What has been the impact of Fiscal Policy on Long-term Interest rates in New Zealand?

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Abstract

Understanding the impact of fiscal policy on long-term interest rates has important implications for economic policy-makers. This empirical study discovers a strong positive long-run relationship between fiscal policy and long-term interest rates in a New Zealand context. The results are consistent with the ‘conventional view’ of the effects of government debt on interest rates, as they suggest budget deficits ‘crowd out’ interest sensitive components of investment. Over the long run a lower capital stock is likely to impact negatively on New Zealand’s rate of economic growth. Further, in the short run, it suggests fiscal policy may have prevented monetary policy from properly managing interest rates.

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1 Introduction

The relationship between a government's fiscal position and long-term interest rates is potentially of great importance to economic policy-makers. Evidence supporting a positive relationship between budget deficits and long-term interest rates could have two important implications. First, as predicted by the ‘conventional view’ (Blinder and Solow 1973), when the government runs a budget deficit it competes with the private sector for funds. In turn this drives up real interest rates and leads to a decline in interest-sensitive components of private spending like investment. Over the long run capital accumulation diminishes, and future economic growth is negatively impacted. Second, large budget deficits may prevent monetary policy from properly managing interest rates. This would have further implications for deciding on the appropriate mix between fiscal and monetary policy.

Two theoretical hypotheses have been used to explain the possible absence of a relationship. The first of these has become widely known as the Ricardian Equivalence Hypothesis [REH] (Barro 1974). Assume that the government cuts taxes today without any plans to reduce government purchases today or in the future. REH asserts that this policy will not alter consumption, interest rates, capital accumulation, or any macroeconomic variables. The hypothesis is based on the insight that lower taxes and a budget deficit today require, in the absence of any change in government purchases, higher taxes in the future. If the government issues debt to finance a tax cut this does not represent a reduction in the tax burden, but merely a postponement of it (for a given level of government purchases). Sufficiently forward-looking agents will realise that their future tax burden is unchanged and will not respond to the tax cut by increasing consumption. Instead, they will save the entire tax cut to meet the projected future tax liability. That is the decrease in public saving (the budget deficit) will coincide with an increase in private saving of precisely the same size. National saving will stay the same, as will all other macroeconomic variables including interest rates.1

The second explanation is often referred to as the Capital Inflow Hypothesis [CIH] (Dwyer 1985). CIH is based on the idea that the demand for government debt is infinitely elastic. That is, an increase in the deficit will be financed partly or wholly not only by
domestic savings but an inflow of capital from abroad. If CIH holds interest rates will remain unchanged. This seems entirely plausible in a world of increased capital mobility, particularly for a small open economy.

Evidence?

Empirical evidence on the relationship has been mixed. Findlay (1990:438) goes as far as to call it one of the "most econometrically elusive relationships in economics". Budget deficits have been found to have significant positive, no, and even negative effects on a range of interest rates. Not surprisingly, approaches have varied widely in methodology, sample period, definition of deficit variables and estimation technique, however some points of commonality can be identified.

Studies that fail to find a relationship, ‘non existence’ studies, predominantly use quarterly or monthly data on short-term rates. One obvious justification for this is being able to use a significant number of observations, since most studies span only some two decades. Some researchers have charged that monthly or quarterly data may bias the results in favour of finding no significant linkage. Hoelscher (1986) reasoned that portfolio adjustment lags are too long for monthly or even quarterly data to reflect the actual correlation between budget deficits and interest rates. That is, these data may be a further source of measurement error, and bias the estimated coefficients toward zero and the null hypothesis of ‘non existence’. This approach is in contrast with recent studies that support the existence of a relationship. These studies tend to use the actual (cf. expected) deficit as an explanatory variable, and test using annual data on long-term interest rates; for example, Hoelscher (1986), Tran and Sawhney (1988), Vamvoukas (1999), Allen and Wohar (1996), Monadjemi and Kearney (1991), and Correia-Nunes and Stemitsiotis (1995).

The role of the term structure

Economic theory provides important guidance to which interest rate is appropriate. If budget deficits matter for the general economy, and interest rates in particular, then it must be on an inter-temporal decisions basis (Correia-Nunes and Stemitsiotis 1995:427).
In a growth economy with capital accumulation, government dissaving may create, over the long run, a shortage of funds available for investment. If the imbalance between the supply and demand for intended investment funds is not met, long-term interest rates react via the term structure. The term structure plays a potentially important role in the transmission of macroeconomic policy (Turnovsky 1989). For instance, if the government runs an anticipated fiscal deficit in the current period then this may create, over the long term, a shortage of funds available for investment. If this anticipated shortfall is not met, long-term interest rates will rise now as rational agents respond to the shortage. The effect on short-term rates however will be initially small, since future short-term rates will be anticipated to rise.

Term structure theory also highlights the role played by monetary policy when conducted through leverage of short-term interest rates. These effects can also be transmitted into long-term interest rates via the term structure, which in turn influences the real rate of investment and capital accumulation.

*The New Zealand experience*

In New Zealand the behaviour of long-term nominal and real interest rates over the past three decades has been influenced by a number of important historical factors. Following the first oil shock of 1973-1974, New Zealand, like many industrialised countries, experienced negative or very low real long-term interest rates as increases in inflation were larger than increases in nominal long-term interest rates (Figure 1).\(^2\) Two conceivable factors lay behind this negative correlation. Following the oil shock and the sharp acceleration in inflation, strict financial regulations meant inflationary pressures were unable to be fully reflected in the nominal rate. This can be observed in Figure 1 in the step-wise appearance of the long-term nominal interest rate (LN) up until late 1984, prior to financial deregulation.

**FIGURE 1**

Following deregulation, the long-term nominal interest rate increased rapidly as high inflation persisted from the second oil shock of 1979 and as inflationary expectations
became more fully reflected. Importantly, this event coincided with the Reserve Bank's strong (and increasingly credible) disinflationary stance which helped push nominal short-term interest rates to historically high levels, which in turn was transmitted via the term structure to long-term rates.

The remainder of the paper is structured as follows. Section 2 presents a simple loanable funds model. Sections 3 and 4 describe data issues and time-series properties. Section 5 applies a recently developed econometric method and presents results. Section 6 discusses and interprets the empirical evidence and section 7 summarises the overall approach and draws conclusions.

2 Model Specification

In the interest rate literature, the majority of recent studies have adopted either a standard IS/LM, loanable funds, or term structure framework in which to derive a testable reduced form interest rate equation. The model used in this study is couched in the loanable funds framework. This model offers a sufficiently large and flexible framework for the analysis of long-term interest rate behaviour in that it allows for the major theoretical, empirical and historical considerations to be directly incorporated.

The loanable funds model is a partial equilibrium model that predicts that the long-term nominal interest rate is determined by the supply and demand for funds. The model developed is adapted from Echols and Elliot (1976) and based primarily on the approaches taken by Hoelscher (1986), Cebula (1988), Tran and Sawhney (1988), and Correia-Nunes and Stemitsiotis (1995), in that the term structure is explicitly incorporated. The equilibrium relationship can be represented as:

\[ S(\cdot) = D(\cdot) \]  

(1)

The flow supply of long-term funds, \( S(\cdot) \), is assumed to depend: positively on the long-term nominal rate, \( i_L \), as lending becomes more attractive; negatively on the short-term real rate, \( r_S \), as the short end of the market competes directly with the long end for funds; and negatively on the expected inflation rate, \( \pi^e \), since expected real returns of lenders
will fall as expectations of inflation rise; positively on the budget deficit, $d$, consistent with REH as rational agents bring forward decisions to save in line with government dissaving; and finally positively on foreign capital inflows, $c$, via increased access to foreign savings.

The demand for long-term funds, $D(\cdot)$, is assumed to depend: negatively on the long-term nominal rate (i.e. the nominal cost of borrowing); positively on expected inflation as the expected real cost of borrowing falls when inflation rises; negatively on short-term real rates again via the substitution effect with long-term rates; and positively on the budget deficit as the public sector increases its demand for funds.

The key reduced form equation that provides the basis for this empirical investigation emerges from solving and linearizing the equilibrium condition:

\[
  i_L = \gamma_1 + \gamma_2 r_S + \gamma_3 \pi^e + \gamma_4 d + \gamma_5 c
  \]

where the nominal long-term interest rate depends positively on short-term interest rates and expected inflation, $\gamma_2 > 0$ and $\gamma_3 > 0$, respectively. The impact of budget deficits is theoretically ambiguous. $\gamma_4 > 0$ would support the ‘conventional view’. $\gamma_4 = 0$ would support the REH. $\gamma_4 < 0$ would be inconsistent with both views. The effect of capital inflows is similarly ambiguous since it is a function of both the supply and demand for funds. CIH would predict $\gamma_5 > 0$. Thus, (2) nests several competing hypotheses.

Also by specifying the nominal long-term interest rate and the expected inflation rate separately, (2) allows for departures from the full Fisher effect which predicts a coefficient of unity on $\pi^e$, that is, $\gamma_3 = 1$ (Correia-Nunes and Stenitisiotis 1995:432). This is important since recent empirical evidence regarding the full Fisher effect is mixed (for instance Mishkin (1992) used cointegration analysis with period dependent results).
3 Data Issues

3.1 Expected Inflation

Many of the criticisms levelled at studies into the relationship between deficits and interest rates centre around their perceived failure to construct appropriate measures of expected inflation, thus biasing results toward non-existence. Here two alternative measures of expected inflation are constructed.

The Hodrick Prescott [HP] filter (Hodrick, R. and E. Prescott (1980)) has been routinely used as a method of de-trending aggregate output in the real business cycle literature. More recently, Tease et al. (1991), Correia-Nunes and Stemitsiotis (1995), and Kramer (1998) have used the HP filter to model expected inflation. The motivation for using the HP filter can be viewed in light of the basic problem faced by the researcher: trying to capture a measure of expected inflation from an observed series. One way to do this is to assume that observed inflation π contains both an expected π^e and unexpected π^u component. This decomposition can be represented in time as:

\[ \pi_{t+i} = \pi_{t+i}^e + \pi_{t+i}^u \]  

(3)

This equation states that observed inflation in period \( t+i \) is equal to the anticipated inflation rate formed in the previous period \( t \) (about \( t+i \)), plus an unexpected random component. At period \( t+i \) one is able to observe \( \pi \), but cannot measure either the expected or unexpected components. Thus, an expectations adjustment rule is required. If prices are sticky a rule can be assumed in which expected inflation moves continuously but adjusts only gradually over time. Such a rule can be expressed in the following Lagrangian minimisation problem, which also happens to form the basis for the HP filter

\[
\min_{\{\pi_t^e\}} \sum_{t=1}^{T} \left[ (\pi_t - \pi_t^e)^2 + \lambda \left[ (\pi_{t+1}^e - \pi_t^e) - (\pi_t^e - \pi_{t-1}^e) \right] \right]
\]  

(4)

The objective is to select values of \( \pi_t^e \) which minimise the sum of the squared deviations from observed inflation, \( \pi \), subject to the constraint that changes in expected inflation vary gradually over time. The Lagrange multiplier, \( \lambda \), is positive and has the
interpretation that large values penalise changes in expected inflation. By manipulating the first order condition, a time representation of the filter expressed as a two-sided moving average of observed inflation can be obtained

\[ \pi^e = \sum_{j=-\infty}^{\infty} \mu_j \pi_{t+j} \]  

(5)

where \( \mu \) depends on \( \lambda \).

The HP filter has good economic properties in that it contains both forward and backward-looking information on inflation rates (Correia-Nunes and Stemistsiotis (1995:434)). Past information is necessary to adjust prices back toward equilibrium, whilst forward information regarding future trends is also incorporated as rational agents use this to form expectations about future inflation rates.\(^5\)

The effect the HP filter has on the time-series properties of the extracted series \( \pi^e \), when the underlying series, \( \pi \), is difference stationary, that is I(1), is important. Unlike traditional linear trend filtering which requires stationary time series, the HP filter permits the series to have a stochastic growth component. This has important implications for the unit root testing analysis and estimation techniques employed later in the paper.

The use of survey measures of expected inflation, as a proxy for the unobservable variable, is also consistent with a number of past studies that have investigated the relationship.\(^6\) The National Bank of New Zealand has conducted a survey of inflationary expectations since 1983, as part of its Business Confidence Outlook Survey. A second survey based measure was constructed from this series.

3.2 The Budget Deficit Variable

There is a large amount of disagreement in the empirical literature about what constitutes an appropriate measure of the government's fiscal stance over a given period. This disagreement can be attributed to several sources of ambiguity.
The first of these concerns the relationship between inflation and the real value of outstanding government debt. The real deficit is defined to be the change in the real value of the debt. That is the real deficit is the nominal deficit, deflated by the price level, less the inflation rate times the existing debt

\[
d(D/P)/dt = (dD/dt)/P - [(dP/dt)/P](D/P)
\]

The inflation correction, which is represented by the second term on the right-hand side of this equation, can be large when inflation is high or the outstanding debt is large. In fact, it can turn a nominal budget deficit into a real budget surplus.\(^7\)

A second source of ambiguity concerns the level of interest rates. The market value of the debt may be more important than the par value because when interest rates rise, the value of outstanding debt falls, and when interest rates fall, the opposite occurs. Mankiw and Elmendorf (1998) point out that, in the US, the annual change in the market value differed noticeably from the annual change in the par value. However, they do note that both series follow the same broad trends. Unfortunately in New Zealand's case no such readily available series of the market value of debt has been constructed.

The third common adjustment to the budget deficit is for business cycle conditions. Because the deficit rises automatically when economic activity slows, and vice versa, the budget deficit in a given year may offer a misleading impression of underlying fiscal policy.\(^8\) Thus, many studies have included ‘accelerator’ variables to account for the procyclical nature of budget deficits. The problem has been, not surprisingly, that these variables have been highly correlated with the budget deficit variable thus causing multicollinearity problems.

The measure chosen to represent the government’s fiscal stance in this study is consistent with the flow based model presented in Section 3. It was constructed as follows

\[
d = \frac{DDB}{GDP}
\]

where \(d\) is the deficit measure, DDB is the Deficit Before Borrowing (corresponding to Table B2, published in various volumes of the Reserve Bank Bulletin)\(^9\) as a proportion of...
nominal GDP (source: OECD 1998). As mentioned there is a general consensus that the
deficit is an annual concept, since quarterly observations likely contain large seasonal
variations (depending on the timing of receipts and payments). To remove seasonal
effects (as well as for consistency with the denominator), the quarterly deficit figure was
annualised by summing the current and three previous periods for each observation.

Since most economic decisions occur at the microeconomic level the aggregation from
the micro level to the macro level should be scaled appropriately (Hoelscher 1986:4).
One way to do this is by the size of the population. Another is to express the deficit as a
proportion of nominal GDP, thus accounting for the size of the economy (since an
absolute measure of the deficit is essentially meaningless). Note the GDP figure
represented the seasonally adjusted annual figure for each quarter. The measure
constructed is consistent with the loanable funds model in that it captures the flow of
funds in a given period. This is different from papers that use the existing stock of debt
(accumulated deficits) where the effect on interest rates is transmitted via wealth effects.

4 Unit Root Pre-testing

The problems caused by non-stationary variables in standard regression analysis have
been well documented in the time-series literature. Thus, Augmented Dickey-Fuller
[ADF] tests were employed to determine the order of integration of each variable.

Maddala and Kim (1998:45) have argued that traditional ADF tests lack power,
especially against meaningful alternatives. In this study the ADF test results were not
relied on totally but used only as a guide. The estimation technique used did not strictly
require pre-testing for unit roots if the variables under consideration were I(0), or I(1) or
even partially integrated. Nevertheless, pre-testing had the important task of testing for
I(2) variables. For the sake of completeness I(1) versus I(0) tests were also employed.

TABLES 1 and 2

Tables 1 and 2 summarise the ADF testing results for unit roots using the ‘General to
Specific’ approach to lag order selection and the Perron (1988) testing strategy. They
indicate that all variables contain unit roots except for the short-term real interest rate and
capital inflow measures. That is the variables tested are a mixture of I(1) and I(0) processes.

5 Estimation

The choice of econometric technique used to estimate equation (2) was important because this study was faced with several phenomena that needed to be properly addressed.

First, the ADF tests indicated that all but two of the variables may be non-stationary processes, that is I(1). ‘Standard’ estimation techniques applied in the presence of non-stationary variables were unlikely to be appropriate. Second, although the dependent variable was I(1) the independent variables (regressors) appeared to be a mixture of I(0) and I(1) processes. Third, to address the main hypothesis of whether there exists a relationship between budget deficits and long-term interest rates, valid inferences needed to be drawn on individual coefficients in the levels relationship. Fourth, past long-term interest rates could influence present and future deficits via interest payments on debt accumulated in previous periods.

To address the first consideration a Bounds Testing Approach [BTA] to the analysis of a levels relationship was used developed by Pesaran, Shin, and Smith (2001) [PSS]. The BTA had the advantage of being applicable irrespective of whether the underlying regressors were purely I(0), purely I(1) or even mutually cointegrated. This also directly addressed the second consideration. The BTA differs from existing methods, such as the two-step residual-based procedure and Johansen's (1991) system-based approach, in that potentially no pre-testing of the variables is necessary. A problem with pre-testing is that it invariably introduces a further degree of uncertainty. Given the doubt surrounding the order of integration of some variables and the traditional criticisms of ADF tests (Maddala and Kim 1998), the applicability of this approach seemed particularly relevant.

The third consideration required, in the face of non-stationary variables, an approach that could correct for non-normal standard errors on the individual estimated coefficients in a valid levels relationship. Thus, the ‘autoregressive distributed lag’ [ARDL] approach to cointegration (Pesaran and Shin 1999) was employed to estimate valid asymptotic $t$-
statistics. Finally, the fourth consideration implied autocorrelation in the residuals, which could bias the estimated coefficient on the budget deficit toward zero. Fortunately, the ARDL approach and resulting Error Correction Model [ECM] explicitly incorporated such dynamic considerations.

Therefore, the econometric approach adopted made specific allowances for all four considerations.

5.1 A Bounds Testing Approach to Cointegration

This section derives the ECM representation of equation (2). First consider the following matrix and time representation of all variables under consideration

\[ z_t = (i_t, r_t, \pi^e_t, d_t, c_t)' = (i_t, x_t)' \]

where all variables have identical interpretations to those contained in (2). Using this notation the conditional ECM representation for the reduced-form interest rate equation (2) can be expressed as

\[ \Delta i_t = a_0 + a_1 t + \alpha_{i_{t-1}} + \beta x_{t-1} + \sum_{j=1}^{p-1} \phi^j \Delta z_{i,t} + \lambda' x_t + u_t \]

where \( \beta = [\beta_1, \beta_2, \beta_3, \beta_4]' \) and \( t = \) time trend

Under the assumption that the lagged long-term nominal interest rate, \( i_{t-1} \), does not enter the sub-VAR model for \( x_t \)—which contains the ‘long-run forcing variables’—the above equation is said to be identified and can thus be estimated consistently by OLS (PSS 2001:18).

It is important to emphasise the main assumptions and limitations underpinning (9). The equation is conditional in that it assumes there exists a single long-run relationship between the variables. In this case \( r_t, \pi^e_t, d_t \) and \( c_t \) are assumed to be ‘long-run forcing’ variables on \( i_t \). This means consideration of (9) is restricted to cases in which there exists at most one conditional level relationship between \( i_t \) and \( x_t \). This assumption effectively rules out the simultaneous determination of the variables—at least in the long run.
If more than one long-run relationship is found to exist, then this single-equation approach is no longer valid and a multi-equation systems approach, such as Johansen (1991), should be employed. This problem is inherent in all single-equation approaches. Thus, in order to proceed it is necessary to assume that, if there exists a levels relationship involving $i_t$, then it is unique.

### 5.1.1 Selecting Lag Order ‘p’

Equation (9) is also based on the assumption that the disturbances $u_t$ are serially uncorrelated. Therefore it was important that the lag order $p$ was selected appropriately.\(^{14}\) PSS (2001:19) state that there is a delicate balance between choosing $p$ sufficiently large to avoid the presence of serial correlation in the disturbance term, whilst at the same time sufficiently small so that (9) is not over-parameterized. This point was particularly relevant given the limited number of observations ($T=52$).

Thus, (9) was estimated by OLS, with and without a linear time trend, for $p = 1, 2, 3, 4$ and 5.\(^{15}\) The $t$-statistics on the lagged differenced variables in all regressions were then checked against their 0.10 critical values. It was found that the coefficients on the lagged changes of the deficit variable ($\Delta d_{t-1}$, $\Delta d_{t-2}$, $\Delta d_{t-3}$ and $\Delta d_{t-4}$) were insignificant in all regressions. They were subsequently dropped.\(^{16}\) The coefficients on all other lagged differenced variables were found to be significant (either singly or jointly) and thus included. With these modifications, all regressions were re-estimated. The values of $p$ selected by four selection criteria, Akaike’s Information Criteria [AIC], Schwarz’s Bayesian Criteria [SBC], $\chi^2(1)$ and $\chi^2(4)$ (LM statistics for testing no residual serial correlation against orders 1 and 4), for the two alternative specifications are contained in Tables 3 and 4.

**TABLE 3**

In Table 3 the lag order selected by AIC was $p_{aic} = 5$ with a deterministic trend and $p_{aic} = 4$ without. These lag orders were inconsistent with those selected by the SBC which selected $p_{sbc} = 1$ in both cases. The $\chi^2$ statistics suggested a relatively high lag selection although not in all cases. On the weight of this evidence and in view of the importance of
the assumption that $u_t$ is serially uncorrelated for the BTA to be valid, $p = 4$ was deemed the preferred lag length selection for the HP equation.

**TABLE 4**

The results in Table 4 were $p_{aic} = 2$ and $3$, with and without a deterministic trend respectively, and $p_{sbc} = 1$ in both cases. These statistics suggested a lower value of $p$ than those in Table 3 did. However the $\chi^2$ statistics were less conclusive in this table, although they did tend to point to a value of $p < 5$. On balance $p = 2$ seemed the most preferred choice.

In summary, the results were less than conclusive regarding the exact value of $p$. For completeness and to check sensitivity, regressions using $p = 1, 2, 3$ and $4$ were ultimately used in the BTA.

5.1.2 **Bounds Tests for a Level Relationship**

The next step involved computing the $F$-statistic to test the significance of the lagged levels relationship in (9). However, the asymptotic distribution of the $F$-statistic is non-standard under the null hypothesis, that there exists no level relationship, irrespective of whether the regressors ($r_t$, $\pi^t$, $d_t$, $c_t$) are I(0) or I(1). Thus, PSS (2001:Tables 1-5) have tabulated two sets of asymptotic critical values for the two polar cases: one when all of the regressors are purely I(1) and the other when they are all purely I(0). The two sets of asymptotic critical values thus provide ‘critical value bounds’ covering all possible classifications of the regressors from purely I(0), purely I(1) or mutually cointegrated (PPS 2001:1). Formally, the hypothesis being tested with respect to (9) was that there existed no valid levels relationship

\[ H_0 : \alpha = \beta = 0 \quad \text{versus} \quad H_1 : \text{‘at least one of } \alpha \neq 0, \beta \neq 0' \]

Thus, the relevant statistic was the familiar $F$-statistic (or Wald) for joint significance. If the computed $F$-statistic fell outside the critical bounds a conclusive inference can be drawn without needing to know the integration/cointegration properties of the underlying regressors—that is pre-testing could be avoided.
As well as the $F$-statistic, PSS have constructed similar critical bounds values for the $t$-statistic of Banerjee et al. (1998) corresponding to the coefficient on the error correction term (PSS: Tables C2). In this case with respect to (6.2) the hypothesis was

$$H_0 : \alpha = 0 \quad \text{versus} \quad H_1 : \alpha < 0$$

The results of both the $F$ and $t$-tests, reported in Tables 5 and 6, were then compared with bounds testing Tables C1 and C2 from PSS. Since $k = 4$ the 0.05 critical bounds are (3.05, 3.97), (3.47, 4.57) and (2.86, 4.01) for $F_{IV}$, $F_V$ and $F_{III}$ respectively. The outcome of the test was thus dependent on the choice of lag order $p$.

**TABLE 5**

In Table 5 for $p = 1, 2$ and 4 the $F$-statistics fell outside the critical bounds at 0.05, thus rejecting the hypothesis that there exists no level relationship. For $p = 3$, $F_{IV}$ and $F_{III}$ reject at the 0.10, but $F_V$ was unable to reject at both the 0.05 and 0.10 critical values. PSS argue that the statistic $F_{IV}$, which sets the trend coefficient to zero under the null hypothesis, is more appropriate than the $F_V$ statistic, which ignores this constraint. Recall that Table 3 indicated that the preferred $p$ was equal to 4 for the HP equation to safely ensure $u_t$ was serially uncorrelated. The $t$-statistics also support this result. For values of $p < 4$ the $t$-statistics can not reject the existence of no level relationship; however for $p = 4$ it is rejected in both cases.

**TABLE 6**

Table 6 indicates that for values of $p = 3$ and 4 the hypothesis that there exists no level relationship is not rejected, irrespective of whether the regressors are purely I(1), I(0), or mutually cointegrated. However, for $p = 1$ and 2 the hypothesis is rejected for all statistics at 0.10 and the majority at 0.05 critical bounds values. This result is also consistent with the preferred $p = 2$ from Table 4. In testing the null hypothesis of the absence of level effects it was important that the coefficients of the lagged difference terms remained unrestricted in order to avoid pre-testing difficulty. However with these tests completed and with evidence of valid levels relationship in both equations, the
second stage in the estimation procedure could be implemented using the ARDL modelling approach.

5.2 ARDL Estimation Approach

Assuming Tables 5 and 6 contain sufficient evidence of a valid levels relationship the ARDL approach (Pesaran and Shin 1999) could be used to estimate the long-run levels relationship and short-run dynamic effects because it enabled a more parsimonious specification than that used in the previous section.

Consider the following ARDL representation

$$\phi(L, q)i_t = a_o + a_t + \sum_{j=1}^{4} \beta_j(L, p_j)x_{jt} + u_t$$  \hspace{1cm} (10)

where $j = 4$ and $x_{jt} = (r, \pi, e, d, c)'$

where the lag operators are

$$\phi(L, q) = 1 - \phi_1L - \phi_2L^2 - \ldots - \phi_qL^q$$

$$\beta(L, p_j) = 1 - \beta_{1j}L - \beta_{2j}L^2 - \ldots - \beta_{pj}L^{pj}$$

To determine the order of the ARDL $(q, p_r, p_\pi, p_d, p_c)$ in (10) the maximum lag length of $p = q = 4$, was specified for initial estimation. A total of 3125 ARDL models were estimated for the two equations.19

Given the large number of models estimated, the final two models were selected based purely on statistical criteria, namely AIC and SBC—which were consistent across both equations. The specifications corresponding to the AIC, SBC and Rbar$^2$ model selection criteria are presented in Tables 7 and 8.

**TABLES 7 and 8**

Although the results for Table 7 give different lag selections for one of the criteria the results in Table 8 are strikingly consistent, as the three different criteria all picked the
same lag lengths. Thus, the models ARDL(1, 0, 1, 0, 3) and ARDL(1, 0, 3, 0, 4) for the HP and Survey equations respectively were chosen.

5.2.1 ECM representations

The two estimated ARDL models were reparameterized to yield their corresponding ECM representations. Now, consider the rearrangement of ECM (9)

\[
\Delta i_t = \alpha \left[ \frac{d_0}{\alpha} + \frac{d_1}{\alpha} t + \frac{B}{\alpha} x_{t-1} \right] + \sum_{j=1}^{g-1} \varrho^j \Delta z_{t-j} + \lambda^j \Delta x_t + u_t
\]  

To ensure the stability of the ECM the error correction term \( \alpha \) must be negative. For example, if the expected long-term nominal interest rate is below its long-run equilibrium level, the bracketed expression in (11) is negative. A negative \( \alpha \) will ensure that the first difference of the expected long-term nominal interest rate is positive, thus causing the level of the long-term interest rate to rise toward its long-run equilibrium level in subsequent periods.

Table 9 presents the final ECMs for the Survey and HP models as selected by the AIC and SBC criteria. All coefficients in the HP model were statistically significant as were the majority in the Survey model. The underlying ARDL models also passed all the standard diagnostic tests (for Serial Correlation, Functional Form, Normality and Heteroscedasticity). The error correction coefficient for both equations was statistically highly significant and of the correct sign, consistent with the existence of a cointegrating long-run relationship. Both coefficients were similar in magnitude and suggested a moderately fast speed of convergence to long-run equilibrium following a shock.

TABLE 9

5.3 The Long-run Levels Relationship (CV)

In (11) the expression in brackets implicitly defines the long-run levels relationship

\[
i_t = \gamma_0 + \gamma_1 t + \gamma_2 r_t + \gamma_3 \pi_t + \gamma_4 d_t + \gamma_5 c_t + \tau_t
\]

where
\[ \gamma_0 = -\frac{a_0}{a}, \gamma_1 = -\frac{a_1}{a}, \gamma_2 = -\frac{\beta_1}{a}, \gamma_3 = -\frac{\beta_2}{a}, \gamma_4 = -\frac{\beta_3}{a}, \gamma_5 = -\frac{\beta_4}{a}, \gamma_6 = -\frac{\beta_5}{a} \]

with the inclusion of a time trend and disturbance term (2), the reduced-form interest rate equation, is identical to (12). Although the BTA was supportive of a levels relationship (refer Tables 7 and 8) as expressed in (12), estimation of (11) by OLS, although providing consistent estimates of the long-run coefficients, will not produce normally distributed standard errors (because of the presence of non-stationary variables). Thus, inferences based on \( t \)-statistics will not be valid.

The ‘ARDL approach to cointegration’ remedies this problem by calculating the long-run coefficients and their asymptotic standard errors using the “delta” or \( \Delta \)-method.\(^{21}\) The approach allows for non-zero covariances between the estimates of the short and long-run coefficients; and these covariances are asymptotically uncorrelated in the case of a single valid cointegrating relationship (12) (see, Pesaran and Pesaran 1997:404).

Being able to draw valid inferences from the long-run level relationship was particularly important to determine the nature of the relationship between budget deficits and long-term interest rates. The results are discussed and interpreted in the next section. However, Table 12 briefly illustrates the sensitivity of the estimated long-run coefficients, as expressed in (12), to changes in sample period. The results indicate the estimated long-run coefficients from the selected ECMs appear statistically robust to changes in sample period for both models.

6 Discussion and Interpretation of Results

The two final ECM models estimated in the previous section allow for a combination of short-run dynamics, determined via the first difference terms, and a long-run equilibrium relationship reflected in the error correction term. This section makes inferences based on the following estimates of the levels relationship contained in the error correction terms and their asymptotically valid \( t \)-statistics

\[
I_L = 6.517 - 0.0516t + 0.2930r_S + 0.6427\pi^e + 0.115d + 0.2860c + u_t
\]

\[
(5.418) \quad (-2.603) \quad (3.086) \quad (7.029) \quad (2.128) \quad (0.896)
\]
Estimated levels relationship for Survey Equation

\[ i_L = 8.9924 - 0.0883t + 0.4395r_S + 0.4563\pi_e + 0.1298d + 1.393c + u_t \quad (14) \]

(4.125)   (-2.156)   (3.456)   (2.859)   (1.411)   (3.793)

Estimated levels relationship for HP Equation

The signs on all estimated coefficients are identical across both equations and very similar in magnitude. Furthermore, almost all are significant with many being strongly significant. This would indicate that the data strongly support both specifications. Notably the importance of including a constant and time trend in the specification is illustrated.

The estimated coefficients on both measures of expected inflation are significant, in particular the Survey measure (as reflected in a better fit (adjR^2)). Both coefficients are less than unity, indicating some departure from the full Fisher effect and highlighting the importance of not imposing the unity restriction.

The positive coefficient on the real short-term interest rate is less than unity in both cases consistent with \textit{a priori} expectations. Broadly speaking, the results suggest that around a one percentage point increase in the short-term real rate, corresponds to a 29 to 44 basis point rise in the long-term nominal rate. This is consistent with the expectations theory of the term structure in that long-term interest rates appear less volatile than short-term rates (Kramer 1998:283). Assuming the Reserve Bank can effectively influence real short-term interest rates, then the result suggests it is also able to significantly influence the long-term nominal rate, thus shifting both ends of the yield curve. There is one obvious reservation about this result, in that monetary policy is also likely to influence expected inflation. However, the results point to a significant long-run co-movement between the two rates and show the importance of capturing the term structure in the model.

Turning to the hypothesis that is the principal subject of this study, after controlling for other systematic factors, a significant positive effect of the budget deficit on the long-term nominal interest rate is supported by (13) but not as strongly by (14) (with the \textit{t-}
statistic being significant only at the 0.15 level). An encouraging result is the similar magnitude of the estimated coefficients in both equations, perhaps indicating the robustness of the inflation proxies. Coefficients of 0.12 in the Survey measure and 0.13 in the HP measure can be interpreted as follows: a one percentage point increase in the annualised budget deficit to GDP ratio corresponds with a 12 to 13 basis point rise in the nominal long-term rate in the long-run. Thus, evidence that the public sector is able to ‘crowd out’ private sector investment via higher long-term nominal interest rates is supported by these results. This result is inconsistent with the REH.

Finally, examining the effects of foreign savings on the long-term interest rate, the results support a significant relationship in (14) but not in (13). One possible explanation is that net capital inflows may be correlated with the deficit measure (consistent with CIH or "twin deficits" story). The hypothesised sign on this coefficient was indeterminate, depending on the relative magnitude of supply and demand side effects. The evidence presented suggests capital flows and long-term interest rates may be positively related.

7 Conclusions

This study has attempted to isolate the statistical nature of the relationship between budget deficits and interest rates in New Zealand over the period 1985-1997 by drawing on several different strands in the literature.

The theoretical model developed emphasised the flow of funds and the direct effect that this has on long-term interest rates through changes in the supply and demand for loanable funds. Specifically, this framework allowed for a combination of characteristics of the term structure and important policy variables.

A critical issue in successfully being able to estimate interest rates concerns the modelling of expected inflation. The Hodrick Prescott (HP) filter was employed to this end and contrasted with a measure constructed from Survey data. The results presented suggest the filter may be an appropriate tool for modelling expected inflation in empirical work, thus complementing its attractive mathematical and theoretical properties.
The econometric approach employed had several distinguishing characteristics. First, it employed a ‘bounds testing approach’ to the existence of a levels relationship. This approach had the advantage of being applicable in the face of variables with uncertain orders of integration. In light of the unit root testing results this became a particularly relevant consideration. Second, the ARDL estimation approach avoided the problems caused by restricting the dynamics. It also allowed for parsimonious models based on consistent selection criteria. This limited the potential for data mining based on ad hoc criteria. Third, the approach corrected for problems caused by non-stationary variables and hence non-normal standard error distributions in the levels relationship. Importantly this enabled valid inferences to be drawn from the estimated long-run coefficients contained in the error correction term.

The results indicate that budget deficits did contribute to higher long-term interest rates over the period. Thus, evidence of ‘crowding out’ is supported by these results. Further, the evidence suggests fiscal policy may have prevented monetary policy from properly managing interest rates.
Appendix A: Data - Definitions and Construction

Data were collected spanning the period 1985.I to 1997.IV ($T = 52$). Consistent with the historical considerations discussed, the post 1984 period was chosen to avoid some of the structural complications caused by financial market regulation. For example, interest rate and capital controls meant that interest rates were not able to fully reflect inflation. The period is also post exchange rate float. In this period monetary policy was devoted solely to fighting inflation via short-term interest rates with limited exchange rate considerations.

Hoelscher (1986), Correia-Nunes and Stemitsiotis (1995) and others that tend to find a significant relationship advocate the use of annual interest rate observations. They suggest that annual data are less distorted by transitory shocks and place more emphasis on fundamentals. Furthermore, they argue that annual data allow for a sufficient adjustment period for deficit effects to be reflected in interest rates. Although this is a valid point, of all the markets, capital asset markets are likely to be the most efficient (Cebula and Belton 1993:189). That is, adjustment periods could well be much shorter than a one-year cycle. The final consideration was a practical one. Annual observations would have severely limited the power of the empirical tests later employed given the relatively short span. Thus, quarterly observations were employed.

*HP Filter measure of expected inflation*

The choice of $\lambda$ is essentially an arbitrary one that depends on the degree to which prices are assumed to be sticky over the period (i.e. the speed of adjustment), as well as the frequency of the data. However, particularly in the real business cycle literature when applied to quarterly data, studies almost always set $\lambda = 1600$ (Cogley and Nason (1995:256)). Thus, for the purposes of this study $\lambda$ is similarly set to 1600. The measure of inflation corresponds to annualised quarterly changes in the CPI, sourced from OECD Main Economic Indicators—Historical Statistics 1960–97, CD-ROM [OECD].

*Survey measure of expected inflation*
These observations are taken monthly with actual figures representing the average of participants' expectations of the annual rate of inflation. For this investigation these figures were reconciled into quarterly observations by taking a three month average for each quarter.

**Interest rates**

To capture the effects, primarily of monetary policy, on the long-term nominal rate a measure of short-term real interest rates was needed. However, *ex ante* real interest rates are dependent on the expected rate of inflation over the holding period. The measure used was constructed by deflating the nominal quarterly 90 day Bank Bill rate by the unadjusted CPI measure of actual annual inflation (both from OECD 1998). That is, actual inflation was used to proxy expected inflation. Potentially this adds a further source of measurement error. However, Kramer (1998:280) argues that such a measure was not unreasonable given that it is a short-term interest rate. The HP and Survey measures were not used to construct the *ex ante* real short-term rate, as these measures were used only to proxy long-run inflationary expectations. Furthermore, a single consistent real rate measure was required to estimate two specifications; one with the Survey measure and one with the HP measure, with the intention of assessing the appropriateness (quality) of these two measures.

The measure chosen to represent long-term interest rates, the dependent variable, in the New Zealand economy, was the 10-year secondary market rate on government bonds (as published in IMF International Financial Statistics (line 61)).

**Capital flows**

To factor in open economy considerations, a measure of net capital inflows was needed. The data used were taken from the net capital inflows section in balance of payments statistics (OECD 1998). A particularly important consideration with this measure, like the budget deficit measure, was to remove seasonal variation. Again, this was achieved by annualising the data (summing the current and past three periods for each observation). Although not perfect, the approach importantly had the advantage of eliminating the need to use dummy variables in the regression analysis. This measure was then expressed as a
percentage of seasonally adjusted nominal GDP consistent with the budget deficit measure.
REFERENCES


Figure 1: Long-term Interest Rate Behaviour (1970-1997)

Long term Nominal vs. Real Interest rates

Quarters

LN

LR
Table 1: General to Specific Differences ADF Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>$\Delta i_L$</th>
<th>$\Delta r_S$</th>
<th>$\Delta i_S$</th>
<th>$\Delta \pi^{(hp)}$</th>
<th>$\Delta \pi^{(s)}$</th>
<th>$\Delta d$</th>
<th>$\Delta c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE3</td>
<td>$p=7$</td>
<td>$p=0$</td>
<td>$p=4$</td>
<td>$p=10$</td>
<td>$P=10$</td>
<td>$p=0$</td>
<td>$p=6$</td>
</tr>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>-46.333*</td>
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<tr>
<td>$t_{\alpha}$</td>
<td>-4.618*</td>
<td>-10.459*</td>
<td>-4.807*</td>
<td>-3.932*</td>
<td>-3.944*</td>
<td>-6.1883*</td>
<td>-5.010*</td>
</tr>
<tr>
<td>$\phi_2$</td>
<td>11.726*</td>
<td>36.467*</td>
<td>7.995*</td>
<td>6.1443*</td>
<td>5.265*</td>
<td>12.771*</td>
<td>8.399*</td>
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<tr>
<td>$\phi_3$</td>
<td>7.96*</td>
<td>54.700*</td>
<td>11.880*</td>
<td>7.9496*</td>
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<td>$p=7$</td>
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<td>$p=0$</td>
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<td>-10.504*</td>
<td>-4.851</td>
<td>-0.81353</td>
<td>-2.555</td>
<td>-6.1479*</td>
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<td>$\phi_1$</td>
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<td>0.676</td>
<td>3.265</td>
<td>18.9*</td>
<td>-</td>
</tr>
<tr>
<td>Conclude</td>
<td>Not I(2)</td>
<td>Not I(2)</td>
<td>Not I(2)</td>
<td>Not I(2)</td>
<td>Not I(2)</td>
<td>Not I(2)</td>
<td>Not I(2)</td>
</tr>
</tbody>
</table>

Notes: Refer to Table 2.
Table 2 : General to Specific Levels ADF Results

<table>
<thead>
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<th>Variables</th>
<th>$i_L$</th>
<th>$r_S$</th>
<th>$\pi^{(hp)}$</th>
<th>$\pi^{(i)}$</th>
<th>$d$</th>
<th>$c$</th>
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<tr>
<td>RE3</td>
<td>$p=8$</td>
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<td>$p=6$</td>
<td>$p=9$</td>
<td>$p=0$</td>
<td>$p=6$</td>
</tr>
<tr>
<td>$Z$</td>
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<td>-29.736*</td>
<td>N/A</td>
<td>N/A</td>
<td>-5.934</td>
<td>N/A</td>
</tr>
<tr>
<td>$t_\alpha$</td>
<td>-1.229</td>
<td>-4.3931*</td>
<td>-1.1075</td>
<td>-2.505</td>
<td>-1.756</td>
<td>-4.039*</td>
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<tr>
<td>$\phi_2$</td>
<td>5.578*</td>
<td>6.5344*</td>
<td>3.879</td>
<td>3.304</td>
<td>1.701</td>
<td>5.502*</td>
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<tr>
<td>$\phi_3$</td>
<td>3.910</td>
<td>9.767*</td>
<td>4.991</td>
<td>4.561</td>
<td>2.0205</td>
<td>8.226*</td>
</tr>
<tr>
<td>RE2</td>
<td>$p=7$</td>
<td>$p=0$</td>
<td>$p=6$</td>
<td>$p=9$</td>
<td>$p=0$</td>
<td>$p=7$</td>
</tr>
<tr>
<td>$Z$</td>
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<td>N/A</td>
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<td>$t_\alpha$</td>
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<td>-2.484</td>
<td>-1.955</td>
<td>-1.585</td>
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<td>$\phi_1$</td>
<td>8.466*</td>
<td>8.2176*</td>
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<td>3.462</td>
<td>2.450</td>
<td>1.321</td>
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<td>RE1</td>
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<td>$p=1$</td>
<td>$p=6$</td>
<td>$p=9$</td>
<td>$p=0$</td>
<td>$p=7$</td>
</tr>
<tr>
<td>$Z$</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>-4.985</td>
<td>N/A</td>
</tr>
<tr>
<td>$t_\alpha$</td>
<td>-3.7304*</td>
<td>-1.032</td>
<td>-3.448*</td>
<td>-2.300*</td>
<td>-2.108*</td>
<td>-1.515</td>
</tr>
</tbody>
</table>

Conclusion I(1) Not I(1) Not I(1) I(1) I(1) Not I(1)

Notes: The ADF tests were based on 56 observations over the period 1984.I to 1997.IV. To capture the effects of autocorrelation Dickey and Fuller (1979) suggested adding lagged differenced values of the variable to approximate the process and ensure the error term was white noise. Furthermore, since the underlying data generating process is unknown, ADF tests like the original DF tests use the three following ‘regression estimated’ [RE] specifications to allow for the possibility of nuisance parameters under the null

$$\Delta y_i = \alpha y_{i-1} + \sum_{j=1}^{g} d_j \Delta y_{i-j} + \epsilon_i \quad \text{RE1}$$

$$\Delta y_i = \mu + \alpha y_{i-1} + \sum_{j=1}^{g} d_j \Delta y_{i-j} + \epsilon_i \quad \text{RE2}$$

$$\Delta y_i = \mu + \lambda t + \alpha y_{i-1} + \sum_{j=1}^{g} d_j \Delta y_{i-j} + \epsilon_i \quad \text{RE3}$$
\( t_\alpha \) is the relevant ‘t-like’ test of the null that \((\alpha)=0\), for each RE. \( \phi_1 \) tests the joint hypothesis that \( \mu=0, (\alpha)=0 \) in RE2, \( \phi_2 \) tests the joint hypothesis that \( \mu=0, (\alpha)=0, \lambda=0 \), in RE3, and \( \phi_3 \) tests the joint hypothesis that \( (\alpha)=0, \lambda=0 \), in RE3. Z Represents the ‘normalized bias’ statistic only reported when \( p=0 \). *reject using DF tables at 0.05.
Table 3: Selecting Lag Order of the HP Equation

<table>
<thead>
<tr>
<th></th>
<th>With Deterministic Trends</th>
<th></th>
<th>Without Deterministic Trends</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>AIC</td>
<td>SBC</td>
<td>$\chi^2(1)$</td>
<td>$\chi^2(4)$</td>
</tr>
<tr>
<td>1</td>
<td>-58.675</td>
<td>-73.164</td>
<td>0.521</td>
<td>11.44**</td>
</tr>
<tr>
<td>2</td>
<td>-58.278</td>
<td>-76.631</td>
<td>0.774</td>
<td>10.96**</td>
</tr>
<tr>
<td>3</td>
<td>-54.885</td>
<td>-77.101</td>
<td>0.5873</td>
<td>14.85*</td>
</tr>
<tr>
<td>4</td>
<td>-51.135</td>
<td>-77.215</td>
<td>3.115</td>
<td>3.16</td>
</tr>
<tr>
<td>5</td>
<td><strong>48.796</strong></td>
<td>-78.433</td>
<td>0.826</td>
<td>7.12</td>
</tr>
</tbody>
</table>

Notes: See Table 4.
Table 4: Selecting Lag Order of the Survey Equation

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>p</td>
<td>AIC</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>-43.738</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td><strong>-40.194</strong></td>
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<td>3</td>
<td>-41.565</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>-43.913</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>-40.545</td>
</tr>
</tbody>
</table>

Notes: $p$ is the lag order of the conditional ECM (9), with zero restrictions placed on lagged differences of the deficit variable. * significant at 10% ** significant at 5% ***significant at 1%. AIC and SBC denoted Akaike's and Schwarz's Bayesian Information Criteria for a given $p$. $\chi^2$(1) and $\chi^2$(4) are LM statistics for testing no residual serial correlation against orders 1 and 4.
Table 5: F and \( t \)-statistics for the Existence of a Levels Relationship in the HP Equation

<table>
<thead>
<tr>
<th></th>
<th>With Deterministic Trends</th>
<th>Without Deterministic Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( F_{IV} )</td>
<td>( F_V )</td>
</tr>
<tr>
<td>1</td>
<td>10.558(^c)</td>
<td>9.856(^c)</td>
</tr>
<tr>
<td>2</td>
<td>5.0382(^c)</td>
<td>4.897(^c)</td>
</tr>
<tr>
<td>3</td>
<td>3.915(^b^*)</td>
<td>3.456(^a)</td>
</tr>
<tr>
<td>4</td>
<td>5.455(^c)</td>
<td>5.354(^c)</td>
</tr>
</tbody>
</table>

Notes: See notes on Table 6.
Table 6: F and t-statistics for the Existence of a Levels Relationship in the Survey Equation

<table>
<thead>
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<th>p</th>
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<th>Without Deterministic Trends</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>$F_{IV}$</td>
<td>$F_{V}$</td>
</tr>
<tr>
<td>1</td>
<td>8.142$^c$</td>
<td>7.985$^c$</td>
</tr>
<tr>
<td>2</td>
<td>7.7746$^c$</td>
<td>6.891$^c$</td>
</tr>
<tr>
<td>3</td>
<td>2.3297$^a$</td>
<td>1.987$^a$</td>
</tr>
<tr>
<td>4</td>
<td>1.988$^a$</td>
<td>1.975$^a$</td>
</tr>
</tbody>
</table>

Notes: $F_{IV}$ is the F-statistic for testing $\alpha = 0$, $\beta = 0'$, and $a_i = 0$ in (9). $F_{V}$ is the F-statistic for testing $\alpha = 0$ and $\beta = 0'$ in (9). $F_{III}$ is the F-statistic for testing $\alpha = 0$ and $\beta = 0'$ and $a_i$ set to zero in (9). $t_V$ and $t_{III}$ are the t-statistics for testing $\alpha = 0$ in (9) with and without a deterministic trend. $^a$ indicates that the statistic lies below the 0.05 lower bound, $^b$ that it falls within the 0.05 bounds, and $^c$ that it lies above the 0.05 upper bound.$^{b*}$ indicates falls outside bounds at 0.10.
Table 7: Lag Selection for ARDL, HP Equation.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>ARDL (q, p_r, p_π, p_d, p_c)</th>
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</thead>
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<td></td>
<td>q</td>
</tr>
<tr>
<td>AIC</td>
<td>1</td>
</tr>
<tr>
<td>SBC</td>
<td>1</td>
</tr>
<tr>
<td>Rbar^2</td>
<td>4</td>
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Table 8: Lag Selection for ARDL, Survey Equation.

<table>
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<th>Criteria</th>
<th>ARDL $(q, r, \pi, d, c)$</th>
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<td>AIC</td>
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</tr>
<tr>
<td>SBC</td>
<td>1 0 3 0 4</td>
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<tr>
<td>Rbar$^2$</td>
<td>1 0 3 0 4</td>
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### Table 9: ECM Results

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<td>HP Model</td>
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<td>$(1,0,1,0,3)$</td>
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<td>-0.537 (-4.910)</td>
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<tr>
<td>$\Delta r_t$</td>
<td>0.160 (2.828)</td>
<td>0.236 (3.153)</td>
</tr>
<tr>
<td>$\Delta \pi_t$</td>
<td>0.932 (7.681)</td>
<td>1.961 (2.564)</td>
</tr>
<tr>
<td>$\Delta \pi_{t-1}$</td>
<td>-0.099 (-0.882)</td>
<td>-</td>
</tr>
<tr>
<td>$\Delta \pi_{t-2}$</td>
<td>-0.303 (-3.190)</td>
<td>-</td>
</tr>
<tr>
<td>$\Delta d_t$</td>
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<td>0.070 (1.471)</td>
</tr>
<tr>
<td>$\Delta c_t$</td>
<td>0.102 (1.456)</td>
<td>0.244 (2.665)</td>
</tr>
<tr>
<td>$\Delta c_{t-1}$</td>
<td>-0.193 (-1.689)</td>
<td>-0.457 (-3.759)</td>
</tr>
<tr>
<td>$\Delta c_{t-2}$</td>
<td>-0.106 (-1.133)</td>
<td>-0.323 (-3.592)</td>
</tr>
<tr>
<td>$\Delta c_{t-3}$</td>
<td>0.118 (1.978)</td>
<td>-</td>
</tr>
<tr>
<td>Constant</td>
<td>3.550 (3.199)</td>
<td>4.828 (3.448)</td>
</tr>
<tr>
<td>Time Trend</td>
<td>-0.028 (-2.140)</td>
<td>-0.047 (-2.141)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.739</td>
<td>0.458</td>
</tr>
<tr>
<td>Adj$R^2$</td>
<td>0.650</td>
<td>0.325</td>
</tr>
<tr>
<td>DW</td>
<td>1.6613</td>
<td>1.806</td>
</tr>
</tbody>
</table>
Table 10: Period Sensitivity Analysis of Long Run Coefficients

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient (t-statistic)</th>
<th>Coefficient (t-statistic)</th>
<th>Coefficient (t-statistic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.550 (-5.065)</td>
<td>-0.545 (-4.686)</td>
<td>-0.580 (-4.960)</td>
</tr>
<tr>
<td>r&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>0.293 (3.086)</td>
<td>0.237 (2.355)</td>
<td>0.398 (3.081)</td>
</tr>
<tr>
<td>π&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>0.643 (7.029)</td>
<td>0.645 (6.565)</td>
<td>0.468 (3.032)</td>
</tr>
<tr>
<td>d&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>0.115 (2.128)</td>
<td>0.171 (2.699)</td>
<td>0.149 (1.67)</td>
</tr>
<tr>
<td>c&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>0.286 (0.896)</td>
<td>0.436 (1.234)</td>
<td>1.444 (4.053)</td>
</tr>
<tr>
<td>Constant</td>
<td>6.517 (5.418)</td>
<td>6.639 (5.365)</td>
<td>8.659 (4.018)</td>
</tr>
<tr>
<td>Time</td>
<td>-0.052 (-2.603)</td>
<td>-0.046 (-2.156)</td>
<td>-0.0711 (-1.828)</td>
</tr>
<tr>
<td>BarR&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.650 (0.325)</td>
<td>0.665 (0.316)</td>
<td>0.467 (0.42487)</td>
</tr>
<tr>
<td>DW</td>
<td>1.6613 (1.806)</td>
<td>1.651 (1.845)</td>
<td>1.456 (1.3767)</td>
</tr>
</tbody>
</table>

ECMs based on ARDL(1,0,3,0,4) for Survey and ARDL(1,0,1,0,3) for HP.
FOOTNOTES

1 Seater (1993) explores the Ricardian Proposition in great detail; he outlines the theory, its constraints and limitations, and provides a thorough review of the literature as well as important empirical considerations for researchers.

2 The *ex ante* real rate has been calculated using the CPI measure of actual inflation to proxy expected inflation. However, it is widely acknowledged that this conclusion is robust to alternative measures of expected inflation (Correia-Nunes and Stemitsiotis 1995).

3 The excess returns approach pioneered by Plosser (1982) was not seriously considered on grounds discussed previously. Further, it can be shown that the standard IS/LM and loanable funds models derive practically identical reduced form equations (Cebula and Belton 1993:190).

4 Owen (1992) questions the role of the real interest rate in testing the Fisher effect, and presents an alternative framework for the analysis of the Fisher hypothesis that distinguishes between a “thinly disguised identity” and a long run behavioural relationship in a cointegration context.

5 It should be noted that in constructing the proxy no allowance was made for structural changes affecting the observed series (CPI), such as changes in tax rates (namely Goods and Services Tax [GST]). This could be a fair criticism of the approach, although HP filter is a low frequency filter and tends to remove large variations by default (see Figure 3, where the GST spikes around 1987 and 1990 are effectively smoothed).

6 Particularly those using US data. Studies by Hoelscher (1986), Tran and Swahney (1988), and Russek (1996), to name but a few use the popular Livingston Survey measure as published by the Federal Reserve Bank of Philadelphia for their proxy for expected inflation.

7 Some studies have even treated inflation induced wealth transfers from bondholders to government as a source of revenue (refer to Hoelscher 1986:3 for a discussion).

8 For example studies using US data employ the "standardized employment deficit" (CBO, 1997). This measure eliminates the effects of the business cycle on the budget and is based on estimates of what spending and revenue would be if the economy were operating at normal levels of unemployment and capacity utilization.

9 There was a change in accounting convention in the 1994/1995 fiscal year to an accrual-based system. This was resolved by interpolation.

10 Mutually cointegrated refers to the regressors being cointegrated amongst themselves.

11 Strictly speaking the variables should not be I(2) processes. Results from the previous section supported this requirement.

12 It should be noted that the two measures for expected inflation, the survey measure $\pi^{e(s)}$, and the HP filter measure, $\pi^{e(hp)}$, are not explicitly represented in the above or following equations. This equation therefore represents the general form for (2).

13 It should be noted that this assumption does not rule out the inclusion of lagged changes in the long-term nominal interest rate.

14 This is analogous to selecting $p$ in the ADF tests.
It was deemed values of $p > 5$ would be inappropriate, again because of the limited number of observations.

This approach of checking the significance of the lagged differenced variables is consistent with the approach used by PSS (2001:20) in their application of the technique to the UK wage equation. On these grounds, as well as for the sake of parsimony, it was decided restrictions of zero be placed on the coefficients of all lagged differenced deficit variables.

The tables are reported in PSS where the critical values depend on the number of regressors and whether the conditional ECM contains an intercept or trend.

Again, this is analogous to the ADF tests with respect to nuisance parameters.

A total of $(p + 1)^k$, where $p=4$ and $k=4$ (number of regressors $j$), $(5)^5 = 3125$ models.

Reparameterization of the ARDL does not place any untested restrictions on the model and thus the data remain free to determine the dynamics of the model. For details of the reparameterization of the ARDL to an ECM see Pesaran and Pesaran (1997:393).

This yields the same result as Bewley's (1979) regression approach (see Pesaran and Pesaran (1997:404) for details regarding the Bewley procedure). The two procedures yield identical results and the choice between them is only a matter of computational convenience.