflation from target by adopting a two or three year horizon. These gains accrue because preventing bygones from being bygones is helpful in generating inflation expectations that drive inflation back to target. However, these gains reach a bound when the averaging horizon for the RBNZ becomes too far removed from the annual inflation rate we assume society is really concerned about.

These results appear robust to a model with an augmented set of assumptions regarding exchange rate behaviour. Under this model a two year averaging horizon is always optimal and yields percentage gains to society of up to about 5 percent.

However, both the gains to delegating a medium averaging horizon and the length of the averaging horizon depend on the degree of forward-lookingness in the inflation process. Under a relatively forward-looking specification a three-year horizon is always optimal and yields about half a percent in inflation equivalent terms. Under a backward-looking model, there are no gains from delegating a two, three, or four averaging horizon to the central bank.

Targeting a medium-term average for inflation appears to generate benefits for society even when society cares about an annual rather than a longer term average for inflation. These benefits are relatively small, but suggest that an averaging horizon of between two and three years lowers the inflation-output gap trade-off and enhances the potency of monetary policy to generate good outcomes. An averaging horizon of two years implies that the Reserve Bank should retain regard for recent historical inflation outcomes, but should let bygones be bygones for inflation outcomes that occurred eight or more quarters ago. The benefits from targeting a longer term average for inflation are thus bounded — the averaging horizon the Reserve Bank uses should not become too disconnected from the horizon society really cares about.

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