SHARE PRICES AND INVESTMENT

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Abstract

In this paper we examine two related propositions: the efficiency of pricing of Australian shares and the influences of share prices on business investment. In line with similar studies overseas, we find that the Australian share market may deviate from efficient pricing over short time horizons but that there is little evidence of inefficiency over longer time horizons.

To investigate the influence of share prices on investment decisions we use a simple model of real share prices to identify estimates of the 'fundamental' and 'speculative' components of share prices. As expected, the estimated fundamental component of real share prices is found to have a stronger relationship with investment than the aggregate real share price series. Despite some evidence of share price inefficiencies, the speculative component of real share prices is insignificant in the same investment equations, providing evidence that speculative movements in share prices do not have a significant effect on business investment. There is evidence, however, that these speculative share price movements influence the composition of corporate financing. In particular, the timing of equity raisings appears to be influenced by both components of share prices.

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1.   Introduction

Investment and share prices are closely linked in neoclassical investment models. Managers make investment decisions on the basis of whether the investment will improve the future value of the firm. As share prices are forward looking variables which condense information regarding a firm's expected value, movements in share prices and investment should, in theory, be correlated. Increasingly, however, it has been recognised that share markets may not be efficient processors of information and may deviate from their fundamental value for extended periods.[1] Depending on the extent to which there is a causal relationship between share prices and investment, share prices which are not based on fundamentals may distort investment decisions.

There is little consensus on this issue. One strand of the literature argues that the share market is a passive predictor of future activity and that managers do not rely on share-price movements to make investment decisions. For example, Bosworth (1975, p. 286) argues that it is inconceivable that management who are concerned with the long-run market value of the firm would 'scrap investment plans in response to the highly volatile short-run changes in stock prices'. On the other hand, there is a strand of literature which suggests that share prices provide key price signals to managers regarding corporate investment decisions (Fischer and Merton 1984). If this were the case then any pricing inefficiencies would send misleading signals to managers and would distort investment decisions. Some adherents to this view argue that even sophisticated managers who know the true value of their firm are still likely to react to non-fundamental share-price movements. For example, if managers perceive their firm to be overvalued they will take advantage of the relatively low cost of capital by issuing shares and using the proceeds to invest in capital or to improve their balance sheets (Fischer and

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[1] See Fama (1970, 1991), Poterba and Summers (1988), De Long, Shleifer, Summers and Waldmann (1990), Cutler, Poterba and Summers (1990a, 1990b), Claessens, Dasgupta and Glen (1995) and Kortian (1995).

Merton 1984; Tease 1993). If this were the case then speculative share-price moves would have real effects.

The empirical evidence of the linkage between share prices and investment is mixed. Fischer and Merton (1984) and Doan, Litterman and Sims (1983) show that once allowance is made for other determinants of investment, share prices still play a prominent role in explaining investment. In contrast, Morck, Shleifer and Vishny (1990) find only a minor role for share prices beyond their ability to predict fundamental determinants of investment.

Of the few studies which have attempted to decompose share prices into their speculative and fundamental components, Tease (1993) concludes that, to the extent that pricing inefficiencies may exist, they do not significantly influence investment. Blanchard, Rhee and Summers (1990, p. i) interpret their results as 'pointing, strongly but not overwhelmingly, to a larger role of "fundamentals" than of "valuation" (speculation) in investment decisions'. Chirinko and Schaller (1996, p. 50) establish similar results, concluding that 'there are bubbles in the stock market but they do not seem to affect investment'.

This paper examines the efficiency of pricing of Australian shares and the influence of share prices on investment decisions. The paper is set out as follows. Section 2 examines the theoretical linkages between share prices and investment. The literature and some empirical tests on the efficiency of share-price determination are examined in Section 3. Section 4 decomposes aggregate share prices into estimates of their fundamental and speculative components and presents empirical results from estimating investment equations. Section 5 examines the extent to which managers are able to identify and exploit speculative share-price movements. Section 6 concludes.

2. Share Prices and Investment – Some Theory

The theoretical linkages between share prices and investment have been well documented.[2] In neoclassical investment theory, a manager chooses combinations of

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[2] See Barro (1990), Blanchard *et al.* (1990), Morck *et al.* (1990), Chirinko (1993) and Tease (1993).

capital and labour (subject to certain constraints) in order to maximise the value of the firm.[3] Even if the cost of an additional unit of capital is known in advance, the revenue that the capital is likely to generate over its lifetime is not known with any certainty. Managers have to make an assessment of the likely future profits that the increment to the capital stock will generate, discounted at some appropriate rate, and contrast it with the marginal cost of capital to determine whether the investment should go ahead:

$$\frac{I_t}{K_t} = \frac{1}{a}\left[E_t\{f_t\} - P_t^I\right] \tag{1}$$

where I is investment, K is the capital stock, $E\{f\}$ is the discounted present value of the revenue expected to be generated by the additional unit of capital, P^I is the marginal cost of capital and a is the cost of adjusting the existing capital stock.[4]

A similar framework can be used to calculate the value of the firm. The fundamental value of the firm (V) is equal to the discounted present value of the cash flow stream that the existing capital stock is expected to generate:

$$V_t = \left[E_t\{f_t\}\right]K_t \tag{2}$$

Thus, the same types of expectational variables that determine the investment decision also determine the value of the firm (the firm's share price). This relationship was recognised by Tobin (1969) in the 'q' theory of investment where q is defined as the ratio of the market value of the firm to the replacement cost of its existing capital stock:

$$q_t = \frac{V_t}{P_t^I K_t} \tag{3}$$

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3 For a survey of neoclassical investment theory see Chirinko (1993).

4 In a more general model, the purchase cost (P^I) may not be entirely known in advance. Future training and maintenance costs could be represented by a discounted sum, analogous to f.

Combining Equations (1) to (3) illustrates the basic relationship between investment and Tobin's q:[5]

$$\frac{I_t}{K_t} = \frac{1}{a}(q_t - 1)P_t^I$$

(4)

Equation (4) illustrates that when the market value of capital exceeds its replacement cost ($q>1$), a firm is able to increase its value by investing. Further, as the dominant source of variation in q comes from the numerator – the market value of the firm – the equation also illustrates that investment is related to real share prices (V_t/P_t^I).[6]

As discussed in the introduction, however, there is a body of literature which suggests that a firm's share price incorporates speculative factors unrelated to the value of the firm. In essence, the fundamental value of the firm can be expressed as its market value less its speculative value:

$$V_t^F = V_t - V_t^S$$

(5)

Given the existence of speculative and fundamental elements to a firm's share price, the q investment model (Equation (4)) can be rewritten as:

$$\frac{I_t}{K_t} = \frac{1}{a}\left[q_t^F - 1\right]P_t^I + \frac{1}{a}q_t^S P_t^I$$

(6)

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[5] In theory, investment should be related to 'marginal q' (the ratio of the discounted future revenues from an additional unit of capital to its purchase price). However, as marginal q is unobservable, empirical research has tended to use 'average q' as reflected, for example, in the stock market valuation of the firm. The distinction between average and marginal q is discussed in Hayashi (1982). This distinction highlights a problem in using average q measures in empirical tests of the theory. For example, an energy price shock would reduce the value of the existing capital stock but would encourage energy conserving investment: average q would fall while marginal q would rise (see Blanchard *et al.* 1990, p. 7) . While the distinction between average and marginal q is not examined in this paper, Chirinko (1993), among others, has shown that the relationship is: marginal q = (average q – 1) P^I.

[6] See Barro (1990).

As such, Equation (6) provides the theoretical framework by which we can test whether speculative share-price movements distort investment decisions. A form of this relationship is tested in Section 4. As a preliminary to examining the relationship between real share prices and investment, we first examine the extent to which inefficiencies in share prices can be identified.

3.   Share-Market Efficiency

The Efficient Market Hypothesis states that the share market is weak-form efficient if share prices incorporate all historical information such that investors are unable to predict future share-price movements from previous movements.[7] The implication of this definition is that share-price returns should be uncorrelated with historical returns. One method for testing share-market efficiency involves testing whether share-price returns (ΔS_t) are correlated with past returns, that is testing the significance of the b_i's in Equation (7). One problem with this methodology is that it assumes that the model of expected returns ($E_t(\Delta S_t)$) is reliable. As such, these tests are actually joint tests of share-price efficiency and whether the model of expected returns is correctly specified (Fama 1991).

$$\Delta S_t = E_t(\Delta S_t) + \sum_{i=1}^{k} b_i \Delta S_{t-i} + e_t \tag{7}$$

where: $e_t \sim iid(0, s^2)$

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[7]   In the early efficiency literature (summarised in Fama (1970)), efficiency is classified into three testable forms – weak, semi-strong and strong. In Fama (1991) these definitions are refined into three equivalent categories; *return predictability tests* which include all models that forecast returns using historical share prices, dividends and earnings yields; *event study tests* which are concerned with whether share prices efficiently adjust to new, publicly available information; and *private information tests* which examine whether insiders have information which is not fully reflected in share prices. As such, return predictability tests of efficiency under the Efficient Market Hypothesis (weak-form tests) is the least stringent definition of efficiency but is the most relevant definition from a macroeconomic perspective. The more stringent definitions of efficiency – event study and private information tests – involve more micro-orientated tests and are not examined in this paper.

In the earlier literature, expected returns were assumed to be constant, and so efficiency tests were simply tests of whether share price returns (ΔS_t) were correlated with past returns (Fama 1970). These tests often found that share-price returns were predictable from past returns, that is inefficient.

The view that expected share-price returns are invariant over time is now generally acknowledged as being too simplistic. In the more recent literature, Fama (1991) and others[8] argue that rather than indicating inefficiencies, predictability of long-run returns could indicate that expected returns are themselves serially correlated over time. That is, expected returns are time-varying. For example, if an asset's expected return is equal to the risk-free rate plus a constant instrument-specific risk premium, the expected return is likely to be serially correlated if the risk-free rate is related to the business cycle (Fama and French 1989).

Simple versions of this proposal test whether share-price returns in excess of the risk-free rate are correlated over time. Overseas studies tend to find that the results are largely dependent on the frequency of the data used.[9] They find that 'excess' returns are autocorrelated over short horizons but that this correlation dissipates over longer horizons.

More complicated versions of the 'time-varying' literature explicitly model expected returns with respect to both long and short-run factors. These models test whether short-run movements in share prices are anchored to a long-run fundamental share price. For example, Tease (1993) models expected returns to reflect the present value of expected nominal income flows and shows that although speculative factors may drive returns away from their equilibrium in the short run, returns gradually revert to their fundamental value.

These models appear to indicate that share prices deviate from their fundamental value and are, therefore, inefficient. Recent literature suggests, however, that even rational investors who typically sell high and buy low (and therefore stabilise prices)

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8 Poterba and Summers (1988), Fama and French (1989), Cutler *et al.* (1990a), Fama (1991), French and Poterba (1991) and Black and Fraser (1995).

9 Poterba and Summers (1988) consider excess returns with the risk-free rate measured as the Treasury bill yield, while Cutler *et al.* (1990a) use the dividend yield as a proxy of the risk-free rate.

may rationally and profitably destabilise prices in the short run.[10] For example, technical traders may sell into a declining market if they believe that a price movement is likely to continue, possibly as a result of investors who 'trend chase' or who trade on the basis of stop-loss or portfolio insurance strategies. With this literature in mind, these tests of efficiency which establish short-run share-price deviations from fundamentals should be broadly interpreted as tests establishing long-run efficiency and short-run speculative dynamics.

3.1   Tests of Share Market Efficiency

There are few tests on weak-form efficiency in Australian share prices. Groenewold and Kang (1993) tested both weak and semi-strong form efficiency using monthly data in the Australian share market between 1980 and 1988 and found no evidence of share-market inefficiency. Blundell-Wignall and Bullock (1992) found share prices to be inefficient over short time horizons but that they reverted to their fundamental value in the long run.

In this section we test for Australian share-market efficiency under the alternative assumptions of constant and time-varying expected returns. Although it is not possible to fully resolve the question of share-market efficiency due to the problem of unobservable expected returns, our results reach similar conclusions – that there is evidence of share-price inefficiency over short horizons but little evidence of share-price inefficiency over longer horizons.

3.1.1   Tests for autocorrelation

Our tests of return predictability follow the literature by estimating autocorrelation coefficients and testing their significance with the Ljung-Box Q test. We test for efficiency under the alternative assumptions of constant and time-varying expected share-price returns.[11] The null hypothesis is that the share market is efficient. That is, that the first k autocorrelations are not significantly different from zero.

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[10] See for example, De Long *et al.* (1990), Cutler *et al.* (1990b) and Kortian (1995).

[11] For time-varying expected returns, we assume that the expected share-price return varies in line with the 10-year Commonwealth Government bond yield.

The results under the alternative assumptions of constant and time-varying expected share-price returns are very similar (Table 1). We find that over shorter horizons (daily, monthly and quarterly) positive serial correlation is present, while over a long horizon (annual), it is less evident.[12] These results are in line with overseas studies (Poterba and Summers 1988; Tease 1993).

Figure 1 which plots the correlation coefficients shows that the incidence of positive and significant coefficients declines as the frequency of the data declines. Tentatively, this can be interpreted as providing some evidence that even though share prices are inefficient in the short run, they revert to their fundamental value over time.

Table 1: Tests for Autocorrelation in Share Price Returns

	Ljung-Box Q Statistics	
	Constant expected return	Time-varying expected return
Daily	254.4 **	254.6 **
1987-1996	(0.00)	(0.00)
Monthly	111.7 **	113.5 **
1959-1996	(0.00)	(0.00)
Quarterly	36.0 **	48.8 **
1936-1996	(0.00)	(0.00)
Annual	8.6 *	10.3 *
1889-1995	(0.03)	(0.02)

Notes: * and ** denote significance at the 5% and 1% level, respectively. The marginal significance levels (p-values) are in parentheses. The number of autocorrelations (k) tested are 3 for annual data, 12 for quarterly data, 36 for monthly data and 100 for daily data.

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[12] In recognition of the low power of tests for autocorrelation, the Ljung-Box Q test was supplemented with the Lagrangian Multiplier test which, reassuringly, produced similar results.

Figure 1: Autocorrelation Coefficients of Share Price Returns
All Ordinaries Index
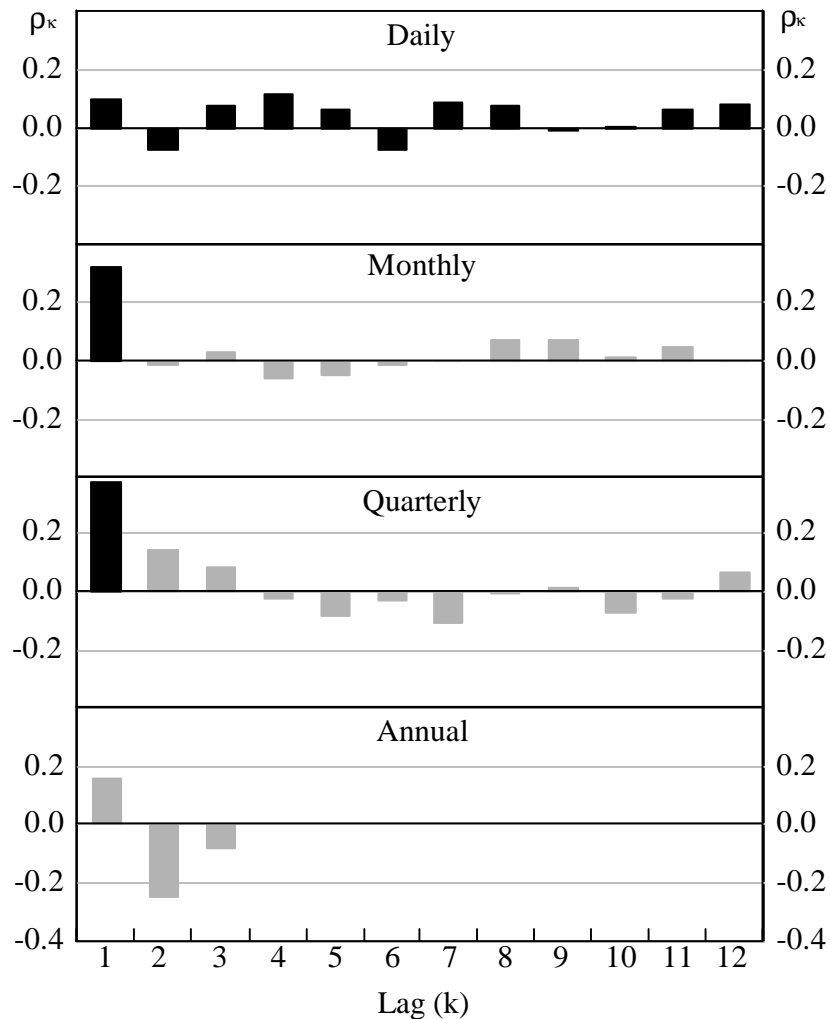
Note: The black bars indicate that the autocorrelation coefficient is significantly different from zero at the 1% level of significance.

One problem with this approach is that the sample period covers quite diverse stages in the development of the Australian share market. Similar correlation tests were made on rolling 36-month periods from 1962. The results are presented in Figure 2 which shows that the Ljung-Box Q statistics tend to be smaller (and less significant) in the eighties and nineties than in the previous two decades. This would seem to indicate that the Australian share market has become more efficient over time and could explain why some papers find evidence of inefficiency while others have failed to do so.

Figure 2: Tests for Autocorrelation in Share Price Returns

On rolling 36 month samples
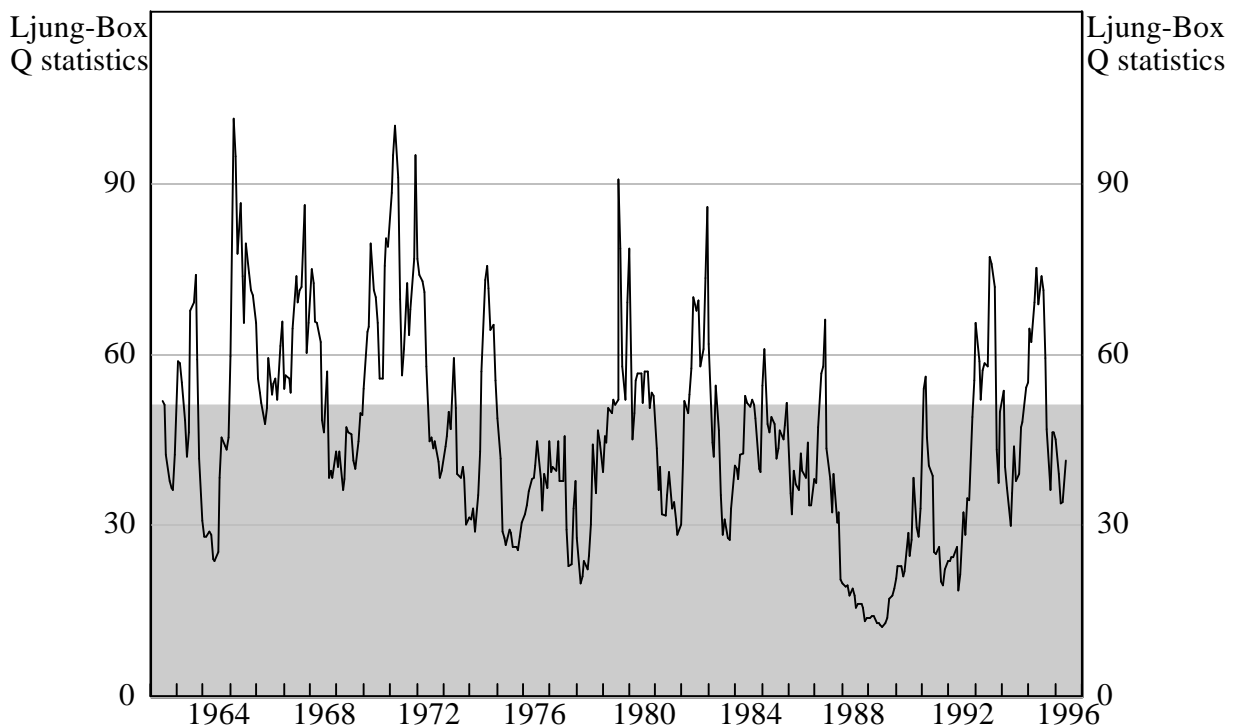
Note: Shaded area indicates acceptance of the null hypothesis of no serial autocorrelation at the 5% level of significance.

Another criticism of this simple approach is that the All Ordinaries Share Price Index incorporates the prices of infrequently traded shares. The implication of this is that while macroeconomic developments such as exchange rate movements or changes in the company tax rate will be immediately reflected in the prices of the frequently traded shares, it may take some time to be reflected in the prices of the less frequently traded shares. Conceptually, the lagged response of the infrequently traded share prices to new information may be spuriously interpreted as indicating autocorrelation. In an attempt to determine whether there is any inherent bias caused by infrequently traded shares, the same autocorrelation tests were re-estimated using the 'narrower' 50-Leaders Share Price Index. While the 50-Leaders Index is only available from 1980, no qualitative difference was evident in the results.

3.1.2 Modelling expected share price returns

A more formal method of testing for efficiency assuming time-varying expected returns is to use an unrestricted error correction model of the form specified in

Equation (8). It is assumed that, in the long run, share prices reflect the present value of expected future cash flows. This is estimated using the log of real corporate profits after interest together with the general price level.[13] To model the short-run dynamics, the log differences of nominal share prices, real corporate profits after interest, the general price level (inflation) and oil prices are included with four lags.[14] The cost of capital, proxied by the 10-year bond yield, is also included with four lags. The null hypothesis tested here is that if share prices are characterised by speculative dynamics in the short run, and a return to equilibrium over time, then the lagged response to changes in share prices (u) should have a positive and significant coefficient and there should be evidence of cointegration in the long run (that is, g should be negative and significant).

As a preliminary to estimation, unit root tests were conducted and the results are presented in Appendix A. The tests showed that all the variables in Equation (8) are integrated of order one. We chose to consider the cost of capital series (estimated by the nominal bond yield) as stationary notwithstanding the unit root test result since the series is necessarily bounded.

$$\Delta S_t = \text{constant}_t + \sum_{g=1}^{4} u_g \, \Delta S_{t-g} + \sum_{i=0}^{4} r_i \, R_{t-i} + \sum_{j=0}^{4} q_j \, \Delta P_{t-j} + \sum_{n=0}^{4} \P_h \, \Delta OIL_{t-n}$$

$$\qquad (8)$$

$$+ \sum_{m=1}^{4} s_m \, \Delta Y_{t-m} + g S_{t-1} + b Y_{t-1} + h P_{t-1} + e_t$$

where: S = nominal share prices
R = cost of capital (10-year bond yield)
P = general price level
OIL = oil price
Y = real cash flow

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[13] A full description of the data can be found in Appendix B.

[14] Oil prices are included to account for the related supply-side shocks in the mid seventies and early eighties. Commodity prices, the exchange rate, world growth and the yield curve were also tested in Equation 8 but were found to be insignificant.

The results are presented in Table 2. Of the short-run explanatory variables, the coefficients for the change in real cash flows and inflation were insignificant and were subsequently dropped to arrive at our preferred equation. The change in share prices and the cost of capital (each with four lags) are significant and have the expected sign. Real cash flows and the general price level are significant in the long run. The change in oil prices, although insignificant, were retained to control for supply-side shocks. Our preferred equation satisfies the diagnostic tests for serial correlation, normality and autoregressive conditional heteroscedasticity.

In line with previous studies (Blundell-Wignall *et al*. 1992; Tease 1993), these results support the hypothesis of short-run speculative dynamics – the coefficients on the lagged changes in share prices are positive and jointly significant at the one per cent significance level. There is also evidence of cointegration, suggesting that share prices return to their fundamental value in the long run.

In summary, while there is evidence that share prices are inefficient over shorter time horizons these results appear to be biased somewhat by the earlier years in the Australian share market when the capital markets may have been less liquid. Reflecting the changes in Australian financial markets in the eighties, there is evidence that the liquidity in the market has improved and share price inefficiencies have been reduced.

Table 2: Share-Price Equation
Dependent variable: ΔS_t

	Quarterly 1962:Q1-1996:Q1 (8)
Explanatory variables – short run:	
constant	-0.01
	(0.0)
$\sum \Delta S_{t-k}$	0.37 **
	(21.4)
$\sum R_{t-k}$	-0.43 **
	(30.6)
$\sum \Delta Oil_{t-k}$	-0.15
	(9.3)
Explanatory variables – long run:	
g (Cointegration test)	-0.10 **
	(2.6)
Y_{t-1}	1.02 *
	(2.1)
P_{t-1}	0.71 **
	(2.6)
Summary statistics:	
$\overline{R}^2$	0.23
$\hat{\sigma}$	0.08
Serial correlation test $(\chi^2(4))$	0.24
Normality test $(\chi^2(2))$	0.09
ARCH Test $(\chi^2(1))$	0.46

Notes: * and ** indicate the coefficients are significantly different from zero at the 5% and 1% significance levels. For the short-run explanatory variables the figures in parentheses are chi-squared statistics testing the null hypothesis that the coefficients are jointly equal to zero. For the long-run explanatory variables, the Bewley (1979) transformation was applied to obtain interpretable t-statistics (shown in parentheses). The cointegration test proposed by Kremers, Ericsson and Dolado (1992) was employed. '$\hat{s}$' is the standard error of the equation. For the diagnostic tests the marginal significance level is shown. The serial correlation test is the Lagrangian Multiplier test for up to fourth order serial correlation. The normality test is the Jacque-Bera (1980) test and the ARCH test is Engle's (1982) test.

4. Share Prices And Investment – Empirical Results

The previous section established that there was evidence of short-run inefficiencies in share prices. In this section we examine the relationship between share prices and investment and, to the extent that share-market inefficiencies do exist, we test the degree to which investment decisions are influenced by speculative movements in share prices.

Three empirical approaches are undertaken to investigate the theoretical linkage between share prices and investment. The first approach employs vector autoregressions to examine whether share prices explain investment after controlling for other variables thought to be important determinants of investment. The second approach more formally estimates investment equations and examines the importance of share prices in such equations. The final approach decomposes share prices into estimates of their fundamental and speculative components which are then incorporated into the preferred investment equation.

Briefly, we find weak evidence of a relationship between share prices and investment although once share prices are decomposed into fundamental and speculative components, the relationship between fundamental share prices and investment is much stronger. Once other determinants of investment are added to the investment equation, however, the fundamental share-price variable becomes insignificant. No relationship is found between speculative share-price movements and investment.

4.1 Causality Tests

The 'q' theory of investment says that if q is greater than one, the market value of the firm exceeds its replacement cost and it is in management's interest to invest. A casual inspection of the data suggests that real share prices, our proxy for 'q', appear to be stationary (Figure 3)[15] and that there are a number of episodes where they have led movements in corporate investment (Figure 4).

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[15] The unit root test results in Appendix A indicate that real share prices and corporate investment (as a ratio to the capital stock) are I(1). However, like Debelle and Preston (1995) we have chosen to characterise these series as stationary. Graphical analysis reveals that clear

This impression tends to be confirmed in two-variable vector autoregressions (VARs) of the log of real share prices and corporate investment (as a ratio to the capital stock). Granger-causality tests indicate that, at the five per cent level of significance, real share prices do provide significant leading information on investment (Table 3).

**Figure 3: Share Prices and Inflation**
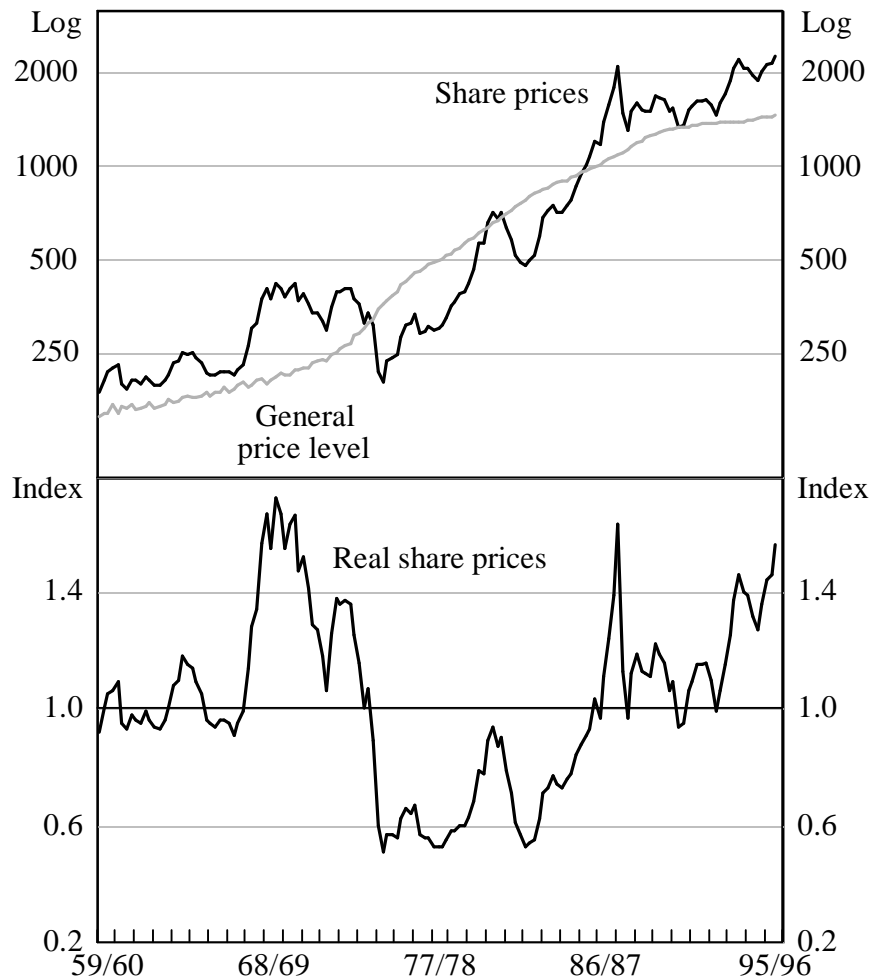
It would be premature, however, to conclude from this two-variable VAR analysis that share prices cause investment. VARs rely on timing to identify causation. To the extent that share prices reflect market expectations of the future earnings of a

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one-off shifts in the levels of these series have occurred. This is confirmed by more sophisticated tests which show that once allowance is made for these shifts, real share prices and investment are better characterised as stationary variables around a broken trend.

firm, share prices are forward-looking variables. As such, the apparent leading property of real share prices may simply reflect the fact that they incorporate expected movements in variables which are also important determinants of investment. Thus, it is doubtful that a two-variable VAR can be used to decisively determine the issue of whether real share prices are exogenous and 'cause' investment.

Figure 4: Real Share Prices and Investment
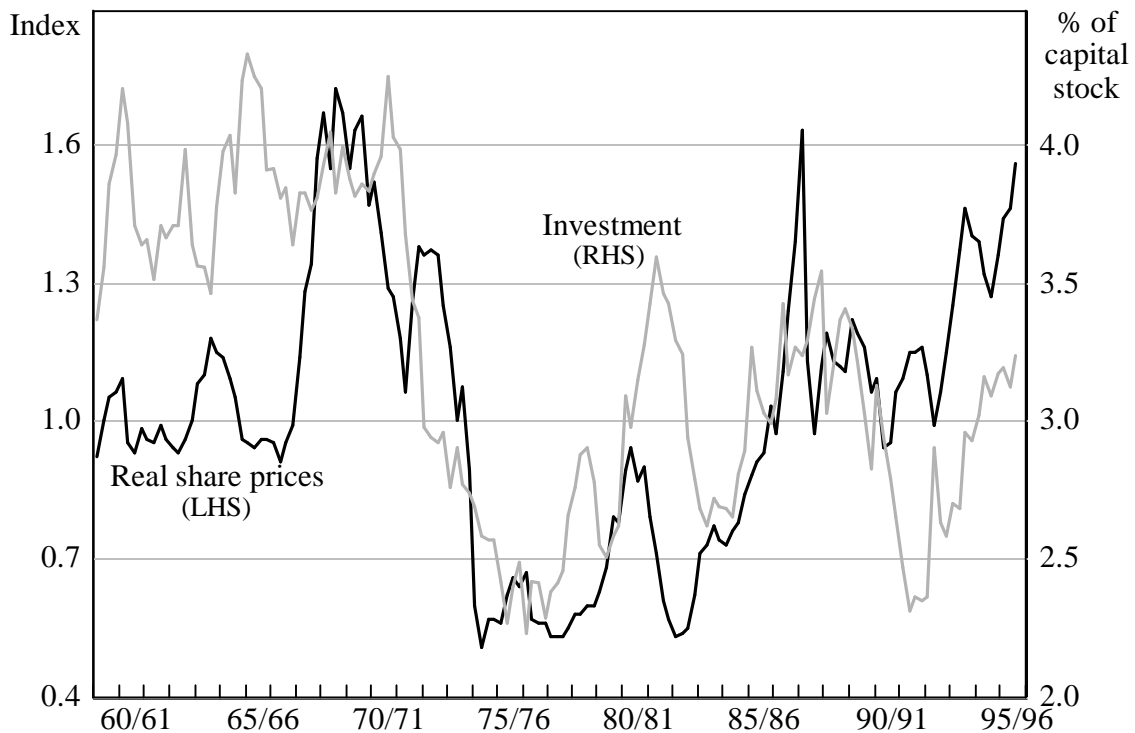
In an attempt to resolve this issue, the two-variable VAR is extended and re-estimated with variables thought to be important determinants of investment. A four-variable VAR incorporating the real cost of capital (proxied by the real 10-year bond yield) and real return on capital is estimated. It shows that real share prices are no longer significant (Table 3). These results tend to suggest that share prices are only a passive predictor of investment.[16]

Similar empirical studies conducted overseas present conflicting results. Morck *et al*. (1990) conclude that share prices are only a passive predictor of investment while Fischer and Merton (1984) and Doan *et al*. (1983) conclude that

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[16] Alternatively, the results may simply reflect that speculative share-price movements are distorting the relationship. We address this issue in Section 4.3.

share prices are causal determinants of investment. Further, Mullins and Wadhwani (1989) found that their results varied between countries; in Japan and Germany, share prices provided no additional explanatory power for investment behaviour whereas they significantly affected investment in the UK and US.

Table 3: Vector Autoregressions

Testing Granger causality from share prices to investment

	Variables in system	Quarterly 1962:Q1-1996:Q1
Two-variable VAR	Investment, share prices	2.6 *
Four-variable VAR	Investment, share prices, real cost of capital, real return on capital	0.9

Notes: The figures are F-statistics from testing the null hypothesis that the lags of the coefficients of real share prices are jointly equal to zero. * indicates the coefficient is significantly different from zero at the 5% significance level. The VARs include four lags of each variable.

4.2 Investment Equations with Aggregate Share Prices

The implied causal relationship presented above is tested more formally in this section. We begin by specifying an investment equation (Equation (9)) whereby investment is estimated by lags of itself and real share prices (q). We begin with a general equation with four lags of each explanatory variable and eliminate those which are insignificant to arrive at our preferred equation. The results of this estimation are shown in Table 4. At the five per cent level of significance, real share prices seem to have a role in explaining investment. As with the simple two-variable VAR approach, however, this result is relatively inconclusive as share prices may be insignificant once other variables which explain investment are included. To test this, we incorporate a vector of variables (Z) traditionally regarded as important determinants of investment (Equation (10)).

$$\left(\frac{I}{K}\right)_t = \text{constant} + a\left(\frac{I}{K}\right)_{t-1} + bq_{t-i} + e_t \tag{9}$$

$$\left(\frac{I}{K}\right)_t = \text{constant} + a\left(\frac{I}{K}\right)_{t-1} + bq_{t-i} + mZ_{t-i} + e_t \tag{10}$$

The results from estimating Equation (10) are also presented in Table 4. Incorporating a general to specific methodology, we found that a number of variables including the real cost of capital, company sales and a measure of business confidence were insignificant and were subsequently dropped from the equation.[17] The significant variables which were retained included the real return on capital, the output gap (a measure of capacity utilisation) and inflation. The real return on capital, the output gap and the first lag of investment are all correctly signed and highly significant at the one per cent level, while inflation is also an important determinant of investment at the five per cent significance level.[18] Real share prices, however, become insignificant.

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[17] Corporate sales was dropped since it was found to be highly collinear with the output gap term.

[18] With the real return on capital and output gap measures entering Equation 10 contemporaneously, the Hausman (1978) test was employed to test for any simultaneity problems. No simultaneous equation bias was found. Moreover, the results are qualitatively similar if the equation is estimated with instrumental variables, although the output gap term becomes less significant.

Table 4: Investment Equations with Aggregate Share Prices
Dependent variable: $(I/K)_t$

| Explanatory variables	Quarterly 1962:Q1-1996:Q1	
	(9)	(10)
constant	-0.30 **	-0.25 *
	(2.7)	(2.3)
$(I/K)_{t-1}$	0.91 **	0.85 **
	(29.0)	(23.2)
$(P/K)_t$	–	0.09 **
		(3.3)
output gap_t	–	0.99 **
		(3.4)
ΔP_{t-1}	–	-0.44 *
		(2.1)
q_{t-2}	0.03 *	0.01
	(2.0)	(0.6)
Summary statistics:		
$\overline{R}^2$	0.90	0.91
$\hat{s}$	0.06	0.05
Serial correlation test	0.16	0.57

Notes: * and ** indicate the coefficients are significantly different from zero at the 5% and 1% significance levels. The figures in parentheses are t-statistics. '$\hat{\sigma}$' is the standard error of the equation and 'serial correlation test' is the Lagrangian multiplier test for up to fourth order serial correlation with the marginal significance shown.

## 4.3 Investment Equations with Fundamental Share Prices

It would be premature, however, to discount the Tobin's 'q' relationship. In Section 2 (Equation (6)) we showed that speculative factors can distort the market valuation of a firm and that this, in turn, can obscure the relationship between share prices and investment. In order to test the validity of this proposition we need to first separately identify the speculative and fundamental components of real share prices. As indicated in Section 2, the fundamental value of a firm is the discounted present value of the firm's expected cash flows. Thus, at a very basic level, the principal determinants of real share prices are future profits and a discount rate. The relationship between these series and real share prices is illustrated in Figures 5 and

6. Implicitly, the expected relationship between share prices and profits is well established with market analysts who often focus on company price-to-earnings ratios (Figure 7).

Figure 5: Real Share Prices and Company Profits
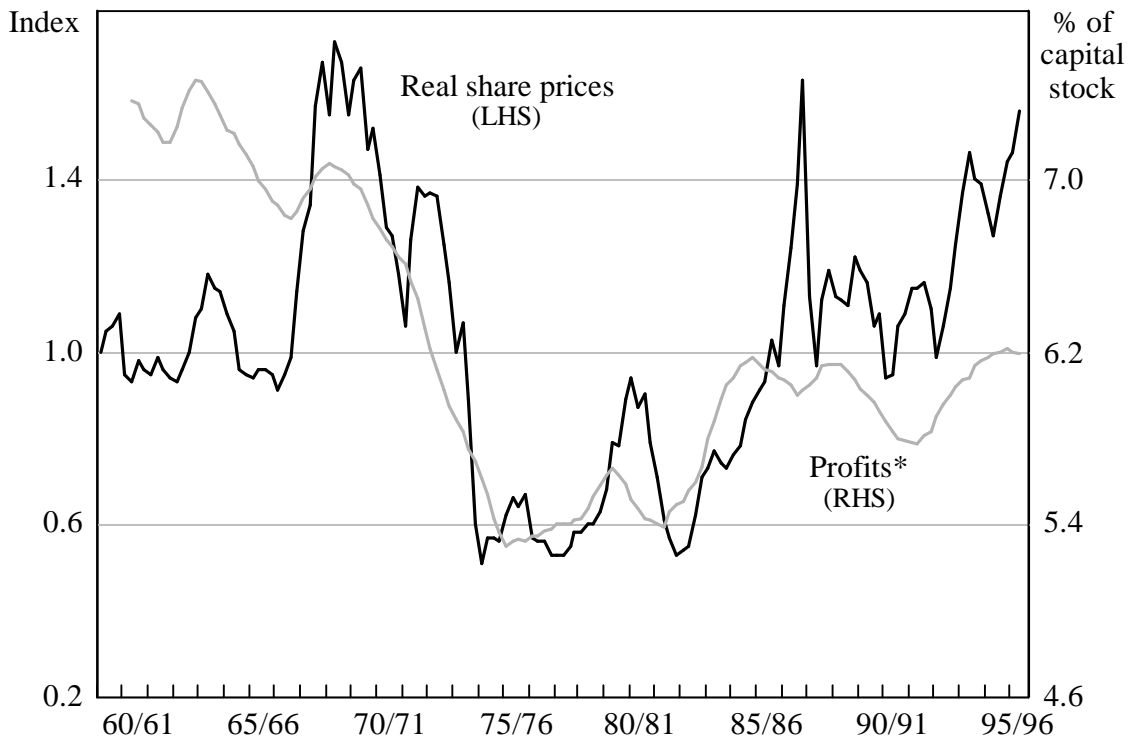
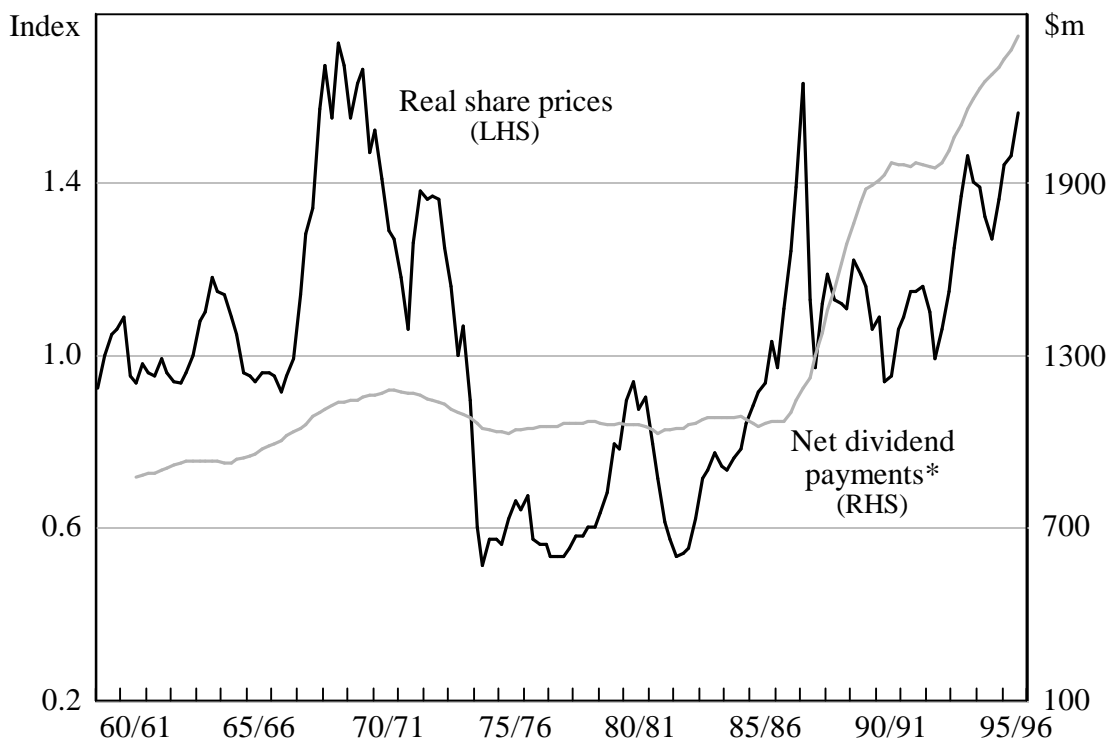Note: * Three-year centered moving average.

Figure 6: Real Share Prices and the Bond Yield
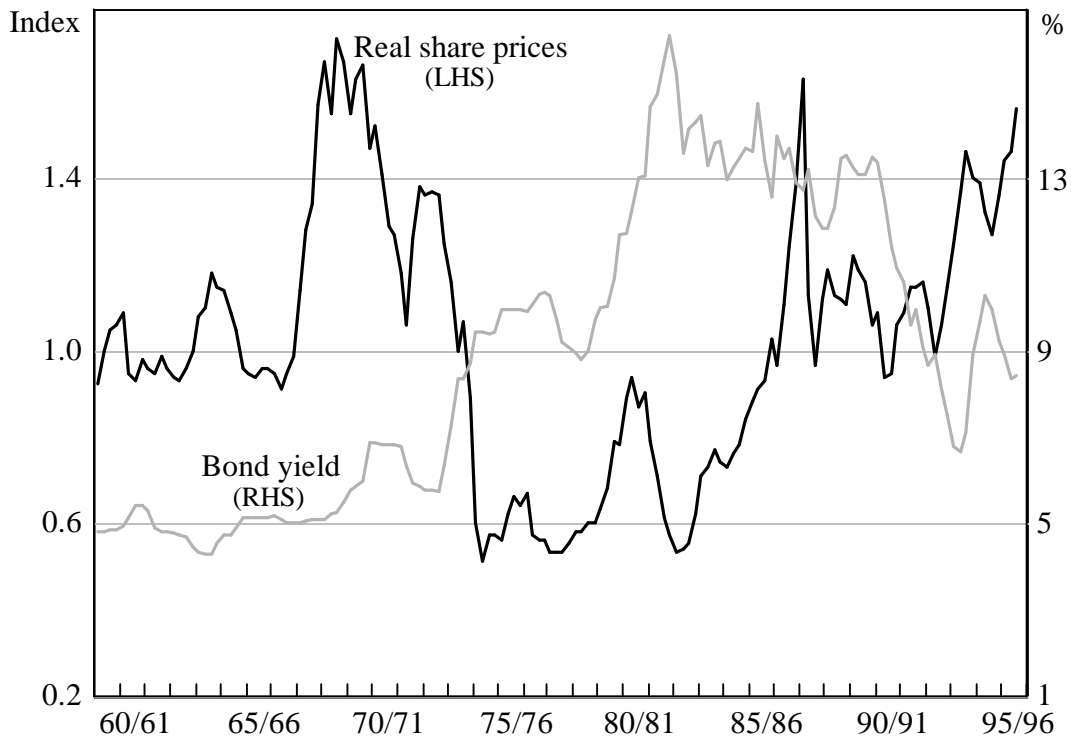
Figure 7: Real Share Prices and the Price-Earnings Ratio
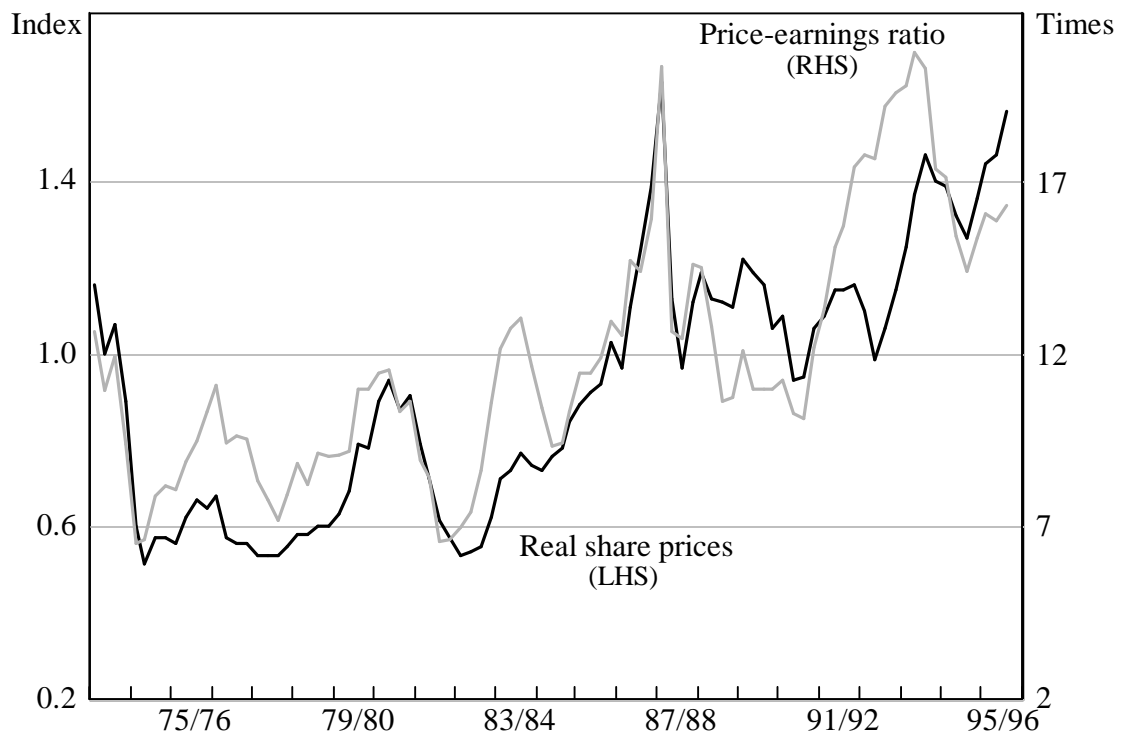
Although there is a clear long run relationship between company profits and real share prices, it appears to break down somewhat from the middle of the 1980s. This

period closely coincides with the introduction of dividend imputation (a means by which the double taxation of dividend income is minimised). It is evident from the relative stability in the dividend payments series that investors have a preference for steady income streams. As a consequence, managers would tend to maintain dividend payments which are consistent with the long-term fundamental value of the firm. While imputation has clear benefits for investors, it also increases the fundamental value of the firm by reducing the cost of equity finance. As such, although the increase in net dividend payments following the introduction of dividend imputation indicates a change in investor preference to dividend income (Figure 8), it could also be seen as indicating a permanent increase in the fundamental value of the Australian corporate sector.

With these observations in mind, we estimate a real share-price equation where the real share price is explained by the real return on capital, a discount rate, and net dividends paid (which captures the effect of the introduction of dividend

Figure 8: Real Share Prices and Net Dividend Payments

Note: * Three-year centred moving average.

imputation in September 1987). Rather than measuring the discount rate with the real bond yield, the nominal bond yield and inflation are entered on the basis that economic agents are slow to adjust to a new inflationary environment and, as such, inflation could reasonably be expected to be another important determinant of real share prices, at least in the short run. The specification of our parsimonious real share-price equation is presented in Equation (11) below:

$$q_t = \underset{(6.3)}{2.2} + \underset{(7.8)}{1.3} \left(\frac{p}{K}\right)_{t-1} - \underset{(4.7)}{3.5} \ R_t - \underset{(0.3)}{0.3} \ DP_t + \underset{(11.7)}{0.3} \ D_t + e_t \qquad (11)$$

$$\overline{R}^2 = 0.53 \qquad\qquad SE = 0.22$$
sample period : 1962:Q1-1996:Q1

The equation fits the data reasonably well.[19] The return on capital, the discount rate and net dividend payments are all highly significant and correctly signed. Inflation is insignificant, but nonetheless was retained in the equation since it is correctly (negatively) signed. Using this equation we are able to separately identify estimates of the fundamental and speculative components of share price movements; the fitted values representing the fundamental component (q^F) and the residuals representing the speculative component (q^S). Figure 9 shows that the fundamental real share-price series is less affected by the events leading up to and including October 1987.

A casual inspection of the data suggests a significant and leading relationship between fundamental share prices and investment (Figure 10). In order to validate this observation and to test the hypothesis that managers ignore speculative movements when formulating investment decisions, we examine the significance of the coefficients on the fundamental, speculative and aggregate share-price series in an investment equation. Equations (9) and (10) are re-estimated with the fundamental and speculative real share-price series replacing the aggregate real share-price series (Table 5). In contrast to the aggregate series,

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[19] To test for simultaneous equation bias, the equation was re-estimated with instrumental variables for the nominal bond yield and inflation. Reassuringly, the results were similar.
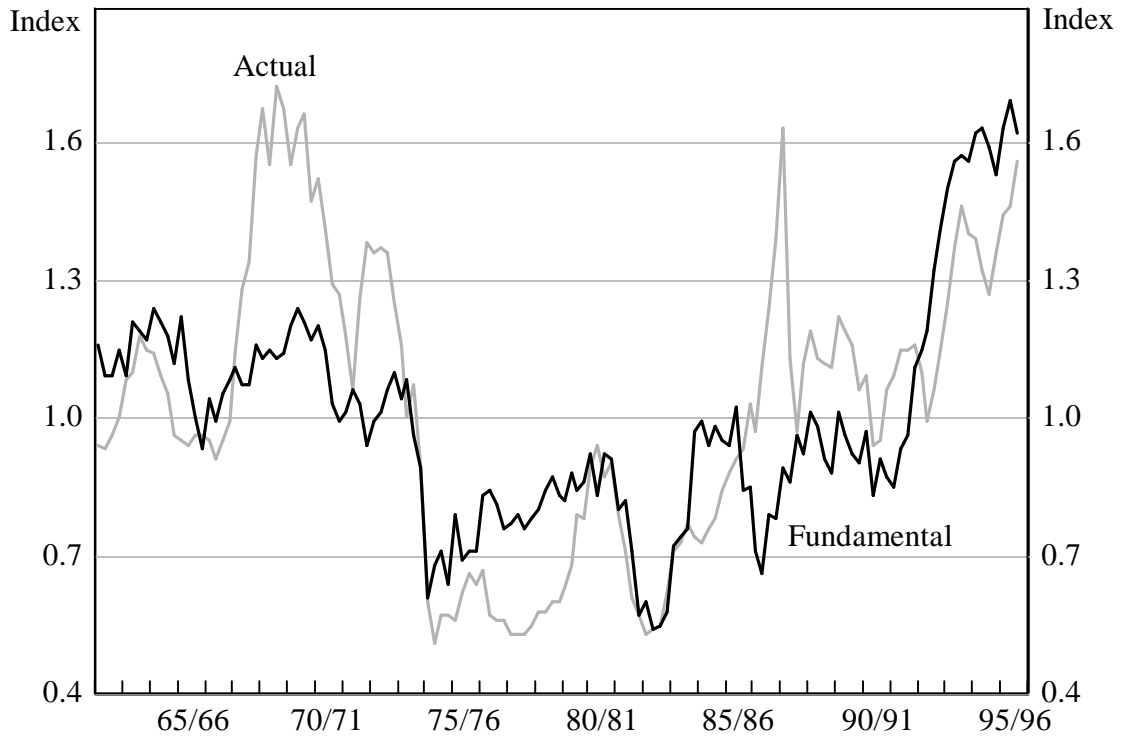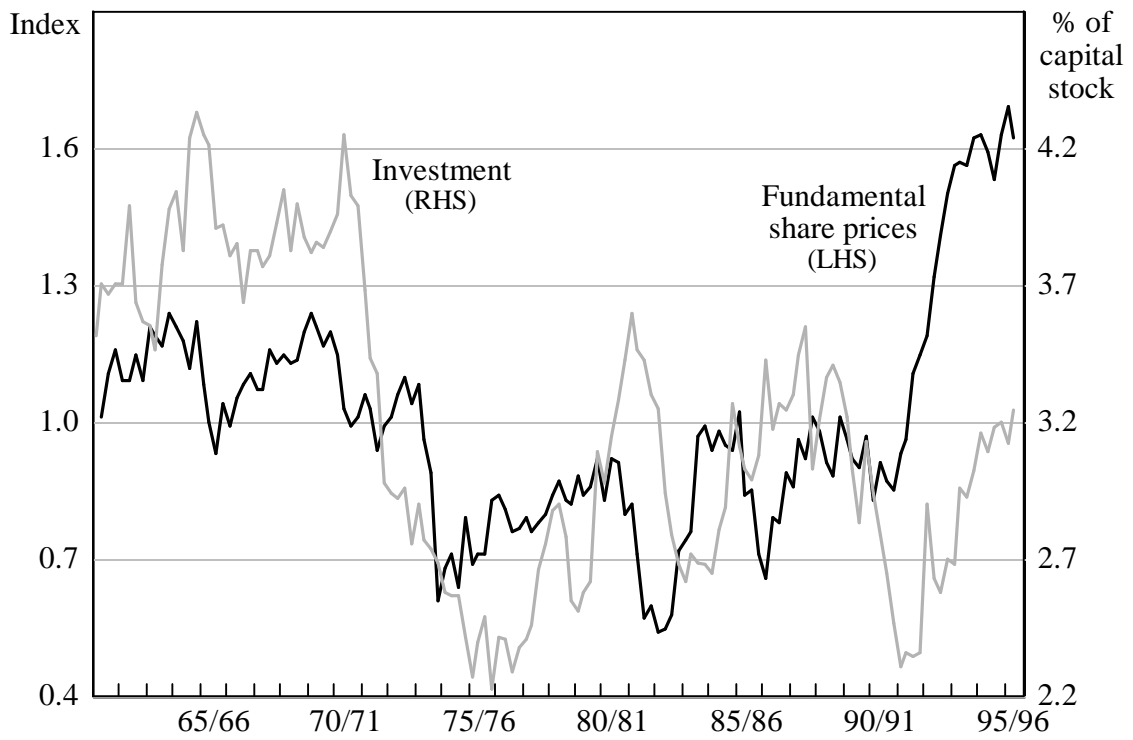
Figure 9: Real Share Prices

Figure 10: Real Fundamental Share Prices and Investment

the fundamental series is highly significant in the simple investment equation (Equation (9a)). However, once other important determinants of investment are included it becomes insignificant (Equation (10a)). The speculative series is insignificant when included in either of the investment equations.

Table 5: Investment Equations with Fundamental Share Prices
Dependent variable: $\left(I/K\right)_t$

	Quarterly 1962:Q1-1996:Q1	
Explanatory variables	(9a)	(10a)
constant	-0.31 **	-0.26 *
	(2.7)	(2.4)
$\left(I/K\right)_{t-1}$	0.91 **	0.85 **
	(27.3)	(23.0)
$\left(P/K\right)_t$	–	0.08 **
		(2.9)
output gap$_t$	–	1.02 **
		(3.4)
DP_{t-1}	–	-0.44 *
		(2.2)
q^F_{t-2}	0.06 **	0.01
	(3.4)	(0.6)
q^S_{t-2}	0.01	0.01
	(0.2)	(0.4)
Summary statistics:		
$\overline{R}^2$	0.90	0.91
$\hat{s}$	0.05	0.05
Serial correlation test	0.40	0.61

Notes: * and ** indicate the coefficients are significantly different from zero at the 5% and 1% significance levels. The figures in parentheses are t-statistics. '$\hat{s}$' is the standard error of the equation and 'serial correlation test' is the Lagrangian multiplier test for up to fourth order serial correlation with the marginal significance shown.

It is well established in the Tobin's 'q' literature that 'running horseraces between competing investment equations has shown that q-models are outpaced by equations including cash flow, output, and other flow measures of corporate activity' (comments by Poterba in Morck *et al*. 1990, p. 209). In this section, we have established a similar conclusion based on Australian data. However, our results go further by addressing the question of whether managers are sufficiently

sophisticated to distinguish between the fundamental and speculative movements in share prices and respond only to fundamentals. We find that investment is influenced by the fundamental level of real share prices but is not significantly influenced by the speculative component.[20] These results are broadly similar to overseas studies discussed above.

5.   Share Prices and Financial Decisions

In the previous sections we have tended to concentrate on equity prices as a mechanism by which potential investors evaluate the relative worth of companies based on their earnings capability. However, equity is also a means by which companies raise finance. Over the past decade, equity raisings have accounted for about 30 per cent of the financing requirements of the corporate sector although, over this period, this proportion has been quite variable (Figure 11). In the previous section we concluded that managers are able to distinguish between

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[20] This is a particularly strong result given the inherent bias in the estimation process which is that the speculative share-price series will incorporate any misspecification of the fundamental share–price series. That is, the results are biased against finding a relationship between fundamental real share prices and investment.

Figure 11: Corporate Sector Funding
Per cent of GDP
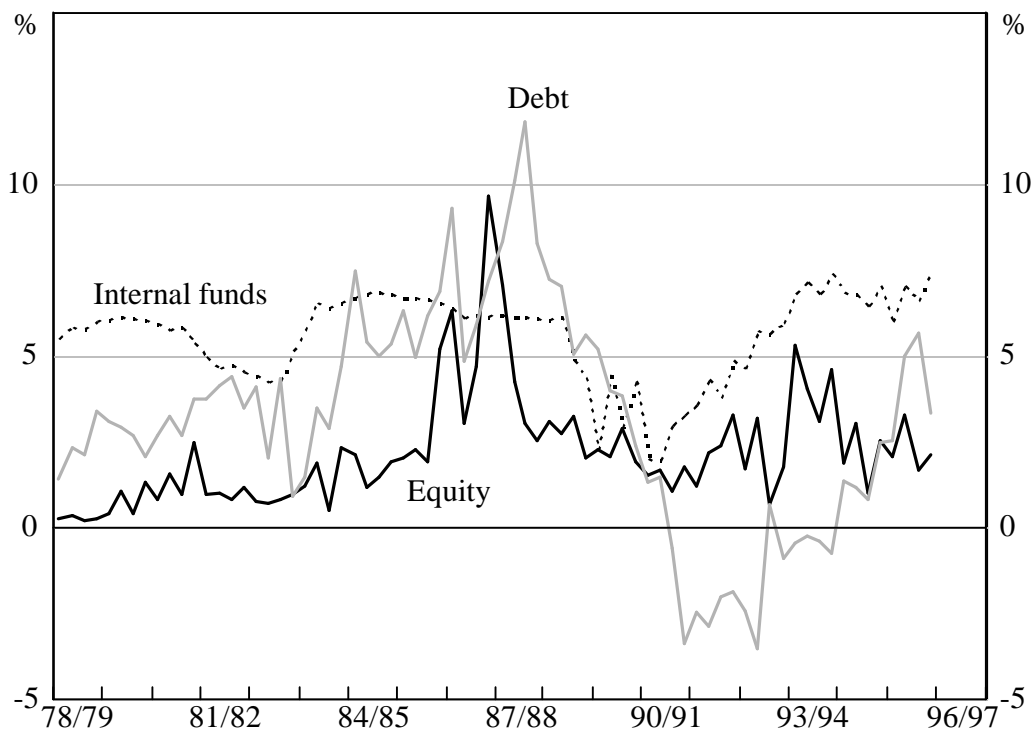
fundamental and speculative share price movements and that investment decisions are not distorted by the existence of share price inefficiencies. A corollary of these results is that managers should be able to take advantage of any identified mispricing of shares by changing the composition of the firm's financing. For example, if a manager plans to issue equity to finance a new venture and the firm's share price is regarded as undervalued, there would be advantage in delaying the share issue and temporarily funding the project with short-term debt. There is a danger, though, that by their actions managers will indicate their views on the fundamental value of their firm. If this were the case, share prices should decline immediately following equity issue announcements.

Overseas empirical studies tend to support both of these propositions – that firms raise equity when their share prices are overvalued and that share prices tend to fall on the announcement of the share issue.[21]

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[21] See Fisher and Merton (1984), Korajczyk, Lucas and McDonald (1988), Lucas and McDonald (1989) and Blanchard *et al*. (1990).

A casual inspection of real equity raisings and the estimated speculative share price series indicates that managers do appear to actively exploit speculative movements (Figure 12). This relationship is tested by regressing real equity raisings against four lags of the estimates of the fundamental and speculative components of real share prices and a vector of variables which we found to be significant in the investment equations (Equation (12)).[22] Of the vector of determinants of investment only the real return on capital was significant. The coefficients on both the fundamental and speculative components in real share prices are correctly signed and significant at the one per cent level of significance. The implication of these results is that managers not only issue shares when there is a fundamental improvement in their company's share price but that they also take advantage of overvalued share prices (Table 6).[23]

$$ ER_t = \text{constant} + \omega q_{t-1}^F + \sigma q_{t-1}^S + \varphi \mathbf{Z}_{t-i} + \varepsilon_t \qquad (12) $$

Figure 12: Real Equity Raisings and Speculative Share Prices
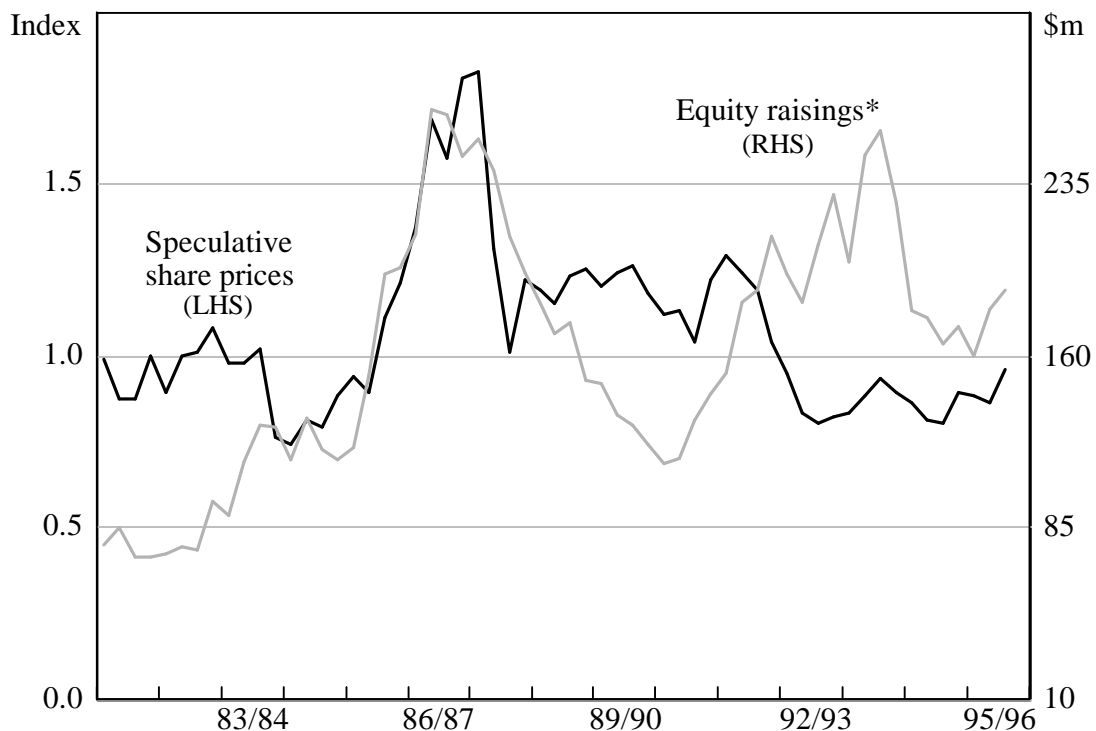
Note: * Five-quarter centred moving average.

Table 6 : Equity Raising Equation

Explanatory variables	Quarterly 1982:Q1-1996:Q1 (12)
constant	3.17 * (2.3)
ER_{t-2}	-0.21 (1.8)
$(P/K)_{t-1}$	0.88 * (2.0)
q^F_{t-1}	1.08 ** (4.6)
q^S_{t-1}	1.83 ** (6.9)
Summary statistics:	
$\bar{R}^2$	0.39
$\hat{\sigma}$	0.40
Serial correlation test	0.14

Notes: * and ** indicate the coefficients are significantly different from zero at the 5% and 1% significance levels. The figures in parentheses are t-statistics. '$\hat{s}$' is the standard error of the equation and 'serial correlation test' is the Lagrangian multiplier test for up to fourth order serial correlation with the marginal significance shown.

The implication of these results and those in the previous section is that managers are able to identify mispricing of their shares. Our results have suggested that while investment decisions are only influenced by fundamental factors (in the absence of other key determinants of investment), equity raising decisions are influenced by both speculative and fundamental factors.

6.   Conclusion

The aim of this paper was to examine two related propositions; whether or not share prices are efficient and, to the extent that any inefficiencies exist, whether they distort investment decisions. In line with overseas studies we find evidence of departures from share-market efficiency over short time horizons but not over longer time horizons.

As expected, the estimated fundamental component of real share prices was found to have a stronger relationship with investment than the aggregate real share-price series. Despite some evidence of share price inefficiencies, the speculative component of real share prices is insignificant in the same investment equations implying that the short-term departures from share-market efficiency do not significantly influence investment spending. We also found, however, that equity raising decisions are influenced by both fundamental and speculative price movements, implying that valuation effects do influence corporate financing decisions.

Appendix A: Unit Root Tests

Since unit root tests are widely recognised as having low power, we use two different test procedures – the Augmented Dickey-Fuller (ADF) test described in Said and Dickey (1984) and the Phillips and Perron (1988) Zt test[24]. Both tests are based on the testing strategy recommended by Perron (1988).

The tests are conducted over the estimation period 1960:Q1-1996:Q1. The tests share the same MacKinnon (1991) critical values which, with the inclusion of a constant at the 1 per cent and 5 per cent levels of significance, are 3.48 and 2.88, respectively. The critical values with the inclusion of a constant and trend at the 1 per cent and 5 per cent significance levels are 4.03 and 3.44, respectively. In both cases, the null hypothesis is non-stationarity. Apart from the 10-year bond yield, all the variables are in logs.

The results for the level of each series are presented in Table A1. The level of the real return on capital, output gap and real equity raisings are determined to be stationary. All the remaining variables accept the null hypothesis of non-stationarity. Subsequent tests confirmed that none of the series are I(2).

However, visual inspection of corporate investment (as a proportion of the capital stock) and real share prices reveal clear one-off shifts in the series. For the real share-price series there is a downward shift in the 1970s due to the oil price shocks and an upward shift in the late 1980s, explained partly by dividend imputation. For corporate investment (as a proportion of the capital stock) there is a clear shift in the level of the series in 1973.

We follow the methodology suggested by Perron (1989) and redo the unit root tests with the inclusion of a dummy variable to allow for the one-off shifts in the level of the series. The results are presented in Table A2. The appropriate tests statistics to be used in the presence of a break have been calculated by Perron (1989) and are 3.72 and 3.44 at the five per cent and ten per cent significance levels. The results show that real share prices are quite close to being stationary once the one-off shifts in the level of these series are accounted for; corporate investment comes very close

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[24] This test involves making non-parametric corrections to the Dickey-Fuller test. Five lags of the residual autocovariance were chosen.

to being stationary. As such, corporate investment and real share prices are treated as stationary for the purposes of estimation.

Table A1: Series in Levels

Series level of:	Φ_3	Φ_2	Φ_1	ADF	lags	Zt	Result
Nominal share prices	3.24	3.29	1.65	0.20	1	0.09	I(1)
Real share prices	1.98	1.34	6.56**	2.78	4	1.80	I(1)
Investment (/K)	3.31	2.22	2.37	2.17	6	2.18	I(1)
Cost of capital	0.99	0.77	1.04	1.33	0	1.47	I(1)
Real cost of capital	3.06	2.04	0.96	1.38	5	1.76	I(1)
Real return on capital	4.65	3.19	4.05**	2.80	1	2.96**	I(0)
Real cash flow	3.83	3.78	2.13	0.86	1	0.84	I(1)
Output gap	11.45**	–	–	4.79*	1	4.84*	I(0)
Real equity raisings	7.34*	–	–	3.82*	1	5.75*	I(0)
GDP price deflator	2.92	2.84	2.49	1.53	8	0.19	I(1)
Oil price	1.39	1.24	1.35	1.33	4	1.25	I(1)

Notes: The testing strategy recommended by Perron (1988) is followed where the likelihood ratio tests are:

$$\Phi_3 : (\alpha, \beta, \rho) = (\alpha, 0, 1) \text{ in } Y_t = \alpha + \beta t + \rho Y_{t-1} + e_t$$
$$\Phi_2 : (\alpha, \beta, \rho) = (0, 0, 1) \text{ in } Y_t = \alpha + \beta t + \rho Y_{t-1} + e_t$$
$$\Phi_1 : (\alpha, \rho) = (0, 1) \text{ in } Y_t = \alpha + \rho Y_{t-1} + e_t$$

The 't-tests' are $\rho = 1$ for

$$\hat{\tau}_\tau : \text{in } Y_t = \alpha + \beta t + \rho Y_{t-1} + e_t$$
$$\hat{\tau}_\mu : \text{in } Y_t = \alpha + \rho Y_{t-1} + e_t$$
$$\hat{\tau} : \text{in } Y_t = \rho Y_{t-1} + e_t$$

* and ** denote significance at the 1% and 5% levels, respectively. The test statistics for the Φ tests are from Dickey and Fuller (1981). The test statistics for the ADF 't-tests' and Zt tests are from MacKinnon (1991).

Table A2: Series in Levels with a Single Break

Series level of:	Φ_3	Φ_2	Φ_1	ADF	lags	Dummy
Real share prices	4.74	3.48	8.95*	3.53**	4	1973:Q1-1979:Q4
Investment (/K)	5.32	3.65	5.45**	3.26**	6	1973:Q1-1995:Q3

Note: * and ** denote significance at the 1% and 5% per cent levels, respectively. The test statistics for the ADF tests are from Perron (1989).

Appendix B :   Data Sources

Series	Construction	Source
Share prices	All Ordinaries Share Price and 50-Leaders Indices; daily closing figures. Monthly, quarterly and annual data are averages of the daily data. Real share prices are calculated using the private business fixed investment deflator.	Australian Stock Exchange, Monthly Index Analysis. Earlier share price data from the Australian Stock Exchange's Indices and Yields Book (1991); ABS Quarterly National Accounts, Cat. No. 5206.0, Table 61.
General price level	Gross domestic product price deflator.	ABS Quarterly National Accounts, Cat. No. 5206.0, Table 61.
Corporate investment	Nominal corporate gross fixed capital expenditure. Ratio to the nominal corporate net capital stock. Quarterly capital stock series is interpolated from the annual data.	ABS Australian National Accounts, Capital Stock, Cat. No. 5221.0, Table 3.
Cost of capital	10-year Commonwealth Government bond yield. Quarterly data are averages of monthly data which are last business day of the month.	RBA *Bulletin*, Table F2; ABS Quarterly National Accounts, Cat. No. 5206.0, Table 60; Reserve Bank of Australia, Occasional Paper 8, Table 3.23; The Butlin database, Reserve Bank of Australia Research Discussion Paper No. 7701.
Corporate cash flow	Gross operating surplus of private corporate trading enterprises less interest payments.	ABS Quarterly National Accounts, Cat. No. 5206.0, Table 64.
Return on capital (real)	Corporate cash flow as a ratio to the nominal corporate capital stock.	As per corporate cash flow. ABS Australian National Accounts, Capital Stock, Cat. No. 5221.0, Table 3.
Output gap	Derived by fitting the Hodrick-Prescott filter to the log of real GDP.	ABS Quarterly National Accounts, Cat. No. 5206.0, Table 48.
Equity raisings	Includes new floats, rights issues, placements and dividend reinvestment of main board stocks. Real equity raisings are calculated using share prices as the deflator.	Australian Stock Exchange, Monthly Index Analysis.
Oil prices	Saudi Arabian light crude oil. Oil spot price, $ per barrel. Quarterly average.	Datastream.
Net dividend payments	Corporate dividend payments less receipts.	ABS Annual National Accounts, Cat. No. 5204.0, Table 35.

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