THE MACROECONOMIC BENEFITS OF MONETARY POLICY REFORM IN NEW ZEALAND

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Abstract

A structural time series model is developed to investigate how monetary policy settings have interacted with inflation outcomes and the real economy in New Zealand since the mid-1970s. State space estimation techniques are used as this allows the derivation of important but not readily observable time varying phenomena such as inflation expectations, potential output and the non accelerating inflation rate of unemployment (NAIRU). The evidence collected supports the view that the Reserve Bank Act, in conjunction with other policy initiatives of the late 1980s/early 1990s, has had a positive influence on the performance of the New Zealand economy. However, the news is not all positive. The recent climb in inflation outcomes seems to stem from a rise in inflation expectations, and not the commonly held view of excess demand pressures. Our model does not directly test the source of this rise in inflation expectations, but we present some evidence that suggests that the performance of monetary policy is being inhibited by both a lack of competition in the non-tradeable economy and by the implementation of monetary policy which tends in practice to be based on backward-looking, reactive actions rather than the forward-looking proactive approach that underpins both the rhetoric and research of the Bank.

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Introduction

The Reserve Bank Act 1989 charged the Reserve Bank of New Zealand with a central task of maintaining price stability in New Zealand. According to the terms of the Act, price stability was to be defined in publicly disclosed Policy Targets Agreements between the Minister of Finance and the Governor of the Reserve Bank. There have been a number of Policy Target Agreements over the years, beginning with some accommodation to allow the Bank time to bring down inflation in the early 1990s and then changing views on what constituted price stability, usually occasioned by a change in government. Without going into specifics about the precise details of each Policy Targets Agreement, price stability has generally been defined in terms of the consumers price index (CPI) with some allowance for external supply shocks (cost-push inflation) such as oil price shocks. There has in general been some relaxation in the bounds around what constitutes price stability, with the target band widening from 0-2% annual inflation to 0-3% and greater scope for inflation to lie outside the target zone at any particular point in time. For example allowance for trade-off's with real activity and allowance for business cycle impacts.

While these changes may be interpreted as a relaxation in what constitutes price stability, the relaxation has been modest in nature and it would be an extreme view to interpret this relaxation as an abandonment of the price stability principles of the Reserve Bank Act. At a superficial level the change in the operation of monetary policy as marked by the Reserve Bank Act 1989 has been spectacular. In the fifteen years from March 1975 to March 1990, the annual increase in the headline CPI averaged 12.3%. In the fifteen years from March 1990 to March 2005 the average annual increase was just 2.0%.

What we propose in this paper is to provide an analysis of the factors that contributed to the fall in inflation and the consequent impacts on the real economy of achieving and maintaining a lower inflation environment. We develop a model of the inflation process in New Zealand based on the approach developed by Dossche and Everaert (2005) to investigate inflation persistence in the United Sates and Europe. From this we can decompose inflation into extrinsic (eg demand pressure) and intrinsic (eg indexation) persistence as well as the impact of inflation shocks and inflation expectations. The model also allows us to investigate the interaction between inflation, monetary policy and real output.

The evidence that we gather is largely circumstantial. For one thing the New Zealand economy was influenced by a number of policy developments as well as exogenous shocks (eg the early 1990s world recession, the mid-1990s 'Asian Crisis', the downward pressure on prices emanating from the industrialisation of Asian economies). The dismantling of import licensing and tariffs, and the privatisation of government activities all increased competitive pressures on New Zealand business activities. There were also changes to labour market regulations, changes in the benefit system, improvements in the tax system and changes in the operation of government activities. The implication is that we can not be categorical about the influence of monetary policy on inflation outcomes or on the consequent economic performance. Irrespective of the relative contribution of individual policies, the evidence presented here is that the Reserve Bank Act occasioned a far more restrained inflation process and this has been accompanied by efficiency gains in product and labour markets which have raised the economy's growth potential.

The implication is that the Reserve Bank Act, in conjunction with other policy initiatives of the late 1980s/early 1990s, has had a positive influence on the performance of the New Zealand economy. However, the news is not all positive. The recent climb in inflation outcomes seems to stem from a rise in inflation expectations, and not the commonly held view of excess demand pressures. Our model can not directly test the source of this rise in inflation expectations, but we present some evidence that implies that the performance of monetary policy is being inhibited by both a lack of competition in the non-tradeable economy and by the implementation of monetary policy which tends in practice to be based on backward-looking, reactive actions rather than the forward-looking proactive approach that underpins both the rhetoric and research of the Bank.

The paper begins with a description of the theoretical model. After describing the state-space estimation approach and data used in this paper, we develop a measure of potential output, examine interaction between monetary policy settings and inflation and output, and decompose the apparent sources of inflation pressures in recent years. The paper finishes with the presentation of, largely circumstantial, evidence supporting the two hypotheses of reactive implementation of monetary policy and the extent that inflationary pressures are being generated by sheltered sectors of the economy.

Model

Following Dossche and Everaert (2005) the inflationary process is assumed to be defined by a baseline structural model such that:

$$\pi_{t+1}^{T} = \pi_{t}^{T} + \eta_{1t} \qquad \textbf{(1)}$$

$$\pi_{t+1}^{P} = E_{t+1}\left[\pi_{t+1}^{T}\right] \qquad \textbf{(2)}$$

$$\pi_{t} = \left(1 - \sum_{i=1}^{q} \varphi_{i}\right)\pi_{t}^{P} + \sum_{i=1}^{q} \varphi_{i} L^{i} \pi_{t} + \beta_{1} z_{t-1} + \varepsilon_{1t}, \qquad \sum_{i=1}^{q} \varphi_{i} < 1 \qquad \textbf{(3)}$$

where π_t^T is the central bank's inflation target, π_t^P is the perceived inflation target, π_t is the observed inflation rate and z_t is the output gap, ie the percentage deviation of real output from potential output. L in the lag operator so that $L^i \pi_t = \pi_{t-i}$. The terms η_{1t} and ε_{1t} are mutually independent and zero mean white noise processes.

Equation (1) presents the monetary authority's inflation target, π_t^T, as a random walk process, implying that shifts in the monetary authority's inflation target are presumed to be permanent. Such shifts represent a change in the monetary authority's (or government's) preferences over different inflation outcomes. As noted by Dossche and Everaert (2005), there can also be implicit changes in the inflation target over time as a result of changing perceptions about the natural rate of different real variables (p5).

An implication of this latter point, is that even with publicly announced and narrowly defined inflation targets (like those potentially achieved with use of the Policy Targets Agreement in New Zealand), a shift in the monetary authority's target is unlikely to be passed on to inflation expectations immediately. It may take agents some time to assess the implication of the new target on expected inflation outcomes. This stems from uncertainty about both the operational impact of the new target and the credibility that the monetary authority has with the public in achieving and maintaining its new target. Agents will assess for themselves, based on actual inflation outcomes, the extent to which the monetary authority is committed to achieving the stated target and the extent that changes in the target will change actual inflation outcomes. For example, inflation targets are often presented in target bands, eg 0-3% annual inflation or to average a certain amount (eg 3%) over a period of time. In each case there are a variety of inflation outcomes that are consistent with achieving the target. In the former case inflation might average 1% or 2.5%, in the latter it could range between 2.5 and 3.5% or between 1 and 5%. Obviously uncertainty about the monetary authority's target increases in the absence of an explicit inflation target.

We do not explicitly define the perceived inflation expectations process, but instead derive inflation expectations from interest rate, inflation and output data. This will be discussed in more detail below.

Equation (3) represents a Phillips curve, relating the observed inflation rate π_t to the perceived inflation target π_t^P, q lags of inflation and the lagged output gap z_{t-1}. The perceived inflation target π_t^P is the inflation rate consistent with private agents' inflation expectations. Both business cycle shocks, reflected in the output gap z_{t-1}, as well as cost-push shocks, measured by ε_{1t}, will induce temporary deviations of π_t from π_t^P. Dossche and Everaert (2005) note that the sluggish adjustment of inflation π_t in response to cost-push shocks ε_{1t} is measured by the sum of the autoregressive coefficients, $\sum_{i=1}^{q} \varphi_i$. This in turn can be interpreted as an estimate of the extent that the economy is subject to intrinsic inflationary persistence related to price and wage setting mechanisms, eg price and wage indexation. The sluggish adjustment of inflation in response to business cycle shocks is determined, besides the intrinsic inflation persistence, by the persistence of the output gap z_t. Dossche and Everaert (2005) refer to this type of inflation persistence as extrinsic inflation persistence. This extrinsic persistence results from a persistence of excess demand conditions within the economy. The actual inflationary impact of this demand persistence depends on the size of the β_1 parameter.

The next step is to relate this inflationary process to monetary policy actions and real economy developments. We once again follow the lead of Dossche and Everaert (2005) who develop a variant of the Rudebusch and Svensson (1999) macroeconomic model which we reproduce below in equations 4-9.

$$i_t = \rho_2 i_{t-1} + (1-\rho_2)(r_t^* + \pi_t^P) + \rho_1(\pi_{t-1} - \pi_t^T) + \varepsilon_{2t} \qquad \textbf{(4)}$$

$$y_t^r = y_t^P + z_t \qquad \textbf{(5)}$$

$$z_t = \beta_2 z_{t-1} + \beta_3 z_{t-2} - \beta_4 \left(i_{t-1} - \pi_{t-1}^{P} - r_{t-1}^{*}\right) + \varepsilon_{3t} \quad (6)$$

$$y_{t+1}^{P} = \lambda_{t+1} + y_t^{P} + \eta_{2t} \quad (7)$$

$$\lambda_{t+1} = \lambda_t + \eta_{3t} \quad (8)$$

$$r_{t+1}^{*} = \gamma\lambda_{t+1} + \eta_{4t} \quad (9)$$

where $\varepsilon_{2t}, \varepsilon_{3t}, \eta_{2t}, \eta_{3t}$, and η_{4t} are mutually independent zero mean white noise processes.

In equation (4) nominal short run interest rates are implicitly determined by a combination of interest rate inertia i_{t-1}, the neutral stance of monetary policy as determined by the natural short term interest rate $\left(r_t^{*} + \pi_t^{P}\right)$ and central bank reactions to deviations of inflation from its target $\left(\pi_{t-1} - \pi_t^{T}\right)$. The natural short term interest rate $\left(r_t^{*} + \pi_t^{P}\right)$ comprises inflation expectations plus the time varying real short-term interest rate consistent with potential output growth r_t^{*}. This consistency with potential output is determined in equation (9), which relates r_t^{*} to λ_t, which is effectively the potential growth rate as equations (7) and (8) define λ_t as innovations in y_t^{P}, the non-inflationary potential output of the economy.

Equation (5) defines observed real output y_t^{r} as the sum of potential output y_t^{P} and the output gap z_t. Equation (6) provides a real economy feedback for monetary policy with the output gap influenced by the extent that recent short run interest rates have exceeded the medium term natural rate $\left(i_{t-1} - \pi_{t-1}^{P} - r_{t-1}^{*}\right)$ as well as an inertia process (hence the inclusion of lags of z_t). Equation (6) does not explicitly include an external economy transmission path, eg via the exchange rate. However, while the inclusion of an exchange rate mechanism would provide a more sophisticated description of the feedback process, it would also complicate the analysis given the strong correlation between interest rates and the exchange rate. Also while the inclusion of exchange rate processes is likely to be informative about how monetary policy impacts on the real economy, it perhaps adds little about what we are most interested here in, the overall impact of monetary policy on short term economic activity. An implication is that equation 6 needs to be interpreted as a reduced form equation with the relationship between interest rate adjustments and output, as represented by the β_4 parameter, is not estimating a strictly partial impact and is therefore difficult to interpret.

Although equation (6) provides an avenue for estimating the relationship between the monetary policy stance and economic activity, via the output gap, neither the output gap nor potential output are directly observable phenomena. We thus require a method for estimating potential output. The method used for estimating potential output is described below (see Potential Output). However, before we do this it may be useful to describe the state space estimation method used in this paper.

Estimation method

The structural model presented above essentially adopts the model developed by Dossche and Everaert (2005). Like Dossche and Everaert (2005) a state space estimation approach is used here, however the approach used here estimates the parameters of interest directly from the data (as distinct from the approach used by Dossche and Everaert which derives parameter estimates based on a Bayesian analysis of parameter estimates obtained by other authors). There is not the depth of knowledge about these parameters in the New Zealand context and we can not be confident that parameters estimated for Europe and North America will necessarily apply in New Zealand.

A consequence of this approach (estimating parameters) is that we have to make a couple of assumptions that limit the analysis as we can not fully derive all of the unobservable phenomena. In particular the explicit inflation target variable of the Reserve Bank, π_t^T, is assumed to be fixed at an annual inflation rate of 1.5%. Secondly, the unobserved time varying real short-term interest rate consistent with potential output growth, r_t^*, is assumed to equal the potential growth rate, λ_t. The key limitation of the first assumption is that changes in the Bank's tolerance for inflation will tend to be incorporated as either inflation shocks or changes in public inflation expectations, π_t^P. The second assumption implicitly assumes that the parameter, γ, is set equal to one in equation (9), which is consistent with the results of Dossche and Everaert (2005), and that $\sigma_{\eta_4}^2$ is minimal, which does not seem unreasonable given our estimate of $\sigma_{\eta_4}^2$, 6.5362xe^{-11}, is equivalent to annual variations of 0.000005 percentage points per year (see and Figure 8 below).

Data analysis is undertaken here with use of the STAMP (version 5.0) software package that was explicitly designed for modelling time series data using state space estimation techniques. STAMP uses a Kalman Filter approach to derive maximum likelihood estimates. A Kalman Filter is primarily a set of vector and matrix recursions based on:

- Computation by one-step ahead predictions of observation and state vectors, and the corresponding mean square errors;
- Diagnostic checking by means of one-step ahead prediction errors;
- Computation of the likelihood function via one-step ahead prediction error decomposition;
- Smoothing which uses the output of the Kalman Filter.

STAMP allows the estimation of structural time series models that may include exogenous explanatory variables, lagged values of the dependent variable, intervention variables, as well as unobserved components such as trend, seasonals and cycle. The general format is:

$$y_t = \mu_t + \gamma_t + \psi_t + \nu_t + \sum_{\tau=1}^{p} \phi_\tau y_{t-\tau} + \sum_{i=1}^{k} \sum_{\tau=0}^{q} \Delta_{i\tau} x_{i,t-\tau} + \sum_{j=1}^{h} \lambda_j w_{j,t} + \varepsilon_t \qquad \textbf{(10)}$$

where the first four terms on the right hand side represent stochastic decompositions of the time series y_t: μ_t represents the trend component, γ_t seasonal components, ψ_t cyclical components, and ν_t a first-order autoregressive component. $x_{i,t}$ represents exogenous variables; $w_{j,t}$ intervention (dummy) variables; φ_τ, $\Delta_{i\tau}$, λ_j are to be estimated parameters and ε_t is the irregular white noise term such that $\varepsilon_t \sim NID(0, \sigma_\varepsilon^2)$.

Not all of these features are utilised in the current study. In particular, none of the equations estimated here include either cyclical or autoregressive components. The models developed here, unless otherwise noted incorporate a simple stochastic trend specification that excludes any slope component to the trend specification, ie

$$\mu_t = \mu_{t-1} + \varsigma_t, \qquad \varsigma_t \sim NID(0, \sigma_\varsigma^2) \qquad \textbf{(11)}$$

Data

A quarterly database is constructed with data from the first quarter of 1974 to the first quarter of 2005, with the start date determined by the shortest time series, 90-day bill rates. The variables and data sources are presented in Table 1. The consumers price index and the NZIER capacity utilisation measure are the only variables for which there is a consistent quarterly time series throughout the time period. For pre-1987 GDP data and pre-1985 90 day bill rate data there are annual measures available from the Long-Term Data Series on the Statistics New Zealand website (http://www.stats.govt.nz/tables/ltds/default.htm). Quarterly pre-1986 labour market data is available due to the efforts of Simon Chapple backdating labour market data to 1956 on a basis that is consistent with Household Labour Force Survey (HLFS) definitions (Chapple 1994). Revisions to HLFS data since Chapple's study have meant that there is no longer a smooth link with the Chapple data. To overcome this, current HLFS data was regressed against the overlap with the Chapple dataset, and the relationship established was used to adjust the pre-1986 Chapple dataset. A similar approach was used to generate quarterly series for GDP and 90-day bill rates based on annual measures available from the Long-Term Data Series. These regression results are not reported here but are available on request from the author. The resulting datasets are presented in the Appendix.

Table 1: Description of data and sources

Symbol	Description	Source
y_t^r	Expenditure on GDP in constant prices	National accounts, Statistics New Zealand
i_t	90 day bill rate	Reserve Bank (?)
π_t	Inflation as measured by the Consumers Price Index	Statistics New Zealand
L_t	Full time equivalent employment	HLFS, Statistics New Zealand
U_t	Unemployment rate (% of labour force)	HLFS, Statistics New Zealand
W_t	Working age population (15 years and older)	HLFS, Statistics New Zealand
C_t	Capacity utilisation	New Zealand Institute of Economic Research

Potential output

Potential output is estimated by substituting measures that are consistent with non-accelerating inflation into an estimated production function. The production function estimated is essentially an intensity adjusted production function or perhaps, given the use of capacity utilisation measures as a proxy for cyclical demand, as a demand adjusted labour production function of the form:

$$y_t^r = \alpha_t L_t^{\phi} C_t^{\theta} \qquad \textbf{(12)}$$

This is estimated in logs in state space form so that the time varying labour productivity measure, a_t, can be derived in the estimation process:.

$$\ln y_t^r = \alpha_t + \sum_{i=1}^{4} \phi_i \ln L_{t-i} + \sum_{j=1}^{4} \theta_j \ln C_{t-j} + \sum_{q=1}^{h} \lambda_q w_{q,t} + \gamma_t + \varepsilon_t \qquad \textbf{(13)}$$

Where L_t is HLFS consistent full time equivalent employment, the demand proxy, C_t, is the NZIER capacity utilisation measure, $w_{q,t}$ are data determined intervention variables, γ_t are stochastic seasonal variables[1], a_t, the proxy for labour productivity is derived in the estimation as the stochastic trend variable of the form in equation 11, and ε_t is the irregular white noise term such that $\varepsilon_t \sim NID(0, \sigma_\varepsilon^2)$. The model is estimated using quarterly data, with lagged rather than contemporaneous explanatory variables. Insignificant variables are step-wise removed from the equation resulting in a preferred equation that has capacity utilisation lagged by one quarter and employment lagged two quarters. A number of level interventions have been introduced into the estimation of equation (13). The timing and type of intervention is determined by auxiliary residual testing for unusual movements in the time series.[2] The inclusion of these intervention variables removes the impact of outliers, or structural changes that can not be explained by the simple model structure, on the parameter estimates for the explanatory variables. The impact of these movements are incorporated within the time varying measure of labour productivity, a_t. Estimation results are presented in Table A2- 1. Innovations over the estimation period of the derived residual labour productivity measure a_t are presented in Figure 1. The implied labour productivity growth rates (presented in annual average percentage changes of the production function residual) are presented in Figure 2.

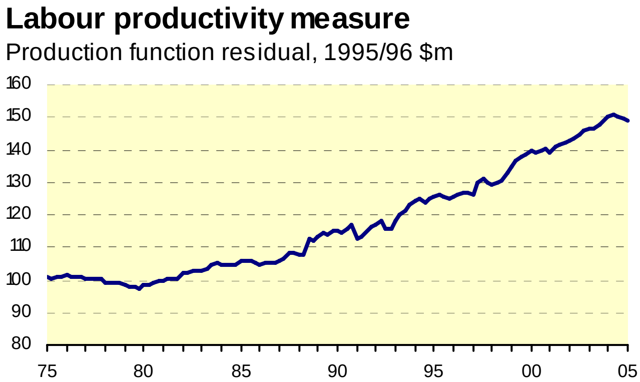

Figure 1

[1] Stochastic seasonal variables were included in all equations reported in this paper, but estimates are not reported as seasonal patterns are not a focus of the paper.

[2] These residuals are the smoothed estimates of the disturbances associated with the irregular and level components. Interventions were introduced in extreme cases only (t-probabilities > 99%). An intervention acts in a similar way to dummy variables in OLS, with an irregular intervention being analogous to a …0, 0, 1, 0, 0,… type dummy variable and a level intervention analogous to a …0, 0, 1, 1,… type dummy variable.

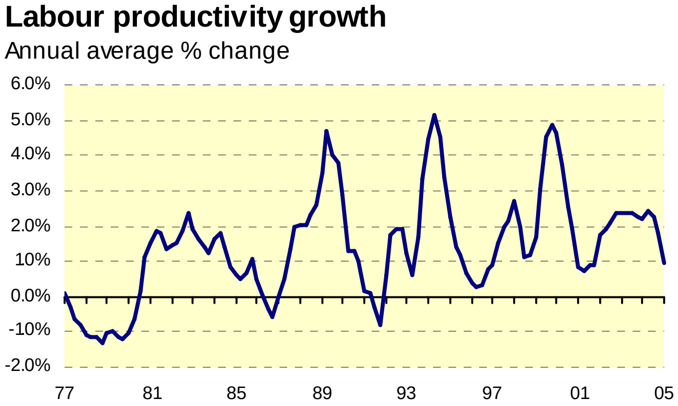

Figure 2

Razzak (2003) has argued that there was a structural step increase in total factor productivity in New Zealand in the early 1990s. Although it is less clear cut that such a structural break occurs in the labour productivity measure derived in our calculations here, the labour productivity performance since the 1980s has been superior to that experienced in the prior fifteen years: the estimated increase in labour productivity averaged 0.9% per year in the 15 year period from 1975 to 1990, but averaged 1.7% per year in the 15 years from 1990 to 2005. As a casual observation of the series presented in Figure 2 indicates, the volatility in annual labour productivity growth does not appear to have diminished in recent years[3], instead the key difference is an absence of declines in labour productivity since the very early 1990s. The partial nature of the production function (using capacity utilisation rather than the capital stock) probably also contributes to the observed cyclical volatility in the derived labour productivity measure.

Potential output is calculated by substituting into the production function reported in Table A2- 1 values for capacity utilisation and employment that are consistent with non-accelerating inflation. This requires estimating the relationship with inflation of capacity utilisation and unemployment respectively. The equations estimated are of the form:

$$\pi_t = \mu_{14,t} + \gamma_{14,t} - \beta_{14} U_t + \varepsilon_{14,t} \qquad \textbf{(14)}$$

$$\pi_t = \mu_{15,t} + \gamma_{15,t} + \beta_{15} C_t - \varepsilon_{15,t} \qquad \textbf{(15)}$$

where the stochastic trend variables μ are estimated as per equation (11), the are stochastic quarterly seasonal processes and the ε_t are the irregular white noise terms such that $\varepsilon_t \sim NID\left(0, \sigma_\varepsilon^2\right)$. The dependent variable is quarterly changes in the CPI and the equations are estimated in natural logarithms[4] using data from 1975.1 to 2005.1 (121 quarters). The full results are presented in Appendix 2 (Table A2- 2 and
Table A2- 3).

[3] The year to year standard deviation of the annual average growth rates in the post 1990 period was 1.35%, only just lower than the 1.45% recorded in the earlier period.

[4] Thus $\pi_t = \ln(p_t) - \ln(p_{t-1})$, where p_t is the price level as measured by the consumers price index in period t.

The estimated parameters for β_{14} and β_{15} were -0.0173 and 0.1837 respectively. Using these parameters, in conjunction with the derived stochastic trend variables, μ , one can derive time varying estimates of the unemployment rate and capacity utilisation that are consistent with maintaining stable inflation, defined in this paper as annual inflation of 1.5% using the formulas:

$$NU_t = Exp(1.015^{0.25} - \hat{\mu}_{14,t} - 1) / \hat{\beta}_{14} \quad \textbf{(16)}$$

$$NC_t = Exp(1.015^{0.25} - \hat{\mu}_{15,t} - 1) / \hat{\beta}_{15} \quad \textbf{(17)}$$

The derived estimates of these time varying non accelerating inflation unemployment and capacity utilisation measures are presented in Figure 3 and Figure 4. To some degree the earlier measures are somewhat artificial as the monetary policy stance was more accommodating pre the late 1980s. But the issue that is being highlighted here is that while accommodating policies may shelter many from the consequences of a poorly performing economy, such shelter can not protect against sustained non-performance.

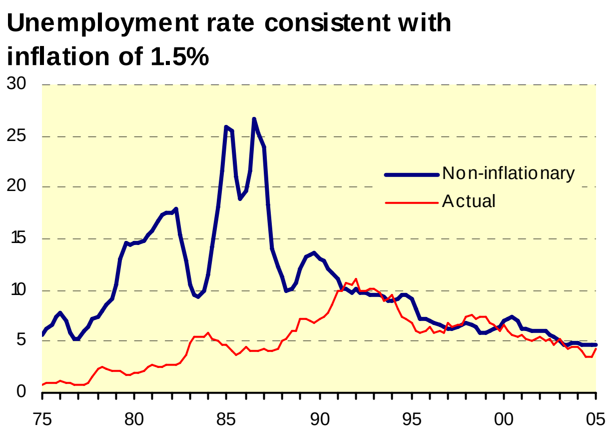

Figure 3

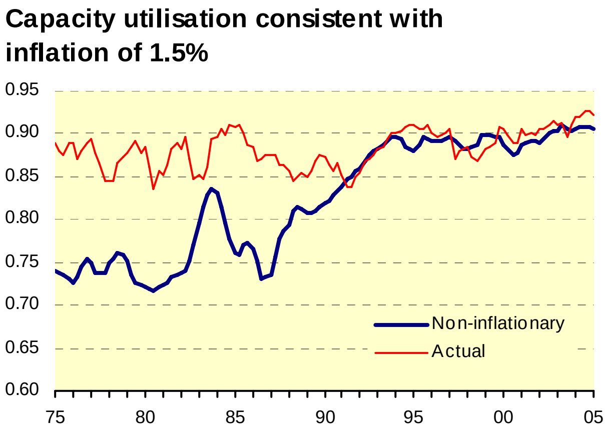

Figure 4

The calculations do however, suggest some interesting insights:

The non-inflationary capacity utilisation moved up in the early 1980s at the same time that the non-inflationary unemployment rate dipped down and coinciding with the wage and price freeze that was imposed from 1982 to 1984. The indication is that this price freeze did have a growth dividend, though not a sustainable one.

Taking the price freeze effect out, there is a steady rise in the non-inflationary rate of unemployment from the mid 1970s. That actual unemployment was significantly lower suggests that accommodating policies can shelter the labour market from poor economic performance for a considerable length of time. The post-1984 economic reforms appear to have removed this shelter resulting in the observed climb in unemployment rates in the late 1980s/early 1990s.

As high as unemployment reached in the early 1990s (peaking at 11.1% in the first quarter of 1992) such rates appear to have been necessary to generate a low inflation environment. The subsequent reduction in unemployment rates, and increases in capacity utilisation rates, consistent with low inflation are indicators of the success of the policy regime in New Zealand since the mid-1980s. Unemployment rates less than 5% and utilisation of more than 90% of capacity are now consistent with a low inflation environment. An implication of this is that the potential growth rate of the economy has improved considerably since the 1980s.

Potential output can be calculated by substituting capacity utilisation and employment rates consistent with low inflation (here defined as 1.5% annual increases in the CPI) into the equation presented in Table A2- 1. This is reasonably straightforward with respect to capacity utilisation, requiring the direct substitution between the series graphed in Figure 4, but it is slightly more complicated and subjective converting non-inflation unemployment estimates into an employment equivalent data series. A comparison of actual full time equivalent employment with our estimate of the potential "full employment" numbers are illustrated below in Figure 5.

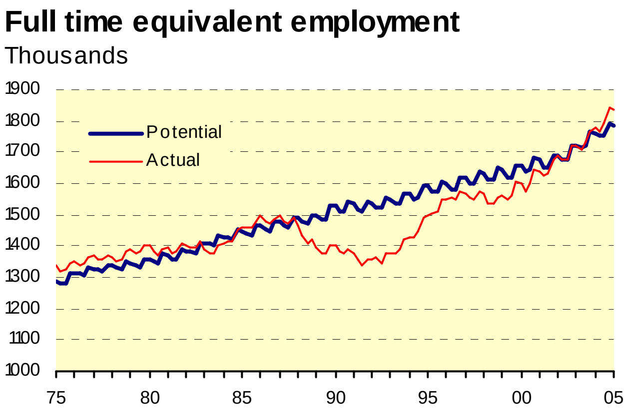

Figure 5

The estimates of potential employment presented in Figure 5 are based on the following assumptions:

Potential employment equals full time employment in the year ended March 2003, when the difference between our estimate of non-inflationary unemployment was within 7 basis points (0.07 percentage points) of the actual unemployment rate.

Against this benchmark, employment is adjusted by changes in the working age population (people aged 15 and over) adjusted for changes in the estimate of non-inflationary unemployment (adjusted to be as a percentage of the working age population).

But prior to 1988 employment is simply adjusted for changes in working age population (as we discount the economic meaning of the non-inflationary unemployment estimates in the high inflationary environment of the 1970s and 1980s).[5]

That is compared with the benchmark employment period (2002/03, indicated by subscript, *B*, in equation 18), potential employment in period *t* is calculated as:

$$E_t^P = E_B^P + \left(U_t^{NI} - U_B^{NI}\right) + \left(WAP_t - WAP_B\right) \quad \textbf{(18)}$$

but where no adjustment for estimated changes in non-inflationary unemployment prior to 1988.

The measure of potential output, y^P, resulting from substituting the non-inflationary estimates of employment and capacity utilisation into equation (13) is presented alongside actual output, y^γ, as represented by the seasonal adjusted measure of real expenditure on GDP, in Figure 6.

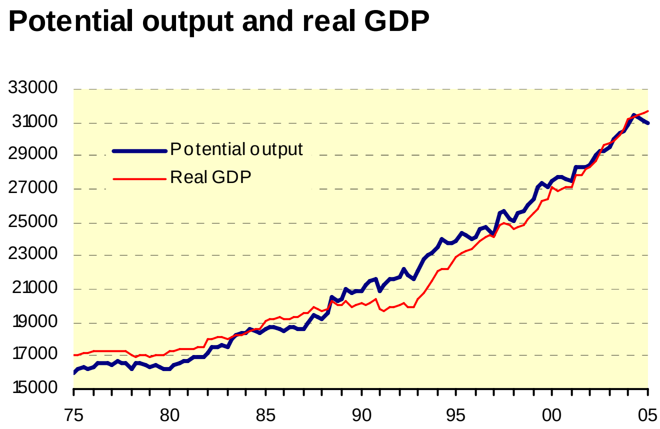

Figure 6

The output gap, z, is the difference between these measures, either expressed as the difference in logs (as per equation 5) or equivalently as the percentage of potential output as presented in Figure 7.

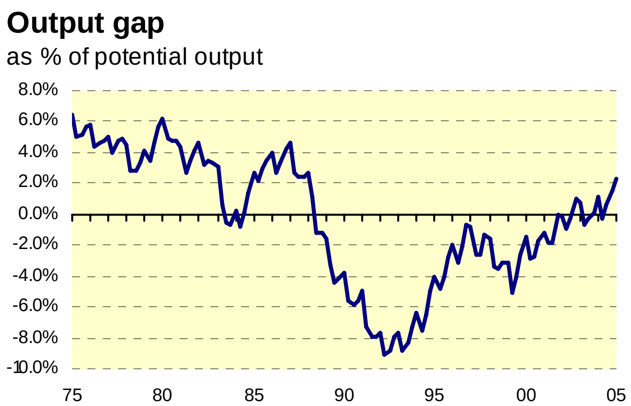

Figure 7

[5] Estimates of potential employment based around our estimates of the NAIRU prior to the late 1980s are highly volatile. By discounting our earlier estimates of the NAIRU we are implicitly assuming that a different Philips curve operated in the different monetary policy regime.

Now that we have an estimate of the potential output of the economy we can, via equations 7-9 estimate the time varying real short-term interest rate consistent with potential output growth, r_t^*. Equations 7 and 8 essentially define the potential growth rate, λ, as the stochastic trend in a simple univariate model of log changes in potential output (see Table A2- 4 and Table A2- 5).

The implied trend annual growth rate in potential output in New Zealand is graphed in Figure 8, demonstrating a steady climb in the potential growth rate of the New Zealand economy from around 1.6% in the late 1970s to around 2.6% currently. Perhaps the one concern suggested by these calculations is the halt in improvements to the potential growth rate in recent years and, indeed, a marginal reduction since 2003.

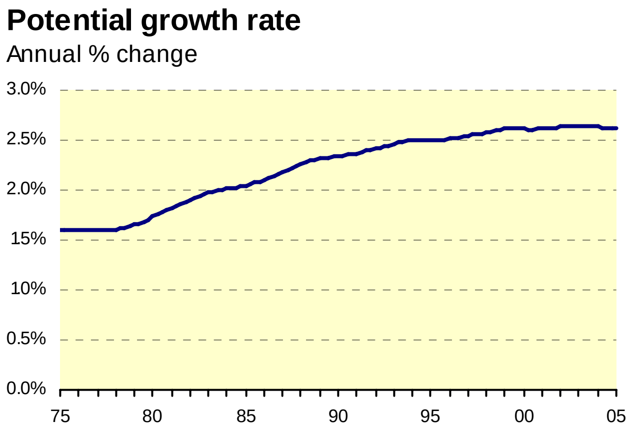

Figure 8

As stated above (in *Estimation method*), we do not formally estimate equation 9, but assume that $r_t^* = \lambda_t$. The low variation in the evolution of λ over time, as illustrated in Figure 8 and demonstrated by the extremely small estimated variance in the level disturbance term in Table A2- 5, which is the equivalent of $\sigma_{\eta_4}^2$ in equation (9), provides us with some assurance that this is not an unreasonable assumption.

As noted in *Estimation method* above, we also assume that the Reserve Bank's internal operational inflation target, π_t^T, is fixed at an annual inflation rate of 1.5%. This means that the deviation from inflation target variable in equation 4, $(\pi_{t-1} - \pi_t^T)$, is calculated as the annualised rate of inflation less 1.5 percentage points. As public perceptions of inflation, π_t^P, is not directly observable, the middle term in equation 4, $(1-\rho_2)(r_t^* + \pi_t^P)$, is derived as the stochastic trend from estimating:

$$i_t = \mu_t + \rho_2 i_{t-1} + \rho_1(\pi_{t-1} - \pi_t^T) + \varepsilon_{2t} \qquad \textbf{(19)}$$

The natural short term interest rate is thus calculated as $(r_t^* + \pi_t^P) = \hat{\mu}_t / (1-\hat{\rho}_2)$. Results for estimating equation 19 are presented in Table A2- 6. The estimate of ρ_1 is 1.025, implying that there is close to a one for one relationship between short term interest rates and the divergence of inflation from the Bank's target (presumed here to be 1.5%). In combination with the considerable amount of inertia apparent in interest rate setting in New Zealand, the estimate for ρ_2 is 0.805, indicating that interest rates have lengthy cycles it would seem that inflation pressures are resisted with considerable determination.

However an interesting thing about this relationship is that equation 4 represents an adaptive expectations reaction function, interest rates rise *after* the inflation target has been missed. There is some evidence that inflation control is more proactive than suggested by these results. Replacing the one quarter lag of the divergence from inflation target variable with a one quarter lead does yield a significant relationship, but with an estimated value of 0.67 this is less emphatic than when there is hard evidence that the target is being missed. Potentially of more concern is that there is no statistically significant relationship between short term interest rates and more lengthy leads of the divergence from inflation target measure. Both four quarter and eight quarter leads of the divergence measure are not significantly different from zero (indeed the parameter estimates suggest that the relationship could even be negative).

Of course a potential reason why one might not be able to observe a positive relationship between current interest rates and future rates of inflation is actually a product of the Bank's success at heading off future inflation pressures. Forecasts of inflation rise, interest rates rise correspondingly and future inflation pressures are dampened.[6] Unfortunately it is not obvious that there is a strong relationship between interest rate settings and the Reserve Bank's own inflation forecasts (we return to this below).

The shift to inflation targeting seems to have considerably reduced financial market uncertainty. The difference between actual interest rates and the natural interest rate $\left(i_t - \pi_t^P - r_t^*\right)$ can be termed as short term interest rate shocks and is graphed in Figure 9. There appears to have been a positive bias to unanticipated interest rate shocks, though less pronounced since 1990. The variability in unanticipated shocks around its mean declined considerably before and after 1990. The standard deviation in our measure of unanticipated interest rate shocks declined from 3.1 percentage points in the fifteen years before 1990 to 1.7 percentage points in the fifteen years from 1990. Interest rate shocks have been even lower in most recent years with unanticipated interest rates shocks having a standard deviation of just 0.5 percentage points in the five years to the March quarter 2005.

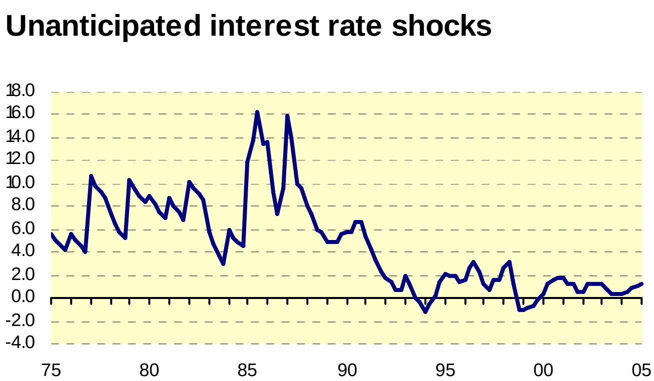

Figure 9

The estimation of equation 19 also allows us to derive estimates of public inflation expectations, $\pi_t^P \left(= \left(r_t^* + \pi_t^P\right) - r_t^* = \hat{\mu}_t / (1 - \hat{\rho}_2) - \hat{\lambda}_t\right)$. This measure, as graphed in Figure 10, suggests that there

[6] The other potential explanation is that the Bank is just not very good at forecasting inflation. While there is always potential for improving forecast performance, the Bank's record on inflation forecasting is not bad. The Theil U measure of the Reserve Bank's published inflation forecasting performance in the period from August 1998 to June 2005, covering inflation outcomes for the six March years 2000 to 2005, averaged 0.15 (where 0 denotes perfection and 1 denotes forecasts that are as bad as could be). This is not a bad outcome, and not one that would justify mistrust in their forecasting ability. The potential concern would be a tendency towards negative bias in their published inflation forecasts (ie for their forecasts to be lower than actual outcomes).

was a steady rise in inflation expectations in the decade to the mid-1980s, followed by moderate declines prior to 1989, a rapid decline in the early 1990s, a spike up in the mid-1990s, further steady declines until 2001, and then a moderate increase in inflation expectations in recent years. Both of the rises in inflation expectations indicate that hard won gains in credibility can erode despite the legal framework.

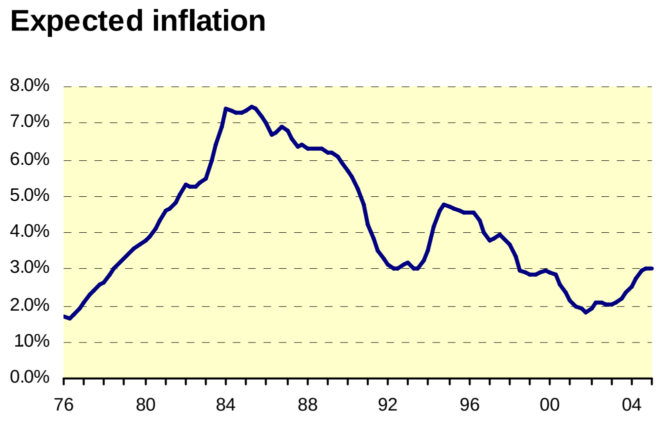

Figure 10

Estimating equation 6 provides an indication of the feedback on short-term output from the operation of monetary policy. Our estimation results are presented in Table A2- 7. The 1.463 and -0.476 estimates of β_2 and β_3 respectively imply a very slow adjustment to an output shock. The estimate for the interest rate impact on output is also not significantly different from zero (suggesting that monetary policy does not have a transmission path via an influence on output). This may reflect the different monetary policy regimes that existed prior to 1989, in particular the presence of interest rate controls and the reliance on reserve asset ratios for the implementation of monetary policy.

A preferred estimation of equation 6 is over a shorter more recent time period, 1990-2005 (see Table A2- 8). This yields a less extreme, but still slow adjustment process to output shocks (1.036 and -0.075 estimates of β_2 and β_3 respectively). It also results in a more credible estimate of the relationship between interest rates and output. At -0.0134, the estimate of β_4 implies that a one percentage point increase in interest rates (over and above that implied by expectations of economic growth and inflation, ie $\left(i_t - \pi_t^P - r_t^*\right)$) has typically been associated with a 1.4 percentage point change in the output gap.

We now also have the necessary information to estimate equation 3 from which we will be able to derive measures of the relative importance of intrinsic ($\sum_{i=1}^{q} \varphi_i L^i \pi_t$, the inertia in inflationary processes whereby past inflation generates current cost-push inflation pressures, for example from wage or price indexation) and extrinsic ($\beta_1 z_{t-1}$, the extent that inflationary pressures are generated by persistent excess demand conditions) inflation persistence. The formulation of equation 3 requires the sum of the parameters on lagged inflation and inflation expectations to sum to 1. We ensure this is the case by subtracting the inflation expectation measure, π_t^P , from both sides of equation 3, yielding:

$$\pi_t - \pi_t^p = \sum_{i=1}^{q} \varphi_i L^i \left(\pi_t - \pi_t^p\right) + \beta_1 z_{t-1} + \varepsilon_{1t} \qquad \textbf{(20)}$$

The results of estimating this equation, using four lags of $\pi_t - \pi_t^p$ are presented in Table A2- 9. The sum of the four estimated φ parameters is 0.9478. This implies very high levels of intrinsic inflation persistence and with the 0.0339 estimate of β_1, it also suggests very low extrinsic inflation persistence. The implication from this is that the inflation process in New Zealand is one that is dominated by intrinsic inflation persistence.

There is evidence that this has changed since the 1980s. Figure 11 graphs the irregular component from the estimation of equation 20, the inflation shocks. Casual observation of this graph suggests that inflation shocks have been lower since 1990. Indeed the standard deviation in $_1$ fell from 1.2 in the pre-1990 period to 0.7 in the post 1990 period.

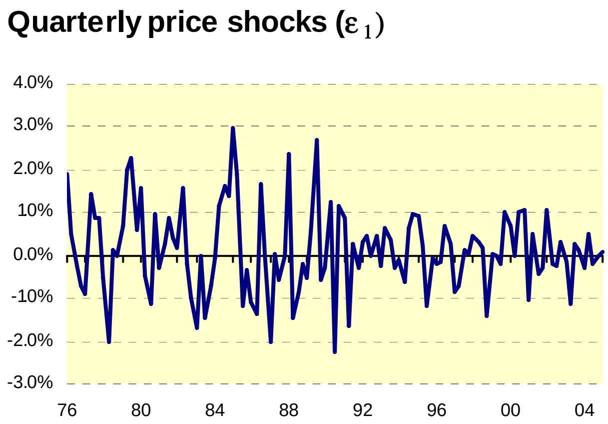

Figure 11

Re-estimating equation 20 just using data from 1990 (see Table A2- 10) suggests that intrinsic inflation persistence is lower than suggested from the full sample estimation. The sum of the four estimated φ parameters is 0.783, which, while still high, implies a greater impact (0.227) from inflation expectations on inflation. Finally, while the implied magnitude of extrinsic inflation persistence remains low (0.0606) it is statistically significant.

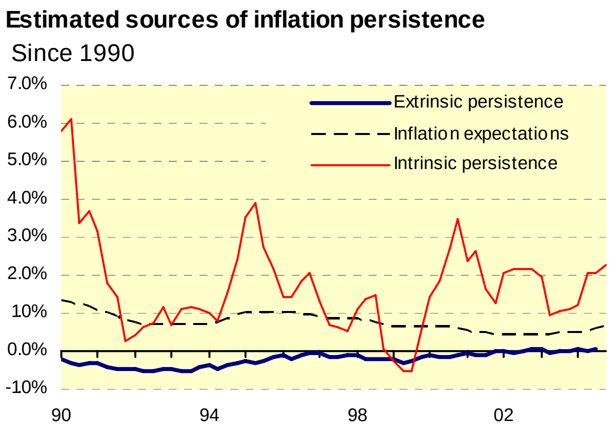

Figure 12

Despite the lower parameter estimate, intrinsic inflation persistence remains the dominant source of inflation pressures in the New Zealand economy (see Figure 12). Demand pressures appear to have had very little impact on inflation outcomes, and if anything have assisted monetary policy in a modest way. Even in the most recent growth phase since 2000 demand factors have been an essentially neutral influence on inflation. The inflationary impact from inflation expectations seems to have steadily declined since 1990. However inflation expectations appear to have been rising since 2001 and this seems to have increased inflation pressures modestly.

Summary of analysis

Key results from the analysis presented above include:

- The Reserve Bank has had considerable success in maintaining inflation at around 1.5% since 1990.
- There has been a steady decline in inflation expectations since the early 1980s, but it still appears to have climbed from 2% to 3% in recent years.
- The magnitude of unanticipated inflation shocks have subsided considerably since the 1970s and 1980s.
- For most of this post-1990 period, it appears that inflation control has been assisted by output rates that have tracked below the economy's non-inflationary potential. However, it is difficult to find much evidence of extrinsic inflation persistence. So while aggregate demand conditions do not appear to have been inflationary, persistent output below potential has not provided much anti-inflationary aid either.
- One reason for the lack of demand pressure on inflation has been the steady expansion in the potential growth rate of the New Zealand economy from an estimated 1.6%pa in the mid-1970s to around 2.6% pa in the first five years of the 21st Century.
- This increase in the potential growth rate has primarily stemmed from increases in the productivity of labour, with estimated labour productivity growth increasing from an average of 0.9% per year in the March 1975 to March 1990 period to 1.7% in the period since, ie from the March 1990 to March 2005. A recovery in labour utilisation since the early 1990s has also contributed.
- There is also evidence of considerable improvements in the efficiency of the New Zealand economy: we estimate that prior to 1985, capacity utilisation rates in excess of 75% of the private sector capital stock were synonymous with accelerating rates of inflation, by 1995 and ever since it appears that 90% of capacity can be utilised without generating inflationary pressures. The last fifteen years have also seen significant improvements in the efficiency of the labour market, with the estimated NAIRU reducing from over 13% in 1990 to under 5% since 2003.

Not all of these outcome improvements can be attributed purely to the operation of monetary policy, as there were, of course, many other policy changes in New Zealand over this period (changes to industry assistance, changes to the operation of fiscal policy, changes to labour laws and so on). But the lower inflationary environment that has prevailed in the period since the Reserve Bank Act 1989 has coincided with a marked improvement in economic performance in New Zealand. The analysis presented here does highlight two potential issues that must be a concern for the operation of monetary policy in New Zealand: the increase in inflation expectations in recent years and the degree that intrinsic inflation persistence contributes to inflation pressures.

Implications for the conduct of monetary policy

Much of the rhetoric that accompanies Monetary Policy Statements and Official Cash Rate Announcements tend to revolve around the extent that demand conditions and, more recently, asset prices are contributing to inflation pressures. However, the analysis presented here suggests that demand conditions in the last fifteen years have typically been assisting inflation control, and even in the period of sustained growth from 2000, output growth remained consistent with maintaining inflation rates at 1.5% pa. Rather it seems that it would be better to characterise recent inflation pressures as resulting from a discontinuation of the excess supply conditions that have previously mitigated the ongoing insidiousness of intrinsic inflation persistence and, more recently (particularly since 2003), an increase in inflation expectations.

What then might explain this indication of persistent intrinsic inflation persistence and the recent growth in inflation expectations? We put forward three potential candidates:

- That despite the intentions of the Reserve Bank Act 1989 and the undoubted genuine attempts of the Reserve Bank to implement monetary policy with a focus on the future, monetary policy in New Zealand in practice tends to be implemented in a reactive, backward looking way.
- That a lack of competition in the domestic sector of the economy is allowing certain sectors to obtain economic rents and a culture of high rates of price increases. That is, aggregate inflation control has not removed inflation persistence from a number of key sectors of the economy. This makes the task of inflation control more difficult for monetary authorities. It is also likely to mask the costs imposed on the economy by sheltered sectors. In the five years from December 2000 to December 2005, a lack of competition in non-tradeable sectors is estimated to have boosted increases in the CPI by 6.8%. The implication is that not only does this represent a direct transfer of resources to these sectors, but it also implies that interest rates and the exchange rate have been higher than they might have been, thus raising the cost of capital for productive sectors and reducing the competitiveness of the tradeable sector.
- That demand conditions in recent years have actually exceeded the economy's supply potential, either due to an understatement of economic activity in official statistics or by our calculations overstating the economy's true supply potential.

Revisions to economic activity data and refinement to estimates of potential output will eventually give a clearer picture of the extent that excess demand may have actually contributed to the increase in inflationary pressures since 2003. Here we present some, largely circumstantial, evidence suggesting at least some role from the first two points in undermining the performance of monetary policy in controlling inflation in New Zealand at the beginning of the 21st Century.

Reactive implementation of monetary policy?

Above, in the discussion about the estimation of equation 19 (see page 13), it was noted that the interaction between interest rates and divergences from the inflation target were stronger (with a parameter of approximately one) one quarter *after* the divergence occurred than with leads of inflation target divergences (a one quarter lead had a parameter of 0.67, falling away to zero with four quarter leads). This is not sufficient evidence to indicate a reactive approach to implementing monetary policy: there will be errors in forecasts of inflation and, more importantly, the implementation of monetary policy will itself change the relationship between interest rates and future inflation outcomes. If monetary policy is implemented based on expectations about future inflation pressures, then as forecasts of inflation rise, interest rates rise correspondingly, future inflation pressures are dampened and there need not be any discernible relationship between current interest rates and future inflation outcomes.

An alternative is to compare interest rate changes with the forecasts of inflation published by the Reserve Bank in their quarterly Monetary Policy Statements. While this approach does not get around all our problems (ideally we would like to compare the monetary policy stance with the Reserve Bank's internal inflation forecasts *prior* to the announcement of policy changes) we would now expect observed interest rate changes to be on balance more marked than forecast inflation outcomes (as published Reserve Bank forecasts would be expected to account for the impact of announced monetary policy changes).

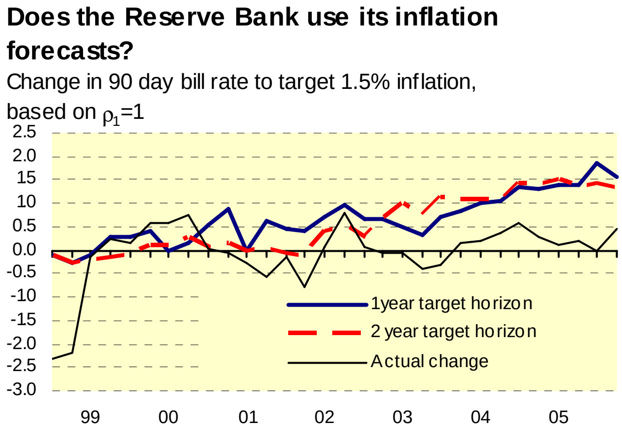

Figure 13

Figure 13 presents actual (percentage point) quarterly changes in 90 day bill rates compared with the percentage point difference between Reserve Bank inflation forecasts and the notional inflation target of 1.5%. The graph presents this divergence in terms of both one-year-ahead and two-year-ahead forecasts of CPI inflation. A one for one relationship between short term interest rates and divergences in inflation expectations with 'target', as suggested by the estimation of ρ_1=1 in equation 19, would be expected to be associated with a collinear relationship between actual interest rate changes and expected divergences of future inflation from target. No such relationship is obvious from the data presented in Figure 13. The correlation between current interest changes and one-year-ahead inflation target divergences is just 0.21. The correlation with two-year-ahead target divergences, at 0.24 is only marginally higher. Regressing the change in 90 day bill rate against the one-year-ahead forecast inflation target divergence over the period 1999.1 to 2005.4, suggests an estimate for ρ_1 of just 0.156 and, like our estimation of equation 19 with four quarter leads of $\pi_{t-1} - \pi_t^T$, not statistically different from zero. A similar result is obtained with two-year ahead forecasts.

Changes in short term interest rates have been consistently lower than what is suggested by the Reserve Bank's own inflation forecasts for every quarter since June 2000 (except for one quarter, June 2002, when the quarterly increase in interest rates appears to have been consistent with the Bank's expectation of two-year-ahead increases in inflation). There are three potential interpretations one can place on this evidence:

The Reserve Bank Governor has put a low weight on the Bank's own inflation forecasts when setting monetary policy in recent years.

The Reserve Bank has a lower perception of what the interest rate adjustment required to reduce future inflation pressures is (ie ρ_1 closer to 0.15 than our estimate of 1.0).

The Reserve Bank's internal operational inflation target, π^T, has been creeping up in recent years.

The potential increase in π^T in recent years implicit from the Reserve Bank's inflation forecasts, changes in short term interest rates, and assuming a 1.0 estimate of ρ_1 is presented in Figure 14. That is the *x*-quarter ahead inflation target is presumed to be the Bank's forecast of inflation in *x* quarters time less the current quarterly change in short term interest rates multiplied by the monetary policy reaction parameter, ρ_1, ie:

$$\pi_t^T = E[\pi_{t+x}] - \rho_1(i_t - i_{t-1}) \qquad (21)$$

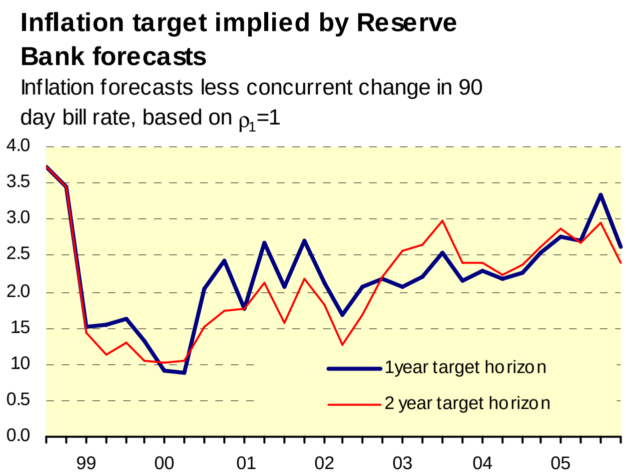

Figure 14

An interpretation of the data presented in Figure 14 is that the operation of monetary policy in recent years has been more consistent with an inflation target of 2-3% than a middle of the target band inflation rate of 1.5-2.5%. This interpretation is also consistent with the evidence presented here that inflation expectations have increased from 2% at the beginning of 2003 to 3% at the beginning of 2005 (see Figure 10).

Such an increase in target and inflation expectations is also consistent with the change in inflation target brought about by the Policy Targets Agreement of 2002 that relaxed the inflation target from deeming price stability to be 0 to 3 per cent inflation over 12 months to one where annual increases of between 1 and 3 per cent on average over the medium term. The concern, however, is that it is not obvious that any benefit in terms of an output dividend from a more relaxed inflation target is likely to materialise if excess demand is not a key source of inflationary pressures and when the rise in target translates directly through into increases in inflation expectations.

Inflation from sheltered sectors

Inflation in New Zealand over the past 15 years has been a largely domestic economy phenomenon. In the fifteen years from 1990.1 to 2005.1 prices for components of the CPI that the Reserve Bank has defined as tradeable increase by 19.4% (or 1.2% per year on average) while non-tradeable components increased by 63.7% (or 3.3% per year). Over the same period, the aggregate CPI increased by 35.5% (or 2.0% per year).

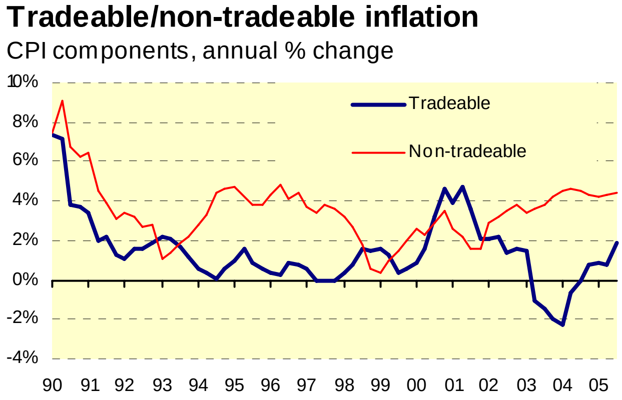

Figure 15

It is too simplistic to presume that consumer price inflation would have been half what it was if all non-tradeable sectors were exposed to international competition. There are legitimate reasons why prices for domestically supplied services might increase by more in New Zealand than in other countries. For example, the smallness of New Zealand's population means that New Zealand providers may not be able to access the economies of scale available in larger population centres. Also the dispersed nature of New Zealand's population may require more duplication of infrastructure capital than is required in more densely populated countries.

However, an investigation of price movements for individual sub-sectors of the CPI suggests that price increases for some products and services have increased considerably more than some other very similar products and services. For example in the five years to December 2005, the price of beer consumed *off* licensed premises increased by 13.2%, while beer consumed *on* licensed premises increased by 23.8%. During the same period the price of international air travel *decreased* by 7.3% while the price of domestic air travel *increased* by 23.6%. In both of these examples price increases have been considerably higher when exposure to competitive forces has been lower. These examples are not atypical. While dwelling rents increased by just 0.9% in five years, the price of purchasing or constructing new dwellings increased by 31.7%, and local authority rates increased by 33.6%. Milk prices increased by 10.6% but the price of a milkshake went up by 27.1%. Telephone rental and connection charges increased by just 2.4%, but then internet charges decreased by 6.2%. While petrol prices increased by 21.6%, electricity prices increased by 32.3% and gas by 40.4%.

What follows is an attempt to estimate the overall impact of such price divergences between similar products or services that have different market structures. The estimation is based on a number of quite subjective and ad hoc judgements about the nature of competition facing different products. The method used is to benchmark the five yearly (December 2000 to December 2005) price movement in each sub-component of the CPI with the component in the CPI that is likely to be most exposed to competition, yet retains broadly similar product or service characteristics. These judgements and a comparison of the five yearly price increases are presented in Appendix 3.

Of the 85 non-tradeable sub-sections of the CPI, 61 (72%) had experienced five year price increases in excess of their assigned "competitive" benchmark, 16 (19%) had smaller increases and 8 (9%) had the same increase (ie they were their own benchmark). Applying the CPI regimen weights to the difference in price increase between benchmarks indicates that the extent that the 61 above benchmark subsections increased in excess of their benchmark contributed an extra 7.2% increase in the CPI over the five year period. Taking off the amount that the 16 smaller increase sub-sections increased less than their benchmark reduces this contribution by 0.4 percentage points. In other words this subjective analysis suggests that a lack of competition may have contributed to a 6.8% increase in the general price level over the five period.

This is a staggering amount. It represents an extra 1.3% inflation on average each year. It represents over half (54%) of the 12.5% increase in the headline CPI over this period. It is also entirely consistent with the evidence presented above that there is a very high degree of intrinsic inflation persistence in the New Zealand economy. It also implies a fairly major inconsistency in the setting of economic policy in New Zealand.

A core factor behind inflation outcomes in New Zealand appears to be imbedded intrinsic inflation persistence that is concentrated in sheltered sectors of the economy. Taking a more conservative line than implied by the numbers just presented, shelter from competition may be adding up to an extra 0.5 percentage points to inflation each year. This in turn, based on our estimated of ρ_1, is potentially adding an extra 50 basis points to short term interest rates. Such higher interest rates potentially act as a brake on economic growth through two mechanisms, it increases the cost of capital for productive sectors of the economy and reduces the competitiveness of the tradeable sector by stimulating a higher exchange rate.

In the absence of policies directly aimed at the regulatory or competitive issues that limit competition or promote price indexation in New Zealand, anti-inflation monetary policy operates as a second-best means of limiting the excesses of monopoly pricing in sheltered sectors of the economy. Inflation control limits the costs imposed by this lack of competition but it is less efficient than addressing the problems directly. The tools available via monetary policy are heavy handed, blunt and are not well suited for targeting specific sector problems. Often the operation of monetary policy simply changes the transmission path by which less efficient sectors impose costs onto the rest of the economy. Higher and more volatile interest rates and exchange rates damage the economic prospects of firms directly exposed to international competition. While exporters bemoan tight monetary conditions and the government bemoan a lack of export growth, the true culprit appears to be an economic structure that continues to encourage a transfer of resources from productive to less productive sectors.

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Appendix 1: Data

Quarter	y_t^r	y_t^r (SA)	i_t	π_t	L_t	U_t	W_t	C_t
1975-1	17124	17007	8.8	148	1337	0.7	2220	0.8887
1975-2	16619	17073	8.1	154	1322	0.9	2232	0.8794
1975-3	16629	17110	7.7	160	1325	1.0	2243	0.8742
1975-4	17999	17162	7.4	166	1347	1.1	2254	0.8901
1976-1	17327	17236	8.9	174	1352	1.2	2262	0.8892
1976-2	16822	17275	8.3	181	1340	1.0	2281	0.8715
1976-3	16832	17316	7.9	187	1342	1.0	2283	0.8799
1976-4	18202	17333	7.5	192	1365	0.9	2285	0.8882
1977-1	17345	17283	14.3	197	1371	0.8	2289	0.8938
1977-2	16840	17291	13.7	207	1358	0.7	2305	0.8784
1977-3	16850	17338	13.2	214	1355	0.9	2304	0.8651
1977-4	18220	17326	12.9	222	1368	1.6	2304	0.8442
1978-1	17026	16982	11.5	226	1364	2.3	2310	0.8455
1978-2	16521	16969	10.9	232	1350	2.6	2324	0.8454
1978-3	16531	17018	10.5	238	1355	2.4	2321	0.8668
1978-4	17901	17029	10.1	244	1381	2.2	2322	0.8724
1979-1	17051	16980	15.2	250	1387	2.2	2326	0.8780
1979-2	16546	16997	14.6	261	1377	2.1	2330	0.8857
1979-3	16556	17042	14.2	274	1382	1.8	2331	0.8907
1979-4	17926	17086	13.8	285	1402	1.8	2337	0.8773
1980-1	17358	17254	14.5	296	1405	1.9	2344	0.8838
1980-2	16852	17302	13.9	308	1386	1.9	2348	0.8607
1980-3	16863	17353	13.5	319	1370	2.2	2357	0.8365
1980-4	18233	17410	13.1	331	1389	2.5	2364	0.8559
1981-1	17490	17369	15.2	341	1395	2.7	2364	0.8512
1981-2	16985	17432	14.6	354	1378	2.6	2370	0.8642
1981-3	16995	17486	14.1	368	1380	2.5	2378	0.8832
1981-4	18365	17571	13.8	383	1410	2.7	2386	0.8887
1982-1	18103	17954	17.4	395	1403	2.8	2391	0.8834
1982-2	17597	18043	16.7	415	1396	2.8	2407	0.8962
1982-3	17608	18107	16.3	429	1397	2.9	2408	0.8704
1982-4	18978	18174	16.0	441	1412	3.7	2423	0.8482
1983-1	18187	18049	13.3	445	1392	4.8	2432	0.8516
1983-2	17681	18121	12.6	449	1376	5.4	2452	0.8469
1983-3	17692	18193	12.2	453	1378	5.5	2455	0.8614
1983-4	19061	18271	11.9	457	1404	5.5	2463	0.8931
1984-1	18547	18391	15.3	460	1408	5.8	2469	0.8967
1984-2	18042	18483	14.7	470	1414	5.3	2484	0.9058
1984-3	18052	18554	14.3	484	1417	5.0	2489	0.8991
1984-4	19422	18644	13.9	500	1451	4.7	2496	0.9098
1985-1	19214	19049	21.4	522	1460	4.6	2500	0.9073
1985-2	18708	19148	23.4	548	1459	4.1	2512	0.9096
1985-3	18719	19232	25.8	563	1461	3.8	2511	0.9017
1985-4	20089	19277	22.7	576	1480	4.0	2517	0.8874
1986-1	19323	19191	22.8	589	1499	4.4	2529	0.8851
1986-2	18818	19247	18.2	605	1481	4.1	2530	0.8676
1986-3	18828	19355	16.2	626	1474	4.0	2532	0.8702
1986-4	20198	19364	18.6	681	1483	4.0	2539	0.8745
1987-1	19622	19506	24.8	697	1495	4.2	2548	0.8753
1987-2	19117	19530	22.7	720	1477	4.1	2552	0.8742
1987-3	19310	19870	18.6	732	1475	4.0	2556	0.8627
1987-4	20682	19801	18.3	747	1492	4.2	2564	0.8633
1988-1	19807	19738	16.6	760	1465	5.0	2569	0.8555
1988-2	19488	19832	15.9	766	1435	5.3	2571	0.8445
1988-3	19583	20239	14.6	773	1409	6.1	2572	0.8497
1988-4	20974	20025	14.3	782	1420	6.0	2577	0.8540

Appendix 1: Data

Quarter	y_t^r	y_t^r (SA)	i_t	π_t	L_t	U_t	W_t	C_t
1990-1	20129	20147	13.8	846	1399	7.3	2602	0.8720
1990-2	19889	20048	13.6	861	1385	7.5	2608	0.8643
1990-3	19263	20210	14.3	869	1378	7.7	2614	0.8563
1990-4	21520	20361	13.8	879	1390	8.6	2624	0.8664
1991-1	19726	19800	12.1	884	1376	9.9	2635	0.8515
1991-2	19647	19722	10.4	885	1358	10.0	2642	0.8374
1991-3	18827	19876	9.3	888	1339	10.7	2649	0.8369
1991-4	21074	19903	8.0	887	1358	10.6	2657	0.8500
1992-1	19970	20035	7.4	891	1355	11.1	2666	0.8533
1992-2	20226	20206	6.8	894	1361	10.0	2672	0.8677
1992-3	18713	19875	6.1	897	1347	10.0	2677	0.8709
1992-4	21115	19928	6.4	899	1374	10.2	2686	0.8751
1993-1	20364	20410	7.5	900	1378	10.2	2695	0.8820
1993-2	20813	20765	6.7	905	1378	9.7	2702	0.8858
1993-3	19868	21100	5.5	910	1387	9.0	2708	0.8937
1993-4	22759	21522	5.5	912	1418	9.1	2718	0.9014
1994-1	21989	22027	4.9	912	1426	9.5	2730	0.9010
1994-2	22284	22159	6.1	915	1431	8.2	2738	0.9026
1994-3	20851	22192	7.2	926	1446	7.5	2746	0.9075
1994-4	23884	22590	8.7	937	1489	7.3	2757	0.9113
1995-1	22862	22898	9.3	948	1496	6.9	2770	0.9098
1995-2	23270	23167	9.1	957	1503	6.1	2779	0.9054
1995-3	21900	23264	9.0	959	1513	5.9	2789	0.9064
1995-4	24675	23346	8.5	964	1546	6.1	2802	0.9100
1996-1	23539	23605	8.6	969	1550	6.5	2816	0.9020
1996-2	23881	23831	9.7	976	1553	5.9	2826	0.8959
1996-3	22806	24134	9.9	982	1552	6.1	2835	0.8977
1996-4	25666	24290	8.9	989	1575	5.9	2847	0.9019
1997-1	24013	24095	7.5	986	1566	6.8	2859	0.9067
1997-2	24805	24822	7.1	987	1557	6.5	2867	0.8702
1997-3	23660	24955	8.0	992	1549	6.6	2873	0.8800
1997-4	26248	24843	7.9	997	1574	6.6	2882	0.8823
1998-1	24527	24626	8.9	999	1566	7.5	2890	0.8850
1998-2	24618	24699	9.1	1004	1537	7.6	2894	0.8719
1998-3	23620	24842	6.8	1009	1537	7.2	2898	0.8687
1998-4	26638	25201	4.6	1001	1556	7.5	2905	0.8749
1999-1	25505	25595	4.4	998	1563	7.5	2911	0.8813
1999-2	25624	25786	4.7	1000	1552	6.9	2914	0.8845
1999-3	25035	26269	4.8	1004	1564	6.6	2918	0.8887
1999-4	27944	26429	5.4	1006	1604	6.1	2925	0.9077
2000-1	26991	27062	6.0	1013	1598	6.6	2932	0.9049
2000-2	26649	26889	6.7	1020	1574	6.1	2935	0.8993
2000-3	25744	26973	6.8	1034	1601	5.7	2940	0.8896
2000-4	28702	27164	6.7	1046	1642	5.4	2947	0.8905
2001-1	27115	27125	6.4	1044	1641	5.7	2953	0.9066
2001-2	27475	27792	5.9	1053	1626	5.2	2958	0.8979
2001-3	26630	27868	5.8	1059	1632	5.1	2966	0.9018
2001-4	29834	28247	5.0	1065	1678	5.2	2981	0.8996
2002-1	28361	28327	5.1	1071	1688	5.5	2997	0.9068
2002-2	28378	28738	5.9	1082	1674	5.1	3010	0.9064
2002-3	27844	29160	5.9	1087	1678	5.3	3023	0.9099
2002-4	31246	29633	5.9	1094	1719	4.7	3040	0.9148
2003-1	29841	29759	5.8	1098	1719	5.2	3059	0.9099
2003-2	29442	29832	5.4	1098	1708	4.6	3074	0.9136
2003-3	28900	30252	5.1	1103	1732	4.3	3087	0.8954
2003-4	32206	30546	5.3	1111	1768	4.5	3101	0.9111
2004-1	31313	31201	5.5	1115	1777	4.5	3116	0.9206
2004-2	30943	31361	5.9	1124	1766	4.0	3126	0.9198
2004-3	30105	31494	6.4	1131	1789	3.6	3136	0.9256
2004-4	33207	31526	6.7	1141	1841	3.5	3148	0.9262
2005-1	31843	31689	6.9	1146	1838	4.2	3160	0.9227

Appendix 2: Estimation results

Table A2- 1: Estimated coefficients of explanatory variables, equation (13)

Variable	Coefficient	R.m.s.e.	t-value
C_{t-1}	0.162978	0.0779190	2.0916 [0.0386] *
L_{t-2}	0.756574	0.122116	6.1955 [0.0000] **
Lvl 1988. 3	0.0440559	0.0106904	4.1211 [0.0001] **
Lvl 1991. 1	-0.0351526	0.0103500	-3.3964 [0.0009] **
Lvl 1997. 2	0.0313467	0.0103578	3.0264 [0.0030] **
Lvl 1998. 4	0.0289074	0.0104196	2.7743 [0.0064] **

Estimation sample is 1975. 1 - 2005. 2. (T = 122, n = 118).
Log-Likelihood is 496.503 (-2 LogL = -993.007).
Prediction error variance is 0.0001313409

Summary statistics	
Std.Error	0.011460
H(39)	1.890
r(1)	-0.015622
r(10)	0.13483
DW	1.839
R_S^2	0.72553

Table A2- 2: Estimated coefficients of explanatory variables, equation (14)

Dependent variable: π_t

Variable	Coefficient	R.m.s.e.	t-value
$\ln(U_t)$	-0.0172970	0.00529132	-3.2689 [0.0014] **

Estimation sample is 1975. 1 - 2005. 1. (T = 121, n = 116).
Log-Likelihood is 529.139 (-2 LogL = -1058.28).
Prediction error variance is 8.07812 xe^{-5}

Summary statistics	
Std.Error	0.0089878
H(39)	0.22173
r(1)	0.094765
r(10)	-0.067196
DW	1.778
R_S^2	0.19260

Appendix 2: Estimation results

Table A2- 3: Estimated coefficients of explanatory variables, equation (15)

Dependent variable: π_t

Variable	Coefficient	R.m.s.e.	t-value
$\ln(C_t)$	0.183663	0.0583428	3.148 [0.0021] **

Estimation sample is 1975. 1 - 2005. 1. (T = 121, n = 116).
Log-Likelihood is 531.755 (-2 LogL = -1063.51).
Prediction error variance is 7.92262xe^{-5}

	Summary statistics
Std.Error	0.0089009
H(38)	0.28053
r(1)	0.062263
r(10)	-0.11294
DW	1.871
R_S^2	0.20814

Table A2- 4: Summary statistics for estimation of equation (7)

Dependent variable: $y_t^p - y_{t-1}^p$

Estimation sample is 1975. 2 - 2005. 1. (T = 120, n = 116).
Log-Likelihood is 531.493 (-2 LogL = -1062.99).
Prediction error variance is 8.87362xe^{-5}

Estimated variance of irregular disturbance, $\sigma_{\eta_2}^2$ = 8.869xe^{-5}

	Summary statistics
Std.Error	0.00942
H(38)	1.583
r(1)	0.038099
r(9)	0.03652
DW	1.900
R_S^2	0.46048

Appendix 2: Estimation results

Table A2- 5: Summary statistics for estimation of equation (8)

Dependent variable: λ_t

Estimation sample is 1975. 3 - 2005. 1. (T = 119, n = 115).
Log-Likelihood is 1336.94 (-2 LogL = -2673.87).
Prediction error variance is $6.29328xe^{-11}$

Estimated variance of irregular disturbance, $\sigma^2_{\eta_3}$ = 0.0000

Estimated variance of level disturbance, $\sigma^2_{\eta_4}$ = $6.5362xe^{-11}$

Summary statistics	
Std.Error	$7.933xe^{-6}$
H(38)	1.477
r(1)	0.044878
r(9)	0.043161
DW	1.887
R^2_S	0.83264

Table A2- 6: Estimated coefficients of explanatory variables, equation (19)

Dependent variable: i_t

Variable	Coefficient	R.m.s.e.	t-value
i_{t-1}	0.804535	0.0429384	18.737 [0.0000] **
$\left(\pi_{t-1} - \pi^T_t\right)$	1.0247	0.223955	4.5757 [0.0000] **

Also unreported results for seasonal and irregular intervention variables (1977.1, 1979.1, 1985.1, 1998.4)

Estimation sample is 1974. 3 - 2005. 3. (T = 125, n = 121).
Log-Likelihood is 268.062 (-2 LogL = -536.124).
Prediction error variance is $7.677189xe^{-3}$

Estimated variance of irregular disturbance, $\sigma^2_{\varepsilon_2}$ = $6.75619xe^{-3}$

Summary statistics	
Std.Error	0.0087320
H(40)	1.055
r(1)	0.14931
r(10)	-0.08101
DW	1.688
R^2_S	0.49619

Appendix 2: Estimation results

Table A2- 7: Estimated coefficients of explanatory variables, equation (6), 1975-2005

Dependent variable: z_t

Variable	Coefficient	R.m.s.e.	t-value
z_{t-1}	1.4626	0.0726733	20.125 [0.0000] **
z_{t-2}	-0.475599	0.0737073	6.4525 [0.0001] **
$\left(i_{t-3} - \pi^{P}_{t-3} - r^{*}_{t-3}\right)$	-0.00118401	0.000933758	1.238 [1.268]

Also unreported results for seasonal and irregular intervention variables (1988.3, 1991.2)

Estimation sample is 1975. 3 - 2005. 1. (T = 119, n = 116).
Log-Likelihood is 594.845 (-2 LogL = -1189.69).
Prediction error variance is 2.02385xe^{-5}

Estimated variance of irregular disturbance, $\sigma^2_{\varepsilon 3}$ = 1.8354xe^{-5}

Summary statistics	
Std.Error	0.0044987
H(38)	1.750
r(1)	0.08632
r(9)	0.22694
DW	2.136
R^2_S	0.4273

Table A2- 8: Estimated coefficients of explanatory variables, equation (6), 1990-2005

Dependent variable: z_t

Variable	Coefficient	R.m.s.e.	t-value
z_{t-1}	1.0359	0.133544	7.7573 [0.0000] **
z_{t-2}	-0.0750213	0.130213	0.5761 [0.5667]
$\left(i_{t-3} - \pi^{P}_{t-3} - r^{*}_{t-3}\right)$	-0.013406	0.003398	3.9453 [0.0002] **

Also unreported results for seasonal and irregular intervention variables (1991.2)

Estimation sample is 1990.1 - 2005. 1. (T = 61, n = 58).
Log-Likelihood is 293.037 (-2 LogL = -586.074).
Prediction error variance is 1.63864xe^{-5}

Estimated variance of irregular disturbance, $\sigma^2_{\varepsilon 3}$ = 1.833xe^{-5}

Appendix 2: Estimation results

Summary statistics	
Std.Error	0.004048
H(19)	3.227
r(1)	-0.059896
r(7)	0. 07388
DW	2.093
R_S^2	0.3801

Table A2- 9: Estimated coefficients of explanatory variables, equation (3), 1976-2005

Dependent variable: $\pi_t - \pi_t^p$

Variable	Coefficient	R.m.s.e.	t-value
$\left(\pi - \pi^p\right)_{t-1}$	1.2649	0.0717781	17.623 [0.0000] **
$\left(\pi - \pi^p\right)_{t-2}$	-0.140997	0.122224	1.1536 [0.2511]
$\left(\pi - \pi^p\right)_{t-3}$	-0.31016	0.119629	2.5927 [0.0108] *
$\left(\pi - \pi^p\right)_{t-4}$	0.134094	0.068453	1.9589 [0.0526]
z_{t-1}	0.0339109	0.0318268	1.0655 [0.2889]

Also unreported results for seasonal and irregular intervention variables (1983.2, 1986.4, 1987.4)

$$\sum_{i=1}^{4} \varphi_i = 0.94784$$

Estimation sample is 1976. 1 - 2005. 1. (T = 117, n = 114).
Log-Likelihood is 484.776 (-2 LogL = -969.553).
Prediction error variance is 9.81817 xe^{-5}

Estimated variance of irregular disturbance, $\sigma_{\varepsilon_1}^2$ = 0.0001078

Summary statistics	
Std.Error	0.009909
H(38)	0.21968
r(1)	0.10383
r(9)	0.08471
DW	1.767
R_S^2	0.60901

Appendix 2: Estimation results

Table A2- 10: Estimated coefficients of explanatory variables, equation (3), 1990-2005

Dependent variable: $\pi_t - \pi_t^p$

Variable	Coefficient	R.m.s.e.	t-value
$\left(\pi - \pi^p\right)_{t-1}$	1.0003	0.13728	7.2866 [0.0000] **
$\left(\pi - \pi^p\right)_{t-2}$	-0.154554	0.18285	0.8453 [0.4014]
$\left(\pi - \pi^p\right)_{t-3}$	0.058423	0.17177	0.3401 [0.7350]
$\left(\pi - \pi^p\right)_{t-4}$	-0.12082	0.11676	1.0348 [0.3051]
z_{t-1}	0.060551	0.02579	2.3477 [0.0223] *

Also unreported results for seasonal variables

$$\sum_{i=1}^{4} \varphi_i = 0.78335$$

Estimation sample is 1990. 1 - 2005. 1. (T = 61, n = 58).
Log-Likelihood is 272.488 (-2 LogL = -544.977).
Prediction error variance is 3.8416 xe^{-5}

Estimated variance of irregular disturbance, $\sigma_{\varepsilon_1}^2$ = 0.00017855

Summary statistics	
Std.Error	0.0061981
H(19)	0.53289
r(1)	0.05658
r(7)	0.18226
DW	1.866
R_S^2	0.17795

Appendix 3: Five year price increases for non-tradeable CPI subsections

Non-tradeable subsection	Price increase five years to Dec 2005	Linked "competitive" subsection	Price increase five years to Dec 2005
Fresh and frozen poultry	-2.5%	Steak	20.0%
Eggs	16.2%	Milk	10.6%
Bread and bread rolls	7.2%	Breakfast cereals	12.9%
Cakes and buns	5.4%	Biscuits	11.8%
Milkshakes	27.1%	Milk	10.6%
Restaurant meals	9.8%	Food group	10.8%
Chicken	8.8%	Food group	10.8%
Fish and chips, french fries	18.3%	Food group	10.8%
Hamburgers	21.9%	Food group	10.8%
Ethnic food	9.2%	Food group	10.8%
Pizzas, pies and quiche	14.2%	Food group	10.8%
Soup	31.8%	Food group	10.8%
Sandwiches and filled rolls	27.4%	Food group	10.8%
Cakes, biscuits, buns and muffins	27.6%	Food group	10.8%
Takeaway drinks	-10.7%	Food group	10.8%
Rented dwellings	0.9%	Rented dwellings	0.9%
Purchase and construction of new dwellings	31.7%	Rented dwellings	0.9%
Professional services	15.1%	Tertiary tuition	8.1%
Real estate services	76.3%	Tertiary tuition	8.1%
Dwelling maintenance services	23.8%	Vehicle servicing and repairs	23.1%
Insurance of dwellings	33.9%	Vehicle insurance	6.8%
Local authority rates	33.6%	Rented dwellings	0.9%
Electricity	32.3%	Petrol	21.6%
Gas	40.4%	Petrol	21.6%
Cleaning and laundry services	12.4%	Vehicle servicing and repairs	23.1%
Repairs to appliances	22.1%	Vehicle servicing and repairs	23.1%
Delivery and removal services	25.1%	International air travel	-7.3%
Household appliance and equipment hire	5.7%	Refrigerators and freezers	1.3%
Television subscription and public broadcasting fee	11.9%	Internet charges	-6.2%
Household contents insurance	12.4%	Vehicle insurance	6.8%
Veterinary services	28.7%	Tertiary tuition	8.1%
Postage	14.0%	Internet charges	-6.2%
Telephone call charges	2.9%	Internet charges	-6.2%
Telephone rental and connection	2.4%	Internet charges	-6.2%
Internet charges	-6.2%	Internet charges	-6.2%
Rental car hire	-13.7%	New cars	-5.1%
Taxi and shuttle hire	24.3%	International air travel	-7.3%
Suburban bus and rail fares	10.2%	International air travel	-7.3%
Long distance bus, rail and ferry fares	3.9%	International air travel	-7.3%
Domestic air travel	23.6%	International air travel	-7.3%
Relicensing, registration and warrant of fitness	9.0%	Vehicle insurance	6.8%
Driving tuition	24.7%	Vehicle insurance	6.8%
Motoring organisation subscriptions	-7.3%	Vehicle insurance	6.8%
Parking fees	72.6%	Rented dwellings	0.9%
Vehicle servicing and repairs	23.1%	Vehicle servicing and repairs	23.1%
Vehicle insurance	6.8%	Vehicle insurance	6.8%
Cigarettes and cigars	17.2%	Cigarette and pipe tobacco	11.3%
Cigarette and pipe tobacco	11.3%	Cigarette and pipe tobacco	11.3%
Beer consumed on licensed premises	23.8%	Beer consumed off licensed premises	13.2%
Beer consumed off licensed premises	13.2%	Beer consumed off licensed premises	13.2%
Spirits(2)	17.6%	Beer consumed off licensed premises	13.2%
Liqueurs(2)	14.5%	Beer consumed off licensed premises	13.2%
Wine(2)	9.2%	Beer consumed off licensed premises	13.2%
Hairdressing	21.0%	Vehicle servicing and repairs	23.1%
Watch and jewellery repairs	23.4%	Vehicle servicing and repairs	23.1%
Funerals	19.5%	Tertiary tuition	8.1%
Employee and vocational society dues	21.2%	Tertiary tuition	8.1%
Term life insurance	4.3%	Vehicle insurance	6.8%
Rest homes fees	13.4%	Rented dwellings	0.9%
General practitioner services	21.0%	Tertiary tuition	8.1%
Medical specialist services	21.2%	Tertiary tuition	8.1%
Dental services	30.5%	Tertiary tuition	8.1%
Hospital services	18.9%	Tertiary tuition	8.1%
Medical insurance	31.2%	Tertiary tuition	8.1%
Optometrist services	18.2%	Tertiary tuition	8.1%
Contraceptive supplies(3)	66.7%	Vitamins	16.7%
Prescription medicines	8.5%	Vitamins	16.7%
Newspapers	37.6%	Magazines and periodicals	12.7%
Cinemas, theatres and concerts	21.8%	Rented dwellings	0.9%
Games and sports events	3.4%	Rented dwellings	0.9%
Sports, fitness and recreation activities	28.6%	Rented dwellings	0.9%
Clubs and societies	13.3%	Rented dwellings	0.9%
Video tape and game hire	0.7%	Audio/video cassettes and CDs	-6.1%
Holiday tours	15.6%	Rented dwellings	0.9%
Photographic services	1.8%	Tertiary tuition	8.1%
Educational accommodation	23.8%	Rented dwellings	0.9%
Hotel and motel accommodation	19.5%	Rented dwellings	0.9%
Motor camp and holiday accommodation	30.9%	Rented dwellings	0.9%
Primary and secondary school tuition	31.8%	Tertiary tuition	8.1%
Tertiary tuition	8.1%	Tertiary tuition	8.1%
Special interest courses and hobbies	12.5%	Tertiary tuition	8.1%
Kindergartens and playcentres	37.3%	Tertiary tuition	8.1%
Child care and crèches	8.8%	Tertiary tuition	8.1%
Financial service charges	-4.2%	Financial service charges	-4.2%
Credit and store card fees	14.5%	Financial service charges	-4.2%