INDICATORS OF INFLATIONARY PRESSURE

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ABSTRACT

This paper examines the statistical properties of a number of leading indicators of inflation, using Australian data over the period 1966 through 1991. We pay particular attention to the much-discussed P^*, as well as measures of capacity utilisation, the cyclical rate of unemployment and the growth rate of a monetary aggregate (currency). Our results show that, up until mid 1990, the gap between trend and observed velocity of currency, as well as the growth rate of currency performed well as inflation indicators. Since then, the rapid decline in inflation has been best predicted by variables such as the level of capacity utilisation, the rate of cyclical unemployment, and the gap between output and its trend value.

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1. INTRODUCTION

The principal aim of monetary policy is the achievement of a low rate of price inflation. However, since monetary policy influences spending, and hence inflation, with lags that are always long and sometimes variable, policy makers must have sufficient warning of any incipient inflationary pressure if this objective is to be consistently achieved. This paper examines the statistical properties of a number of leading indicators of inflation, using Australian data over the period 1966 through 1991. We pay particular attention to the much-discussed P^* (Hallman et al 1991, Hoeller and Poret 1991, Rasche 1991), as well as a measure of capacity utilisation, the cyclical rate of unemployment and the growth rate of a monetary aggregate (currency).

Our method for evaluating the usefulness of these indicators is to examine their out-of-sample forecasting performance, computing static real-time forecasts over the period 1984(1)-1990(2), and dynamic forecasts over the period 1990(3)-1991(4). Anticipating the conclusions, we find lags of inflation and various real variables, such as capacity utilisation, to be relatively good indicators of inflation. P^*, on the other hand, does not perform well in this regard.

The remainder of the paper is organised as follows. In Section 2 we outline some indicative models of inflation. The data and their statistical properties are described in Section 3. In Sections 4 and 5 we report the estimation and forecasting properties of our models. Section 6 concludes.

2. INDICATIVE MODELS OF INFLATION

Our base model is an autoregressive representation in which inflation depends solely on past inflation:

$$\Delta p_t = \beta_0 + \beta_1 \Delta p_{t-1} + \beta_2 \Delta p_{t-2} + \ldots + \beta_n \Delta p_{t-n} + \varepsilon_t \qquad (1)$$

where p is the log of the price level, Δp is the rate of inflation, and ε_t is an independent and identically distributed error.

This is the model against which models containing various indicator variables can be compared. These are described in turn:

(a) P^*

P^* is defined as the price level consistent with the current money stock and equilibrium in the economy's goods and financial markets. A value of P^* in excess of the price level P indicates that the price level will increase as the economy moves toward equilibrium.

The concept of P^* can be made operational in the following way. Consider first the identity which defines the velocity of money:

$$V \equiv PQ/M \qquad (2)$$

where V is velocity, P is the price level, M is the money supply and Q is real output.

Denoting capacity output as Q^* and trend velocity as V^*, P^* can then be defined:

$$P^* \equiv MV^*/Q^* \qquad (3)$$

From (2) and (3), the price gap is defined as the sum of the velocity gap and the output gap, with logarithms of variables in lower case notation:

$$p^* - p \equiv (v^* - v) + (q - q^*). \qquad (4)$$

The inflation rate between periods t and t-1 is assumed to be a linear function of the price gap existing in t-1, plus a distributed lag of past inflation rates:

$$\Delta p_t = \alpha(p^* - p)_{t-1} + \beta_0 + \sum_{i=1}^{n} \beta_i \Delta p_{t-i} + \varepsilon_t \qquad (5)$$

Alternatively, we can specify the inflation process as

$$\Delta p_t = \alpha_1(v^* - v)_{t-1} + \alpha_2(q - q^*)_{t-1} + \beta_0 + \sum_{i=1}^{n} \beta_i \Delta p_{t-i} + \varepsilon_t \qquad (6)$$

where the price level gap has been partitioned into a velocity gap and output gap.

The P^* model can be interpreted as a generalisation of both Keynesian and monetarist theories of inflation. Inflation in most Keynesian models is determined by past inflation, due to inertia, and the output gap, due to price stickiness (Gordon 1990). In monetarist models, an increase in the money supply temporarily depresses velocity below its trend. This leads to an increase in spending, in turn leading to higher prices until velocity has reached its trend and equilibrium is restored (Hallman et al. 1991). The model given by equation (6) can thus be restricted to three more specialised models. These are the price gap model $(\alpha_1 = \alpha_2)$, a Keynesian model $(\alpha_1 = 0)$, and a monetarist model $(\alpha_2 = 0)$.

One practical problem in the estimation of the P^* model is that since trend output, q^*, and trend velocity, v^*, are not observed, estimates of these variables need to be constructed. Another issue is the choice of monetary aggregate which is posited to anchor the price level. In the literature, this choice has turned on which aggregate has had the most stable velocity. Hallman et al 1991, in their study using data from United States, choose M2 because, at least since 1955, its velocity has been (more or less) stable, with no trend. However, while this condition is sufficient for the choice of monetary aggregate, it is not necessary. Velocity can have a trend (either deterministic or stochastic) and yet P^* can still be useful as indicator model, provided that the process generating the trend is stable.

Finding a monetary aggregate with this property is no easy task using

Australian data because both financial liberalisation and changes in transactions technology have substantially altered the velocity of most of the monetary aggregates in recent years. Moreover, in some cases, this has been not just a once-and-for-all effect, as continuing product innovation is likely to see ongoing switches in demand between various types of assets, distorting the growth rates of particular types of money. Very narrow definitions of money have, however, probably been least affected by these changes.[1] Accordingly, we focus on currency, defined as the value of notes and coins held by the non-bank public.

Figure 1 plots the quarterly velocity of currency over the period 1962(1) through 1991(4). Evidently, structural breaks to velocity occurred in the second quarter of 1966 and the third quarter of 1990. Velocity rose substantially until early 1966, and then increased slowly until the second quarter of 1990. This was followed by a sharp fall in the velocity of currency which abated only in the December quarter of 1991.[2]

What is not clear from Figure 1 is whether velocity followed a deterministic or stochastic trend (contained a unit root) during the period in which it was stable. Clearly, this issue needs to be resolved before we can estimate v^*. If v was trend stationary, v^* can be simply estimated as a (possibly non-linear) time trend. If v^* contained a stochastic trend, it must be calculated in some other way. The same considerations apply to the calculation of q^*.

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[1] Broad measures of money have been less affected by these change than intermediate measures, such as M3. However, our attempts to use broad money as an indicator of inflation were unsuccessful.

[2] An article in the Reserve Bank of Australia Bulletin, "Recent Trends in Money and Credit" December 1991 suggests some reasons for this decline in velocity. These include new cash transactions reporting requirements and new arrangements for taxing interest, both of which have probably led to an increase in the demand for currency.

Figure 1: Velocity of Currency

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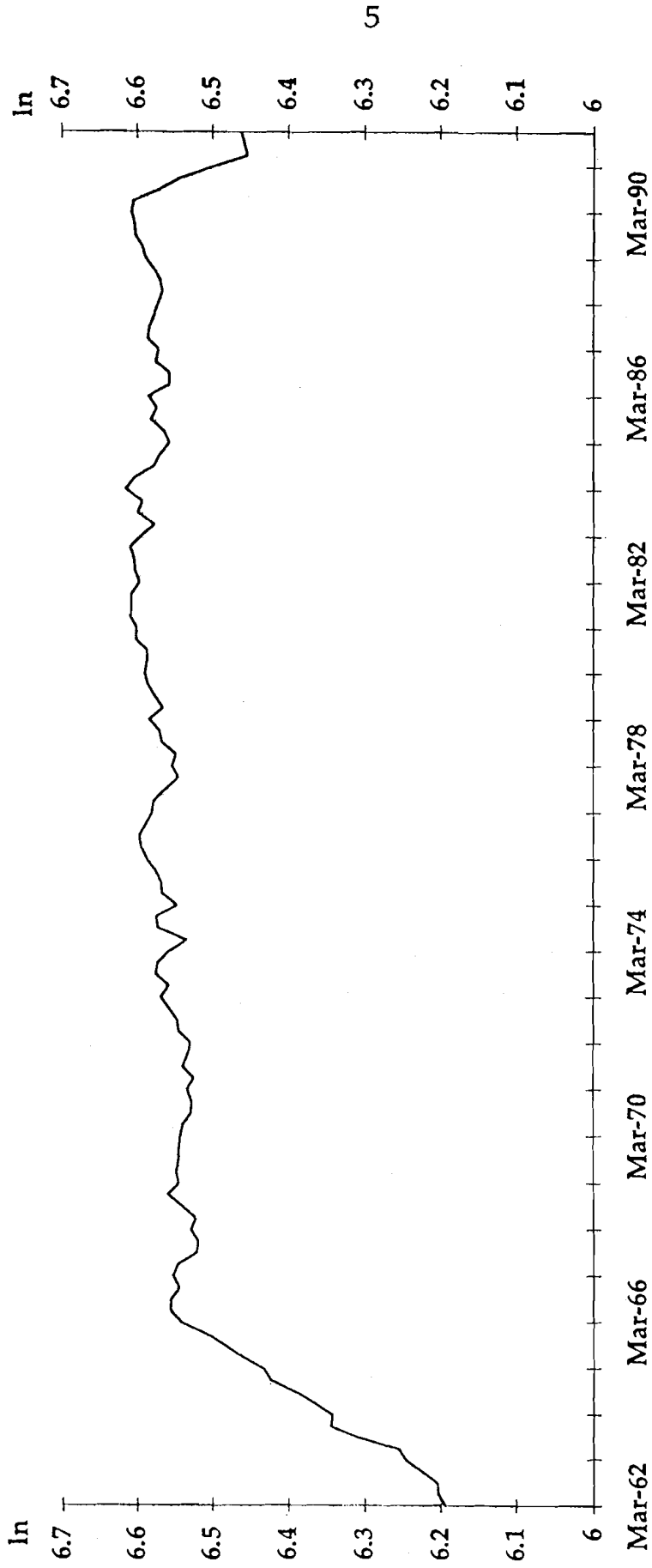
(b) Other Variables

We also test the usefulness of a number of other variables as indicators of inflationary pressure by estimating an equation of the form

$$\Delta p_t = \gamma x_{t-1} + \beta_0 + \sum_{i=1}^{n} \beta_i \Delta p_{t-i} + \varepsilon_t \qquad (7)$$

where x is the indicator variable.[3] These variables are[4]:

(i) Cyclical Unemployment

The output gap model can equivalently be represented as $x = u - u^*$ where u is the rate of unemployment, u^* is the non-accelerating inflation rate of unemployment (NAIRU), and so $u - u^*$ is the rate of cyclical unemployment. Thus if unemployment exceeds the NAIRU, due to say, a tightening of monetary policy, the rate of inflation is expected to decline.[5] Empirical implementation of this model requires estimates of u^*, since only u is observed in the data.

(ii) Capacity Utilisation

Similar in spirit to the output gap model is a model in which the rate of capacity utilisation is an indicator of inflationary pressure. To measure capacity utilisation we use data from a survey conducted by the Confederation of Australian Industry and Westpac in which manufacturers are asked whether they are working below, at or above normal capacity. The percentage difference between those who say

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[3] We could, of course, specify more than one lag of x in equation 7. However, in empirical implementation, we found that, for every variable, only one lag was significant.

[4] Of course, there are many possible indicators that we do not consider. Blundell-Wignall, Lowe and Tarditi (1992) examine various indicators and their implications for the conduct of monetary policy.

[5] If there is hysteresis in unemployment, the rate of inflation could increase when unemployment is falling, even if it is above the NAIRU. However, we found no evidence of such an effect.

they are working above and below normal capacity is our measure of capacity utilisation. Capacity utilisation is plotted in Figure 2.

(iii) Currency

While the level of currency anchors the price level in the P^* model, its rate of growth can also serve as an indicator of inflation. This is not necessarily because changes in the growth rate of currency cause changes in the inflation rate; however, they might be indicative of such changes. This is so because currency in Australia (and every other developed country) is supplied on demand. An exogenous inflationary shock will to lead to an increase in nominal expenditure; the consequent increase in the demand for currency might then be an indication of nascent inflation.

Another potential leading indicator of inflation that has received increasing attention recently is commodity price inflation (Boughton and Branson 1988, Boughton, Branson and Mutardy 1989, Flood 1989 and Rasche, 1991). Because commodities are traded in competitive markets, unencumbered by long-term contracts, commodity prices are thought to react quickly to fundamental developments, and so commodity price inflation might be a good indicator of embryonic inflationary pressure more generally. However, since commodity prices are set in world markets, and so are unaffected by fundamental inflationary impulses in Australia, commodity price inflation is not likely to be a useful direct indicator of Australian inflation.[6]

3. THE DATA AND THEIR TIME SERIES PROPERTIES

We use two measures of inflation in our analysis. These are the quarterly percentage changes in the implicit price deflators of Gross Domestic Product, which we denote as Δp^q; and of private

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[6] This proved to be the case empirically. In regressions of Australian inflation against various lags of commodity price inflation (not reported), we could never reject the hypothesis that coefficients on the latter were equal to zero.

Figure 2: Capacity Utilisation
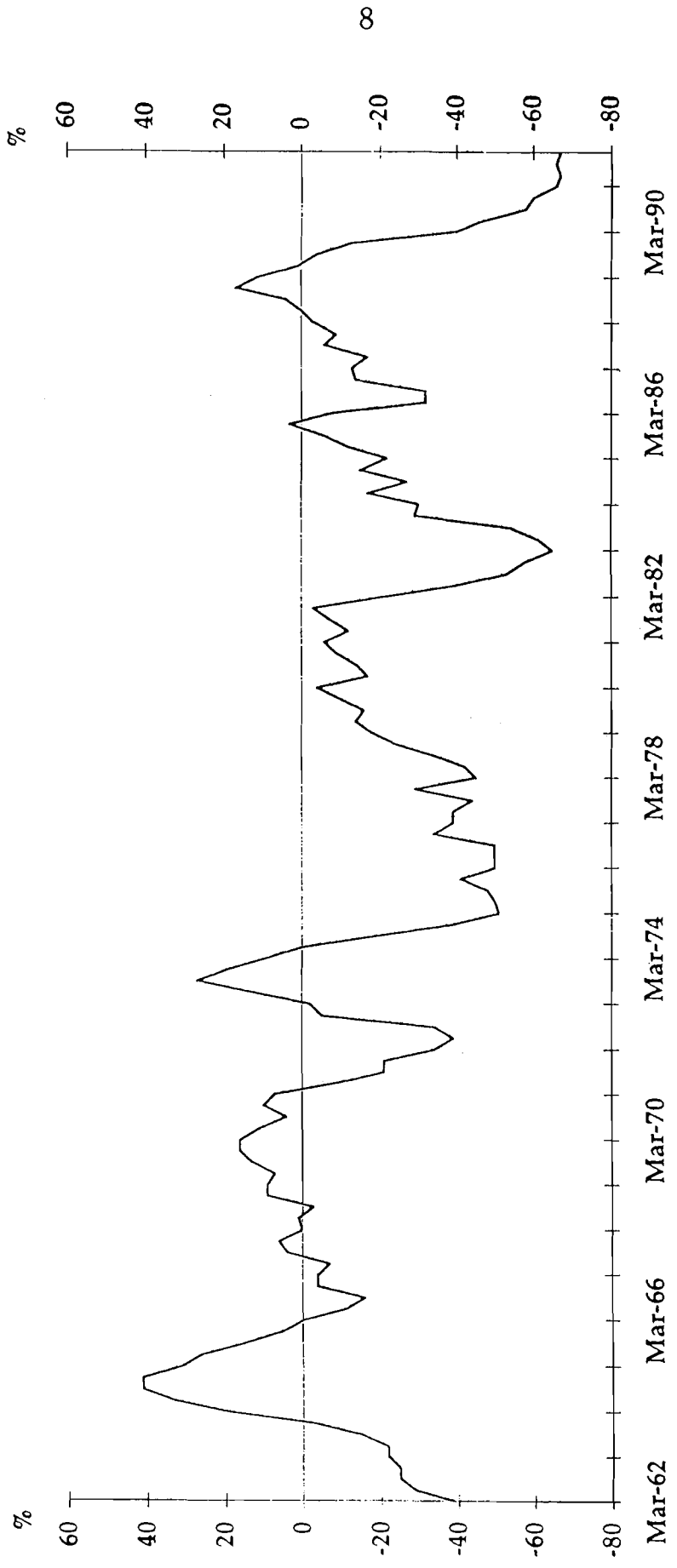
consumption, which we denote as Δp^C. These are plotted in Figure 3.[7]

We conduct Phillips-Perron (1988) unit root tests, with four autoregressive lags, to determine the time series properties of our data. Our sample estimation period begins in 1966(2) and ends in 1990(2). Table 1 presents the results of these tests for unit roots in the variables, which, except for the unemployment rate and the rate of capacity utilisation, are expressed in natural logarithms. The evidence from these tests suggest that all variables contain a unit root (i.e. are integrated of order one), except capacity utilisation (cap), which is stationary.[8]

Each of the I(1) variables is expressed in stationary form in the regressions which follow. For the price deflators and currency, this is achieved by first-differencing. Given the non-stationarity of q, v, and u it is not possible to estimate q^*, v^*, and u^* using simple trends. Instead, we use the Hodrick-Prescott filter (Prescott, 1986) to construct these variables. This filter decomposes a series into permanent and transitory components. It does so by selecting a trend path τ_t (permanent component) which minimises the sum of squared deviations from a series y_t subject to the constraint that the sum of squared second differences be sufficiently small i.e.

$$\min_{\tau_t} \sum_{t=1}^{T} (y_t - \tau_t)^2$$

$$s.t. \quad \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2 \leq \upsilon.$$

where υ is a constant that determines the smoothness of the trend path.

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[7] Δp^C cannot be used when evaluating the P^* model, since this model is based on the definition of velocity as nominal GDP per unit of money. However, we can use the output gap model (a special case of P^*) to forecast Δp^C.

[8] We also tested the hypothesis that each variable contains two unit roots i.e. that there is a unit root in the first differences. This hypothesis was decisively rejected on every occasion.

Figure 3: Australian Inflation
Year-ended % change
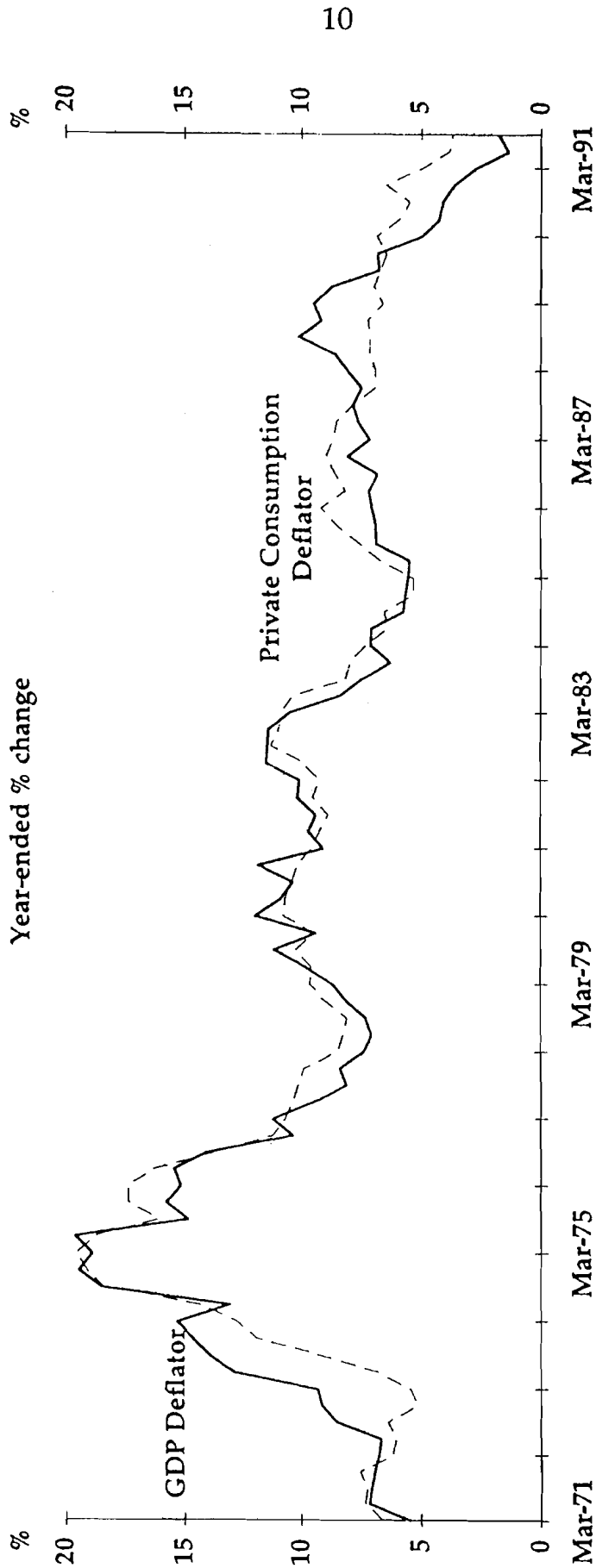
Table 1
Test for One Unit Root Against the Alternative of None
Sample Period: 1966(2)-1990(2)

Variable	$\hat{\alpha}$	Z_t
GDP Deflator (p^q)	1.001	0.021
consumption deflator (p^c)	1.002	0.282
Gross Domestic Product (q)	0.990	-2.372
currency (cr)	0.998	-0.947
velocity of currency (v)	0.884	-1.909
unemployment rate (u)	0.983	-1.431
capacity utilisation (cap)	0.896	-3.149

Critical Values: 1%   5%   10%
                  -3.51   -2.89   -2.58

Note: $\hat{\alpha}$ is the estimate of the autoregressive root, Z_t is the test statistic.

The transitory components are the deviations from the trend, $y_t - \tau_t$. These are plotted in Figures 4 to 7 as the q, v, p and u gaps, respectively. All of these variables have a mean value of zero, by construction.

4. ESTIMATION

The first task is to estimate the optimal lag length for the base models. We use the Schwartz (1978) criterion for this purpose; that is, we estimate m AR models with lag length 1..k..m. The optimal lag length k minimises the function

$$SC(k) = \ln \hat{\sigma}_k^2 + \frac{k \ln T}{T}$$

$$where \quad \hat{\sigma}_k^2 = \frac{SSE_{AR(k)}}{T}$$

We choose m=8, and find that the optimal lag length, for both the Δp^q and $\Delta p c$ models, is four (quarters). The estimation results are presented in Tables 2 to 4 and are generally very good. Nearly all of the coefficients on the indicator variables have the expected sign and are significantly different from zero. (The standard errors are adjusted in the manner suggested by Newey and West (1987) to account for serially correlated and heteroskedastic residuals.)

The restriction that the coefficients on the output and velocity gaps in the P^* model are equal is not rejected ($\chi^2(1) = 0.437$). Imposing this restriction leads to an estimate of 0.244 for the coefficient on the price gap.[9]

Thus, a price gap of one percent implies a rise in the (annualised) inflation rate, in the next quarter, of slightly less than one percentage point. The sum of the autoregressive parameters in the restricted P^*

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[9] In their study of P^* in the OECD countries, Hoeller and Poret (1991) estimate the coefficient on the Australian price gap to be 0.27, though they use a broader measure of money. However, their estimate of the velocity gap is insignificant.
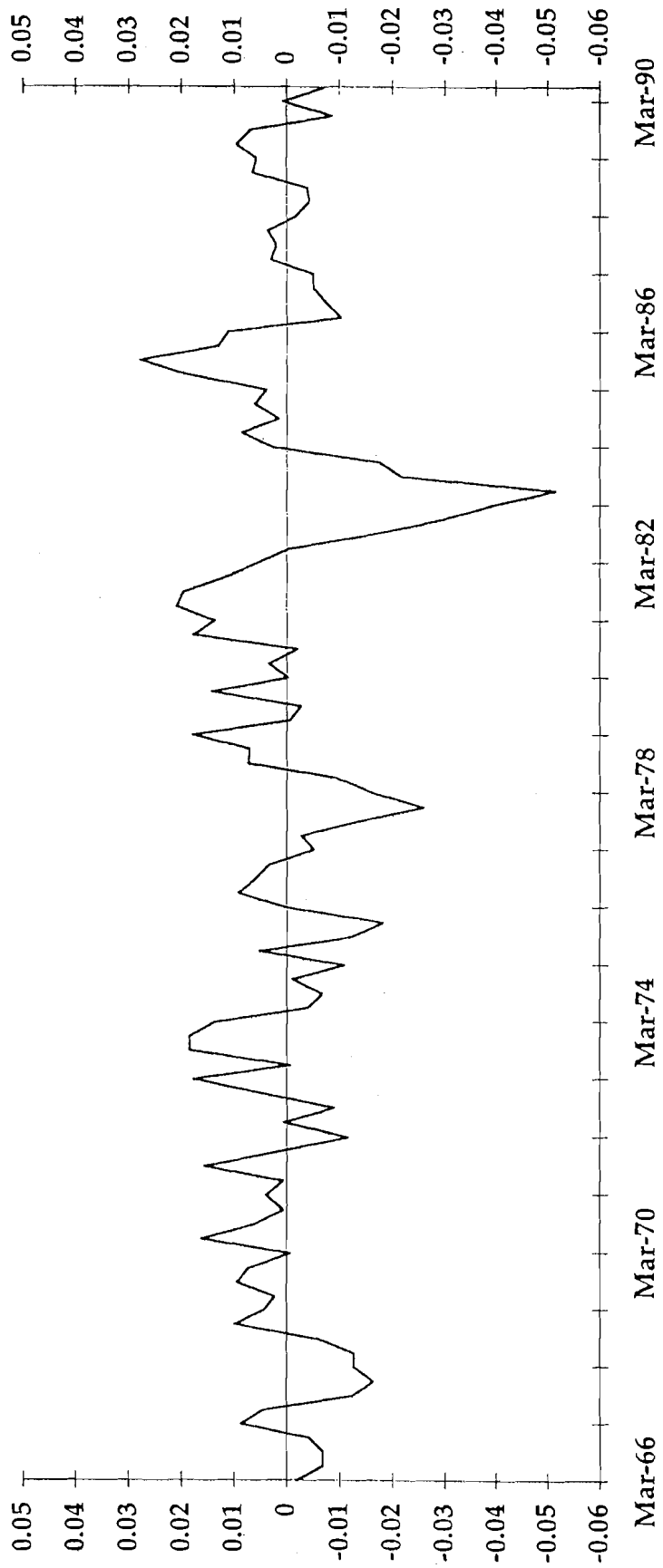
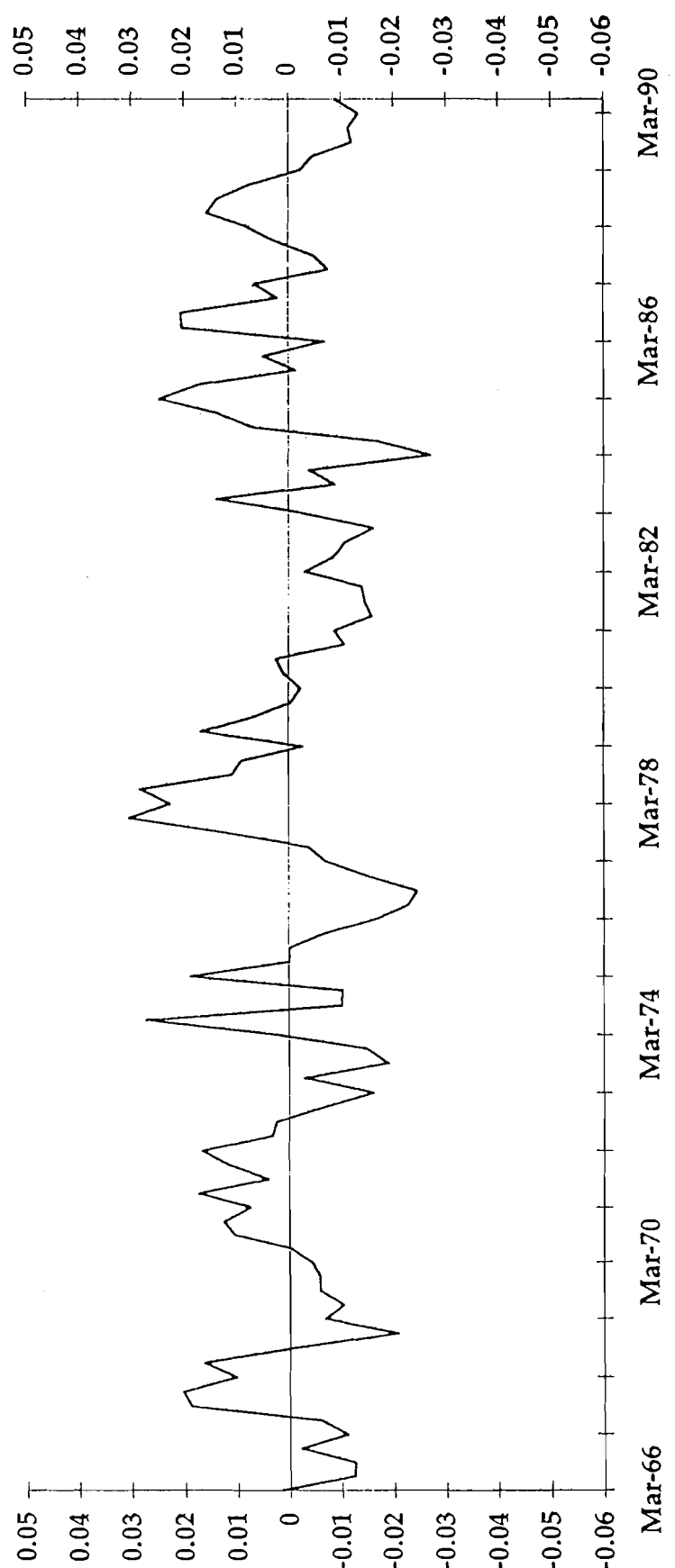Figure 4: Output Gap (q-q*)

Figure 5: Velocity of Currency Gap (v*-v)

Figure 6: Price Gap: (p-p*) = (q*-q) + (v*-v)
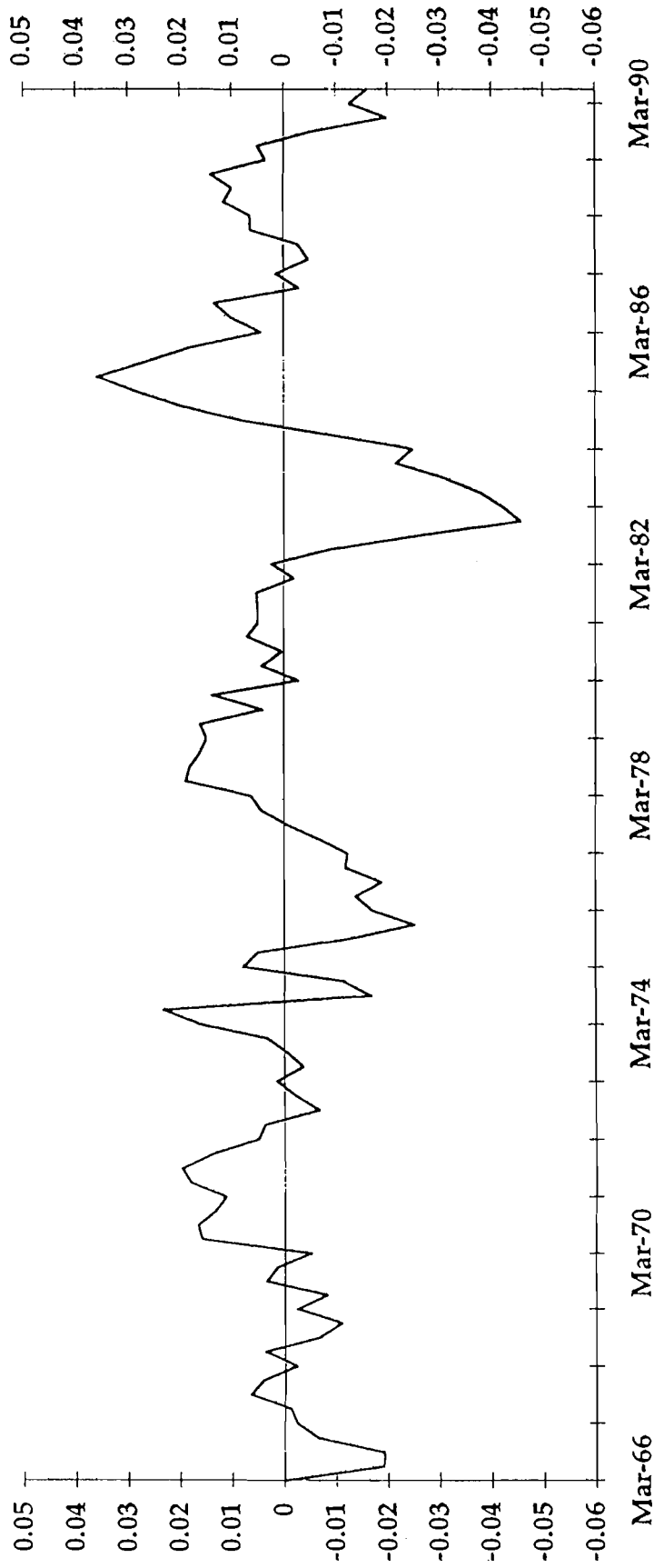
Figure 7: Unemployment Rate Gap (u-u*)
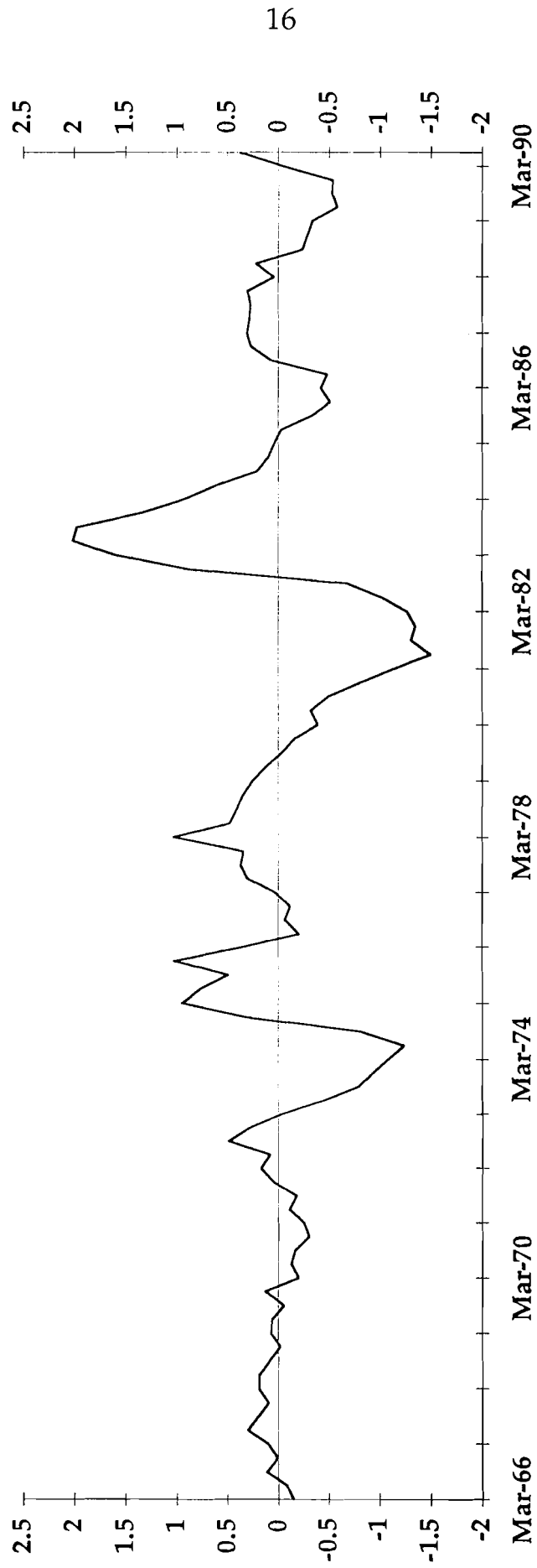
Table 2
Base and P^* Models
Dependent Variable: Δp^q

Model	Base	P^*_u $\alpha_1 \neq \alpha_2$	P^*_r $\alpha_1 = \alpha_2$	$q\text{-}q^*$ $\alpha_1=0$	$v^*\text{-}v$ $\alpha_2=0$
constant	0.005 (0.002)	0.003 (0.002)	0.003 (0.002)	0.005 (0.002)	0.004 (0.002)
Δp^q_{t-1}	0.105 (0.102)	0.152 (0.106)	0.149 (0.105)	0.111 (0.100)	0.132 (0.108)
Δp^q_{t-2}	0.162 (0.105)	0.181 (0.093)	0.172 (0.093)	0.153 (0.098)	0.207 (0.104)
Δp^q_{t-3}	0.209 (0.061)	0.207 (0.075)	0.207 (0.069)	0.209 (0.056)	0.190 (0.080)
Δp^q_{t-4}	0.289 (0.099)	0.314 (0.083)	0.312 (0.082)	0.291 (0.095)	0.306 (0.095)
$p^*\text{-}p$			0.244 (0.067)		
$v^*\text{-}v$		0.284 (0.102)			0.213 (0.103)
$q\text{-}q^*$		0.205 (0.055)		0.111 (0.053)	
R^2	0.340	0.431	0.426	0.354	0.390

Notes: All indicator variables enter with one lag. Sample period: 1966(2) - 1990(2), Newey-West consistent standard errors in parentheses. $P^*_{u(r)}$ refers to the unrestricted (restricted) P^* model

Table 3
Base Model and Other Indicators
Dependent Variable: Δp^q

Model	Base	u-u*	cap	acap	Δcr
const.	0.005 (0.002)	0.005 (0.002)	0.005 (0.002)	0.005 (0.002)	0.004 (0.002)
Δp^q_{t-1}	0.105 (0.102)	0.067 (0.102)	0.090 (0.103)	0.087 (0.102)	0.078 (0.107)
Δp^q_{t-2}	0.162 (0.105)	0.153 (0.096)	0.170 (0.098)	0.196 (0.103)	0.149 (0.106)
Δp^q_{t-3}	0.209 (0.061)	0.220 (0.052)	0.247 (0.062)	0.259 (0.057)	0.200 (0.006)
Δp^q_{t-4}	0.289 (0.099)	0.299 (0.100)	0.338 (0.104)	0.296 (0.107)	0.291 (0.099)
u-u*		-0.004 (0.002)			
cap			0.009$^{\#}$ (0.005)$^{\#}$		
cap(+)				0.003$^{\#}$ (0.006)$^{\#}$	
cap(-)				0.014$^{\#}$ (0.005)$^{\#}$	
Δcr					0.078 (0.103)
R^2	0.340	0.375	0.359	0.371	0.343

Notes: All indicator variables enter with one lag. Sample period: 1966(2) - 1990(2) Newey-West consistent standard errors in parentheses. # x.0.01. See text for explanations of cap(+) and cap(-).

Table 4
Base Model and Other Indicators
Dependent Variable: Δp^c

Model	Base	q-q*	u-u*	cap	Δcr
const.	0 003 (0.001)	0.003 (0.001)	0.003 (0.001)	0.002 (0.001)	-0.000 (0.002)
Δp^c_{t-1}	0.494 (0.125)	0.488 (0.127)	0.415 (0.107)	0.441 (0.097)	0.449 (0.108)
Δp^c_{t-2}	-0.025 (0.138)	-0.032 (0.134)	-0.008 (0.124)	0.018 (0.117)	-0.034 (0.144)
Δp^c_{t-3}	0.104 (0.120)	0.112 (0.117)	0.118 (0.122)	0.146 (0.122)	0.061 (0.123)
Δp^c_{t-4}	0.281 (0.084)	0.306 (0.081)	0.330 (0.008)	0.394 (0.097)	0.293 (0.086)
q-q*		0.141 (0.037)			
u-u*			-0.003 (0.001)		
cap				0.011$^{\#}$ (0.006)$^{\#}$	
Δcr					0.168 (0.077)
R^2	0.572	0.602	0.609	0.604	0.593

Notes: All indicator variables enter with one lag. Sample period: 1966(2) - 1990(2) Newey-West consistent standard errors in parentheses. # x.0.001

model is 0.840, illustrating the highly autoregressive nature of Australian inflation i.e. considerable inertia exists in the Australian inflation rate.

This inertia implies that any inflationary (or disinflationary) impulse is likely to be amplified quite significantly. For example, a cyclical rate of unemployment of one percentage point which lasts for one quarter is predicted by the model to reduce the annualised inflation rate (in the GDP deflator) by about 1.4 per cent after one quarter and 2.5 per cent after six quarters; the corresponding reductions in consumer price inflation are 1.3 per cent and 3.3 per cent, respectively.[10]

Another possibility is that the indicator variables work asymmetrically; for example, a positive value of u-u^* could indicate a fall in inflation, but not *vice versa*. In the event, we could find only one such asymmetric effect; capacity utilisation predicts larger falls in Δp^q than increases. Specifically, the asymmetric capacity utilisation model (denoted acap) contains two variables cap(+) and cap(-), where $cap(+)_t$ = cap_t when $\Delta cap(t) > 0$ and = 0 otherwise, and similarly for cap(-). The estimated coefficient on cap(+) is 0.00003 and is half its standard error, while the estimated coefficient on cap(-) is 0.00014 and is three times its standard error. The hypothesis that these coefficients are equal is rejected at the 5.4 per cent level of significance.

5. FORECASTING PERFORMANCE

In this section we report the out-of-sample forecasting performance of each model. This type of model validation is particularly important since the very point of this analysis is to uncover a model which forecasts inflation relatively accurately; a good fit within the sample is

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[10] These falls in inflation appear to be rather large since the cyclical unemployment lasts for only one quarter. However, the size of this hypothesised shock is also very large. In fact, in all but one quarter in our sample (December 1982) any change in cyclical unemployment was always less than one percentage point.

no guarantee of accurate prediction out of the sample, while a restricted model might out-forecast an unrestricted model, even if the restriction is rejected in the sample.

The forecasting tests take three forms. First, we estimate static forecasting accuracy over the period 1984(1) through 1990(2). We do this by estimating a series of rolling regressions and calculating the one-period ahead forecast for the dependent variable (Δp^q or Δp^c). This enables us to calculate the Root Mean Squared Forecast Error (RMSFE) for each indicator model.

Second, we perform encompassing tests of the various forecasting models, in the manner described by Chong and Hendry (1986). Consider the regressions

$$e_t^i = \beta_i(f_t^j - f_t^i) + \eta_{it}$$

and

$$e_t^j = \beta_j(f_t^i - f_t^j) + \eta_{jt}$$

where e_t^i and e_t^j are the static forecast errors from models i and j, respectively, while f_t^i and f_t^j are these models' forecasts. If β_j is significantly different from zero but β_i is not, model i is said to encompass model j. That is, model i contains information not found in j which helps forecast the forecast error from model j, but the converse is not true.

Finally, we calculate RMSFEs for dynamic forecasts over the period 1990(3) to 1991(4) i.e. we use predicted, rather than actual, values of inflation in the autoregressive parts of each forecasting equation. Realised (rather than forecast) values of the indicator variables are used in these projections.

In Table 5 we report the RMSFEs for the static models. For Δp^q, the best forecasting performance comes from the velocity gap, while currency growth (Δcr) does best for Δp^c (though no better than the base model). The P* models forecast Δp^q considerably worse than the

other models. The cyclical unemployment model also performs relatively poorly. These models apart, the differences between the models are generally quite small. The same appears to be true as far as forecasts of Δp^c are concerned.

The results of the encompassing tests are reported in Tables 6 and 7. For Δp^q, these are quite revealing. Both P^* models are encompassed by all the other models i.e. the other models contain useful information not found in the P^* models, but the converse is not true. The model which does best is the velocity gap, which encompasses all of the other models.[11] The unemployment gap does relatively badly, being encompassed by the velocity gap, acap and Δcr models. The output gap also does badly; in no case does it contain information not found in the other indicators (apart from P^*), and it is encompassed by the velocity gap and acap models.

In terms of forecasting Δp^c, the best model is currency growth (Δcr), which encompasses cap and the unemployment gap, and at the 10 per cent level of significance, the output gap. In summary, the encompassing tests are ambiguous as to whether nominal or real variables have better forecasting properties. The best models are the velocity gap, a real variable, and the growth of currency, which is a nominal variable. The worst are undoubtedly the P^*, or price gap, models.

The RMSFEs for the dynamic forecasts 1990(3) to 1991(4) are shown in Table 8. The output gap, cyclical unemployment and capacity utilisation - all real variables - clearly outperform the other variables in terms of forecasting performance. In marked contrast to its performance in forecasting inflation up until June 1990, the worst model is the velocity gap, no doubt due to the large fall in the velocity of currency from late 1990 onwards.

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[11] This result is somewhat paradoxical since it implies that the velocity gap and output gap, taken together, contain less useful information than the velocity gap alone.

Table 5
Static Root Mean Square Forecasting Errors (x10)
1984(1) to 1990(2)

	Δp^q	Δp^c
base	0.063	0.055
P^*_u	0.087	
P^*_r	0.088	
v^*-v	0.057	
$q-q^*$	0.070	0.059
cap	0.067	0.061
acap	0.065	
$u-u^*$	0.078	0.066
Δcr	0.063	0.055

Table 6
Encompassing Tests: Δpq

	base	P^*_u	P^*_r	$q\text{-}q^*$	$v^*\text{-}v$	cap	acap	$u\text{-}u^*$	Δcr
base		0.84	1.01	2.16	1.18	1.74	1.76	3.26	1.62
P^*_u	0.56		1.05	0.40	1.71	1.29	1.15	1.39	0.50
P^*_r	0.38	5.32		0.57	1.66	1.10	0.95	0.04	0.32
$q\text{-}q^*$	1.03	3.73	3.85		0.43	0.53	0.20	0.91	1.20
$v^*\text{-}v$	2.37	6.32	6.45	3.62		3.12	2.79	4.41	2.26
cap	0.52	3.90	3.87	0.75	0.33		2.58	1.70	0.60
acap	0.35	4.92	4.95	2.28	0.96	1.86		3.62	0.82
$u\text{-}u^*$	1.29	2.80	2.83	0.70	1.23	0.62	0.72		1.33
Δcr	1.47	4.29	4.38	1.63	0.44	2.08	1.37	3.07	

Note: The entry in column i, row j is the t statistic in the regression:

$$e_t^i = \beta_i(f_t^j - f_t^i) + \eta_{it}.$$

Table 7

Encompassing Tests: Δp^c

	base	q-q*	cap	u-u*	Δcr
base		2.54	1.56	4.70	1.29
q-q*	0.93		0.86	1.96	0.28
cap	0.47	1.49		0.32	0.60
u-u*	0.28	2.22	1.36		1.14
Δcr	0.58	1.75	2.31	2.08	

Note: The entry in column i, row j is the t statistic in the regression $e_t^i = \beta_i (f_t^j - f_t^i) + \eta_{it}$.

Table 8

Dynamic Root Mean Square Forecasting Errors (x10)

1990(3) to 1991(4)

	Δp^q	Δp^c
base	0.113	0.099
P$^*_u$	0.192	
P$^*_r$	0.152	
v*-v	0.234	
q-q*	0.085	0.070
cap	0.078	0.084
acap	0.086	
u-u*	0.078	0.068
Δcr	0.117	0.107

Table 9
Out of Sample Forecasts: Δp^q

	Sep-90	Dec-90	Mar-91	Jun-91	Sep-91	Dec-91
Δp^q	0.013	0.010	-0.005	-0.005	0.017	0.001
base	0.014	0.013	0.011	0.013	0.015	0.015
p^*_u	0.009	0.012	0.015	0.024	0.031	0.029
p^*_r	0.009	0.010	0.012	0.019	0.025	0.022
v^*-v	0.011	0.016	0.019	0.028	0.036	0.036
$q-q^*$	0.013	0.010	0.008	0.009	0.008	0.007
cap	0.010	0.008	0.005	0.006	0.006	0.004
acap	0.008	0.005	0.002	0.001	-0.000	0.005
$u-u^*$	0.013	0.009	0.006	0.006	0.005	0.003
Δcr	0.013	0.013	0.012	0.014	0.015	0.014

Table 10
Out of Sample Forecasts: Δp^c

	Sep-90	Dec-90	Mar-91	Jun-91	Sep-91	Dec-91
Δp^c	0.012	0.023	0.003	0.000	0.010	0.007
base	0.014	0.015	0.016	0.015	0.016	0.016
$q-q^*$	0.013	0.011	0.010	0.007	0.005	0.004
cap	0.010	0.008	0.007	0.003	0.001	-0.001
$u-u^*$	0.013	0.012	0.010	0.006	0.004	0.003
Δcr	0.012	0.015	0.018	0.017	0.017	0.014

Table 11

Measures of Slack in the Economy 1990(2) - 1991(3)

	Jun-90	Sep-90	Dec-90	Mar-91	Jun-91	Sep-91
q-q^*	-0.7	-2.7	-3.0	-3.3	-4.0	-3.8
cap	-47	-58	-60	-66	-67	-66
u-u^*	0.4	1.0	1.5	1.9	2.2	2.0

Note: q-q^* and u-u^* are measured as percentage points; cap is the percentage difference between firms working above and below normal capacity

The forecasts themselves are in Tables 9 and 10. Leaving aside the outcomes for December 1990 and March 1991, which were dominated by events in the Persian Gulf, we can see that the cumulative increase in the GDP deflator over September 1990, June 1991, September 1991 and December 1991 was 2.6 percent, which is exactly what is forecast by the capacity utilisation (cap) model. The unemployment gap model also does well, forecasting a cumulative increase of 2.7 per cent.

The corresponding increase in the private consumption deflator was 2.9 per cent. Here, the cap model does not do well, forecasting an increase of only 1.3 per cent. However, the output gap model forecasts an increase of 2.9 per cent, while the unemployment gap forecasts 2.6 per cent.[12]

Finally, we show in Table 11 the values taken by the output gap, level

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[12] Two caveats need to be borne in mind when assessing the accuracy of these forecasts. First, they use realised values of the indicator variables. In practice, these too need to be forecast, inevitably leading to less precision in the forecasts of the inflation rate. Second, the estimates in these paper have used data from the December 1991 National Accounts. Some of these data were revised in the March 1992 Accounts, and will possibly be revised again, but this should not alter our results in any substantive way.

of capacity utilisation and unemployment gap, over the period 1990(2) to 1991 (3) (i.e. corresponding to inflation forecasts one quarter forward.) These all show considerable slack in the real economy; the corresponding indicator models therefore predict low rates of inflation.

6. CONCLUDING REMARKS

In this paper we have examined the forecasting performance of several indicators of inflation. Because of inertia in the inflation rate, lags of inflation are good indicators of future inflation. The velocity (of currency) gap and currency growth do well in forecasting inflation in the period March 1984 to June 1990, but not since. This is due to the large, exogenous, fall in the velocity that has occurred since that time. Real variables, such as the rate of capacity utilisation, appear to have been the best indicators of recent inflation. The P^* model, in various forms, does not appear to forecast well at any time.

This evidence is difficult to interpret because two independent events occurred late in 1990 - both the inflation rate and the velocity of currency started to fall rapidly. Nevertheless, we draw the following conclusions: when the velocity of currency and the inflation rate are relatively stable, the velocity gap and currency growth serve quite well as signals of incipient changes to the inflation rate. However, when the rate of inflation is changing rapidly, due to large fluctuations in the pace of economic activity, real variables such as the rate of capacity utilisation, deviations of output from its trend, and the rate of cyclical unemployment are the best indicators of inflationary pressure.

Appendix: Data Sources

Variable	Source
GDP deflator (p^q)	DataExpress
consumption deflator (p^c)	DataExpress
gross domestic product (q)	DataExpress
currency (cr)	Reserve Bank of Australia Bulletin
unemployment rate (u)	DataExpress and ABS Labour Force (Cat. 6204.0)
capacity utilisation (cap)	CAI-Westpac Survey of Industrial Trends (various issues)

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