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DOES THE FISHER EFFECT APPLY IN AUSTRALIA ?*

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1. INTRODUCTION

It is important for macroeconomic policy-makers to have an understanding of the causes of movements in interest rates. The Fisher effect forms the foundation to any economic theory for interest rates. Fisher (1930) argued that any changes in the expected inflation rate will be reflected in the nominal interest rate, and hence *ceteris paribus* the real *ex ante* interest rate will be constant over time. It is the purpose of this paper to examine the validity of the Fisher effect for Australian interest rates over the last 25 years.

There have, of course, been many empirical studies testing the Fisher hypothesis with data from many countries, including Australia. There are several issues motivating this study. First, there appears to be conflicting results about whether the Fisher effect holds in Australia. Atkins (1989) found evidence in favour of the Fisher effect, while Silvapulle (1987) concluded the opposite. Secondly, deregulation of the financial sector and floating of the Australian dollar have had a dramatic impact on the behaviour of financial variables - how have they affected the inflation-interest rate relationship? Thirdly, use of the most recent econometric techniques for analysing nonstationary data may well shed a different light on the issue.

We will begin the analysis by a discussion of the nature of the Fisher effect and how it can be tested (Section 2). Section 3 will then discuss the econometric issues involved, outlining the procedures required for testing and estimation. Results will be presented and discussed in Section 4. We conclude in the final section that there is strong evidence against the Fisher effect in Australia, indicating that even in the long run, real interest rates respond to nominal variables such as inflation.

2. THE FISHER HYPOTHESIS

The Fisher effect states that in long run equilibrium a change in the rate of growth of money supply leads to a fully-perceived change in inflation and a concurrent adjustment of nominal interest rates. Implicit in this statement is the phenomenon that real interest rates will not respond, in the long run, to movements in expected inflation. Changes in inflation will be absorbed in nominal interest rates, leaving real rates constant *ceteris paribus*. Of course, this does not mean we expect to observe constant real rates over time; many real economic factors may change, bringing about movements in real rates. (For example, Kinal and Lahiri (1988) list several institutional factors which they believe may have affected U.S. real interest rates in the 1980's.) The crucial issue is whether there is any evidence that real rates move in response to expected inflation. If they do, then the inflationary movements have not been totally absorbed in nominal rates, and the Fisher effect does not hold.

Ignoring tax effects[1], the Fisher identity is given by

$$r_t^e = R_t - \pi_t^e , \qquad (1)$$

where r_t^e is the *ex ante* real interest rate, π_t^e the expected inflation rate, and R_t is the nominal interest rate. An implication of the rational expectations hypothesis is that

$$\pi_t = \pi_t^e + u_t , \quad (2)$$

where u_t has mean zero, constant variance σ^2 and is serially uncorrelated. π_t is the observed inflation rate at time t. The *ex post* real interest rate r_t is then given as (Fama, 1975)

$$r_t = R_t - \pi_t . \quad (3)$$

The Fisher effect could then be examined by considering the following model:

$$r_t = \beta_0 + \beta_1\pi_t + \beta_2' z_t + \varepsilon_t , \quad (4)$$

where z_t is a vector of variables that can possibly affect the real interest rate. A test of $H_0 : \beta_1 = 0$ then offers a test of the Fisher hypothesis.

It should be noted that the Fisher effect is a long run equilibrium phenomenon; it is quite possible that inflation impacts real interest rates in the short run. The model in (4) therefore represents a long run relationship, with β_1 being the long run impact of π on r. This point is addressed further in the next section.

3. ECONOMETRIC ISSUES

There is substantial evidence in recent literature to suggest that many macroeconomic time series, including inflation and interest rates, may well possess unit roots; that is, they are integrated processes. Most commonly, series are found to be integrated of order 1, or I(1). If some or all of the variables in (4) are integrated, the appropriate distribution theory for estimators and test statistics is different from that for stationary or I(0) variables. This section describes the tests that we will use for stationarity, and the estimation and testing procedures that are appropriate for analysing (4).

Two tests for unit roots will be used in this paper: the Augmented Dickey-Fuller (ADF) test, which tests the null of a unit root against the alternative of stationarity, and an LM test proposed by Kwiatkowski *et al* (1991), which tests the null of stationarity against the alternative of a unit root. The LM test is based on the model for a time series

$$y_t = \alpha + u_t + v_t , \qquad (5)$$

where

$$u_t = u_{t-1} + e_t ,$$

e_t is i.i.d. $(0,\lambda\sigma^2)$ and v_t is a stationary ARMA process with variance σ^2. That is, the stochastic part of y_t has an error components representation, with an I(1) and I(0) error[2]. When $\lambda = 0$, the I(1) error disappears, and y_t is stationary, so we test the null hypothesis $H_0 : \lambda = 0$ against $H_1 : \lambda > 0$. Having a test with the null of stationarity is helpful, as many times tests of the null that a series is I(1) lead to non-rejection of the null. Researchers are often unsure whether to interpret this as evidence of a unit root, or to attribute it to low power of the test. Reversing the null and alternative hypotheses is helpful in overcoming this dilemma.

The LM test statistic proposed by Kwiatkowski *et al* is given by

$$LM = T^{-1} \sum_{t=1}^{T} S_t^2 \, / \, s^2(\ell) ,$$

where $S_t^2 = \sum_{i=1}^{t} \hat{w}_i^2$, $s^2(\ell) = T^{-1} \sum_{t=1}^{T} \hat{w}_t^2 + 2T^{-1} \sum_{j=1}^{\ell} \theta(j,\ell) \sum_{t=j+1}^{T} \hat{w}_t \hat{w}_{t-j}$, and $\hat{w}_t$ are the OLS residuals from (5). The weights $\theta(j,\ell)$ are chosen so as to guarantee the non-negativity of $s^2(\ell)$ - see Hansen and Phillips (1990, p.238). They are given by $\theta(j,\ell) = 1 - j/(\ell + 1)$. The choice of ℓ is a crucial issue, as an appropriate choice is necessary for the test to have good finite sample properties. ℓ is intended to capture the effect of any autocorrelation in v_t on the variance of the numerator of LM. Inder (1991) has suggested using the sample autocorrelation function of $\Delta\hat{w}_t$ to determine the maximum value of ℓ required.

In the next section we will present some evidence for the presence of a unit root in the time series. This has implications for the choice of estimation and testing procedures. Engle and Granger (1987) have pointed out that if the variables are I(1), the long run parameters in (4) can be estimated consistently by ordinary least squares (OLS), ignoring any possible short run dynamics. Asymptotically valid standard errors and test statistics can be obtained by using Hansen and Phillips' (1990) Fully Modified OLS estimator (FMOLS). There is, however, simulation evidence in favour of estimating the parameters of (4) in the context of a full error correction model (ECM) framework which estimates both long run and short run parameters together [see Hansen and Phillips (1990) and Inder (1992)]. We thus consider estimates of the parameters based on the ECM estimator, as well as OLS and FMOLS[3].

4. THE EMPIRICAL EVIDENCE

The quarterly data in this study cover the period 1964(1) to 1990(4), with inflation based on the Australian Consumer Price Index, and the interest rate is the Bank-accepted Bill rate. This sample period spans a period of major deregulation of the financial system in Australia, including the floating of the Australian dollar in December, 1983. These changes are likely to have a significant effect on the real interest rate, so unit roots tests are undertaken over the two sub-samples 1964(1)-1983(4) and 1984(1)-1990(4) as well as the full sample. We also present estimation results over the full sample with a mean shift dummy variable taking the value zero up to 1983(4) and one thereafter. The other variable considered for inclusion in z_t (equation (4)) is the U.S. real interest rate (90-day commmercial rate), reflecting the dependence of the Australian market on international factors.

Table 1 presents results of the various unit roots tests for the inflation and interest rates. The results are ambiguous, as rarely do the tests lead to the same conclusions! Using ADF tests, we cannot reject the null of a unit root in any series, for any of the sample periods. On the other hand, stationarity is rejected using the LM test in only a few cases. Values of the LM statistic are all very small for the latter sub-sample, suggesting that over such a small period there is insufficient evidence to detect a unit root. On the other hand, over the full sample the LM test indicates a unit root in both interest rate series and possibly in inflation, depending on the choice of ℓ. In the first sub-sample, there is clear evidence of a unit root in nominal interest rate, but results are inconclusive for the other two series.

Overall, we would cautiously conclude that there may well be a unit root in all of the series; we are quite confident of this for the nominal interest rate, and less so for the other series. In any event, analysis of equation (4) will need to be undertaken with procedures that are appropriate for I(1) variables.

Estimates of the parameters of equation (4), using the three estimation techniques described above, are given in Table 2. Rejection of the hypothesis that the coefficient of inflation is zero implies rejection of the Fisher effect. Using standard normal critical values at any reasonable significance level, the overwhelming evidence in this table supports rejection of the null hypothesis.

The coefficients of inflation in Table 2 are between -.30 and -.55. This suggests that nominal interest rates do not respond fully to rises and falls in inflation. For example, if inflation rose by two percentage points, these estimates predict a long run increase in nominal interest rates of just over one percent, and hence a drop in real interest rates of almost one percent. There appears to be some "stickiness" in the response of nominal interest rates to inflation, even in the long run. This interesting phenomenon is worthy of further investigation.

Another point of interest from the estimated equations is the value of the coefficient of the dummy variable when this is included in the model. The three estimation techniques all give estimates of around 5.0, with highly significant t statistics. This suggests that inflationary effects and foreign interest rates cannot explain the higher real interest rates which have characterized the post-1983 period of capital market deregulation and the floating of the Australian Dollar.

We also note the strongly significant coefficient of the U.S. real interest rate in each eqaution. It is clear that the Australian capital market is heavily influenced by the U.S. market. In fact, when the mean shift dummy is excluded, there is almost a one for one relationship. A more realistic value, though, would be the estimates of between .45 and .63 which result when the dummy is included.

5. CONCLUDING REMARKS

The aim of this paper has been to provide further insight into movements in Australian interest rates, with particular reference to the Fisher effect. Using appropriate econometric techniques, the evidence seems to suggest that the Fisher effect does not hold in Australia. Nominal interest rates do not respond fully to rises and falls in the inflation rate, even in the long run. Given the flow-on effects of real interest rates on real economic activity, this implies that movements in inflation can impact the productive economy. The question remains as to the source of this "stickiness" in nominal interest rates.

Since major deregulation of the Australian financial system and floating of the dollar, real interest rates have settled at substantially higher rates. The analysis in this paper suggests that this cannot be explained by short term responses to inflationary movements, nor does its explanation lie totally with increases in foreign rates. It seems more likely that deregulation has led to a greater risk premium component in the real rate of return on capital. Again, this issue merits further attention.

This paper has also revealed the strong dependence of the Australian capital market on foreign markets. It will be difficult for domestic policymakers to control monetary conditions under these circumstances.

<u>Footnotes</u>

1. Atkins' (1989) analysis was performed with pre-tax and post-tax nominal interest rates; the difference in results was minimal.

2. The model can also be written to include a linear trend.

3. Systems estimation based on reduced rank regression as described by Johansen (1988) is not considered appropriate for this study, as there are really only two variables of interest, and hence at most only one cointegrating vector, assuming the variables are I(1).

4. The Durbin-Watson statistics from the two OLS regressions were .683 (Dummy included) and .547 (Dummy excluded), both of which suggest rejection of the null of no cointegration using the CRDW test of Engle and Granger (1987).

TABLE 1

Tests for Unit Roots in the Series*

Series	Sample period	LM test of $H_0: I(0)$ vs $H_1: I(1)$ $\ell=0$	$\ell=4$	$\ell=8$	ADF test of $H_0: I(1)$ vs $H_1: I(0)$ Lags=0	Lags=1	Lags=4
Nominal	64(1)-90(4)	7.208*	1.716*	1.085*	-2.59	-2.41	-2.44
Interest	64(1)-83(4)	3.412*	.847*	.546*	-2.46	-2.31	-2.09
Rate	84(1)-90(4)	.047	.019	.033	-1.97	-2.12	-2.88
	64(1)-90(4)	2.002*	.452	.289	-1.79	-2.16	-2.03
Inflation	64(1)-83(4)	2.608*	.595*	.369	-1.46	-1.65	-1.67
	84(1)-90(4)	.197	.060	.059	-1.53	-2.70	-2.41
Real	64(1)-90(4)	4.266*	1.024*	.639*	-2.62	-2.28	-1.76
Interest	64(1)-83(4)	.737*	.196	.126	-2.85	-2.61	-1.65
Rate	84(1)-90(4)	.102	.036	.038	-2.20	-1.66	-2.76

* 5% critical value for the LM test is .463 and ADF critical values are -2.89 (full sample), -2.92 (first sub-sample) and -3.00 (second sub-sample. A * indicates rejection of the null hypothesis.

Table 2

Estimates of Long Run Relationship between Real Interest Rates and Inflation

Dependent Variable: Real Interest Rate*

	Estimator					
Variable	OLS	FMOLS	ECM	OLS	FMOLS	ECM
Constant	3.26	2.98	4.50	3.95	4.33	6.22
	(4.58)	(2.51)	(7.71)	(4.39)	(2.72)	(9.92)
Mean Shift Dummy	5.06	4.88	5.61			
	(7.82)	(4.55)	(10.50)			
U.S. Real Interest	.55	.63	.45	.97	.86	.97
	(4.56)	(3.20)	(4.26)	(7.12)	(3.59)	(10.64)
Inflation	-.33	-.30	-.47	-.31	-.34	-.55
	(-4.52)	(-2.48)	(-7.79)	(-3.31)	(-2.03)	(-8.51)

* Sample Period is 1964(1) TO 1990(4). The ECM estimator has two lags of each variable. Values in parenthesis are t statistics.

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