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Overreaction in the Australian equity market: 1974–1997

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Abstract

Previous assessment of overreaction in the Australian equity market by Brailsford [Brailsford, T., 1992. A test for the winner–loser anomaly in the Australian equity market: 1958–87, Journal of Business Finance and Accounting, 19 (2) 225–241] and Allen and Prince [Allen, D.E., Prince, R., 1995. The winner/loser hypothesis: Some preliminary Australian evidence on the impact of changing risk. Applied Economics Letters 2, 280–283] finds no evidence of performance reversal in loser portfolios and no significant difference between the test period performance of winner and loser portfolios. This result is not consistent with evidence from overseas markets and warrants further examination. This study finds evidence of price reversal where monthly portfolio rebalancing is employed but the price reversal disappears when a buy and hold strategy is used. Further analysis reveals that the loser portfolio is dominated by small firms and that any abnormal returns are not exploitable given the lack of liquidity in small capitalisation Australian stocks. It is possible that the lack of consistency between Australian and US research can be explained by the different time periods examined in these studies. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

In their seminal work, DeBondt and Thaler (1985) report that a portfolio of US stocks which perform worst (losers) over an initial 3-year period (rank or portfolio formation period) tend to perform best in the subsequent 3-year period (test period). A similar performance reversal is evident for the rank period winner portfolio, which goes on to perform worst in the subsequent test period. This suggests that stock market investors overreact, that excessive optimism or pessimism causes prices to be driven too high or too low from their fundamental values, and that the overreaction is corrected in a subsequent period. It also suggests an easily implemented profitable trading strategy of buying losers and selling winners and has important implications for the validity of the efficient market hypothesis (EMH) which asserts that all publicly available information is incorporated into asset prices.

Chan (1988) argues that DeBondt and Thaler (DT) fail to control for time-varying risk, and when properly controlled the overreaction disappears. Ball and Kothari (1989) make a similar claim. However, DeBondt and Thaler (1987) and Chopra et al. (1992) provide evidence that differential risk cannot explain the performance reversal of winner and loser firms. Zarowin (1990) claims that firm size can explain this overreaction. He argues that losers tend to be smaller than winners and when size is controlled there is no significant difference in test period performance. However, Chopra et al. (1992) find that the overreaction persists after controlling for size as do Albert and Henderson (1995) after correcting potential biases in Zarowin's methodology. Using UK data, Clare and Thomas (1995) conclude that the difference in performance between the loser and winner portfolios is probably due to the size effect. Dissanaike (1997) also uses UK data and finds in favour of the overreaction hypothesis after limiting his study to the larger listed companies. Conrad and Kaul (1993) assert that the overreaction observed in this type of study is due to the process of cumulating single period returns over long periods where these single period returns contain errors caused by bid–ask spread bias and infrequent trading. However, Loughran and Ritter (1996) dispute the methodology employed by Conrad and Kaul and show that their conclusions are not valid after correcting the methodology.

Despite the passage of time and several methodological refinements, the conclusions of DT using the basic methodology still appear to hold. While the bulk of research on this issue has been undertaken using US data, there have been a handful of applications in other markets. For example, Clare and Thomas (1995) examine the UK market and find evidence of overreaction, but conclude that this can be explained by the small firm effect. However, Dissanaike (1997) finds strong evidence of overreaction amongst the larger companies listed on the UK exchange. DaCosta (1994) presents evidence of overreaction in stocks listed on the exchange in Brazil as do Leung and Li (1998) in the case of the Hong Kong stock market. Kryzanowski and Zhang (1992) study the Canadian market and find continuation behaviour for 12- and 24-month test periods, but evidence of reversals for 36- to 120-month test periods though the performance of the arbitrage portfolio is only significant at the 10% level. The results are even weaker when risk is controlled.

There is also evidence of overreaction over much shorter periods than that studied here. Chang et al. (1995) report a price reversal in the Japanese stock market for portfolios formed on 1-month returns. Bowman and Iverson (1998) reach a similar conclusion using New Zealand stocks based on single-week returns.

When the basic DT methodology is employed within and across markets, there appears to be a consistent finding of overreaction and reversal. One apparent exception is the Australian market where both Brailsford (1992) and Allen and Prince (1995) using the basic DT methodology reports no reversal in performance by the loser portfolio and no significant difference in the test period performance between the loser and winner portfolio. As an exception, the Australian market warrants further examination. This study makes a number of contributions towards resolving this apparent anomaly. First, it employs an unbiased approach to calculating returns. Dissanaike (1994) asserts that much previous research employs an invalid or unrealistic method of calculating returns which results in errors in portfolio formation and measurement of test period performance. Second, this study reports and analyses the test period performance of all intermediate portfolios, which is rarely undertaken by authors. Third, this study reports risk-adjusted portfolio returns, which Brailsford argues as problematical. While Allen and Prince do report risk-adjusted returns, their requirement that firms be listed for a minimum of 9 years introduces a survivorship bias and possibly a bias towards larger companies which may adversely affect their results. Fourth, this study explores the role of size in the performance of the winner and loser portfolios. Fifth, this study extends the data set used by Brailsford a further 10 years from 1988 to 1997, and extends the data set used by Allen and Prince another 6 years from 1992 to 1997.

2. Data and methodology

The data used in this study come from the price relative files of the Centre for Research in Finance (CRIF) at the Australian Graduate School of Management, and covers the period from 1974 to 1997. Brailsford uses data supplied by CRIF covering the period 1958 to 1987. Price relative data covering the period 1958 to 1973 is no longer available, so it is not possible to replicate exactly the analysis of Brailsford. The 1958 to 1973 file was compiled by Philip Brown and is limited to (909) industrial companies of at least $1 million in market capitalisation. Given the reported tendency for loser firms to be small relative to winner firms (Zarowin, 1990), it is possible that the absence of small capitalisation stocks from the

1958–1973 part of Brailsford's sample may at least partly explain his result. Allen and Prince use data supplied by CRIF covering the period from 1974 to 1991. Similarly, the requirement of Allen and Prince that companies be listed for at least 9 years may bias the sample toward large capitalisation stocks and may at least partly explain the non-reversal of the loser portfolio.

The initial methodology employed in this study replicates that employed by Brailsford and is generally typical of that used in studies of this type. It first involves identifying non-overlapping 36-month periods. All companies with a complete set of returns for the period 1974–1976 (rank period) are identified [1] and their performance relative to the market over that period is measured using a non-risk adjusted model (i.e. zero–one market model).

$$\mu_{i,t} = R_{i,t} - R_{m,t} \tag{1}$$

where $\mu_{i,t}$ is the market adjusted abnormal return of stock i in month t, $R_{i,t}$ is the return on stock i in month t, and $R_{m,t}$ is the return on an equally weighted index of all stocks in month t. Brailsford defines $R_{i,t}$ as the monthly continuously compounded return on company i over period t and $R_{m,t}$ as the monthly continuously compounded return on the market over period t. Thus,

$$R_{i,t} = \ln(P_{i,t}/P_{i,t-1}). \tag{2}$$

These companies are then ranked in order of their cumulative abnormal return (CAR) over the rank period.

$$\mathrm{CAR}_i = \sum_{t=-35}^{0} \mu_{i,t} \tag{3}$$

where CAR_i is the cumulative market adjusted abnormal return for stock i over the period from 36 months prior to the start of the test period.

Decile portfolios are created with the loser portfolio comprising the poorest performing 10% of stocks and the winner portfolio comprising the best performing 10% of stocks. Intermediate portfolios are also created and followed in this study. This results in portfolios with as few as 40 stocks in the 1980–1982 rank period and as many as 59 stocks in the 1986–1988 rank period. The approach adopted by Allen and Prince of creating portfolios using the most extreme 35 stocks results in only the extreme 5.9% of stocks being used in the 1986–1988 rank period and 8.75% being used in the 1980–1982 rank period.

[1] This will tend to eliminate a larger proportion of small stocks as infrequent trading reduces the number of valid price relatives during the rank period. No look-ahead bias is introduced as portfolios are formed with the benefit of hindsight at the end of the rank period. However, this is not the case with Allen and Prince, who require that companies be listed for a minimum of 9 years including a 3-year establishment period, the 3-year rank period and the 3-year test period. Their approach potentially introduces a look-ahead bias, a survivorship bias and a size bias.

The performance of each portfolio, relative to the market, over the next 36 months (the test period is thus 1977 to 1979), is then measured as

$$\mathrm{CAR}_{p,z,t} = \sum_{t} \left[(1/N) \sum_{i=1}^{N} \mu_{i,t} \right] \tag{4}$$

where $\mathrm{CAR}_{p,z,t}$ is the cumulative average market adjusted abnormal return in month t of test period z for portfolio p, and N is the number of stocks in each portfolio.[2]

This procedure is repeated for each non-overlapping 3-year period. That is, subsequent rank periods are 1977–1979, 1980–1982, 1983–1985, 1986–1988, 1989–1991, 1992–1994. Their matching test periods are 1980–1982, 1983–1985, 1986–1988, 1989–1991, 1992–1994, 1995–1997.

The portfolio CARs are then averaged across the seven test periods:

$$\mathrm{ACAR}_{p,t} = \frac{\sum_{z=1}^{Z} \mathrm{CAR}_{p,z,t}}{Z} \tag{5}$$

where $\mathrm{ACAR}_{p,t}$ is the average CAR across the $Z(7)$ test periods for each portfolio, p, across each month, t, of the test period.

The profitability of the contrarian strategy is tested via the following null hypotheses:

H1. $\mathrm{ACAR}_{\mathrm{L},t} = 0$ where $t = 1 \ldots 36$.

H2. $\mathrm{ACAR}_{\mathrm{W},t} = 0$ where $t = 1 \ldots 36$.

H3. $\mathrm{ACAR}_{\mathrm{L-W},t} = 0$ where $t = 1 \ldots 36$.

The first two hypotheses are tested by calculating a t-test on the mean ACAR with unknown population variance. The test statistic is

$$t_{p,t} = \frac{\mathrm{ACAR}_{p,t}}{S_p/\sqrt{Z}} \tag{6}$$

where S_p is the sample standard deviation of portfolio p, and p is set to L to test H1 and p is set to W to test H2.

[2] N will change from portfolio to portfolio because the total number of eligible stocks is different in each rank period, and because delisted stocks are simply dropped from calculations.

The test statistic for hypothesis three is

$$t_{\mathrm{L-W},t} = \frac{(\mathrm{ACAR}_{\mathrm{L},t} - \mathrm{ACAR}_{\mathrm{W},t})}{\sqrt{2S_t^2/N}} \tag{7}$$

where the population variance S_t^2 is given by

$$S_t^2 = \frac{\sum_{z=1}^{Z} (\mathrm{CAR}_{\mathrm{W},z,t} - \mathrm{ACAR}_{\mathrm{W},t})^2 + \sum_{z=1}^{Z} (\mathrm{CAR}_{\mathrm{L},z,t} - \mathrm{ACAR}_{\mathrm{L},t})^2}{2(Z-1)}. \tag{8}$$

Brailsford refers to his calculation, as outlined above (Eq. (4)), as one which implicitly assumes monthly rebalancing of the portfolio. However, this equation does not appear to be consistent with a rebalancing strategy. Assume, for example, that a portfolio of two securities is held (A1, A2) over a 2-month period and that their prices at the start of the 2-month period is 100 as is the price of the market portfolio. If at the end of the first month, the prices are 110, 100, and 70 for the market, A1, and A2 and at the end of the second month the prices are 105, 60 and 150, then the actual rebalanced CAR is positive 11.57%. However, Brailsford's method gives negative 10.15%.

A realistic calculation of long-term portfolio performance[3] where monthly rebalancing is assumed is given by

$$\mathrm{CAR}_{p,z,T} = \prod_{i=0}^{T} \left(\sum_{i}^{N} \frac{R_{i,t}}{N} \right) - \prod_{i=0}^{T} R_{\mathrm{m},t} \tag{9}$$

where $R_{i,t}$ is the price relative of security i in month t adjusted for dividends and capitalisation changes, and $R_{\mathrm{m},t}$ is the return on the market in month t. This will be referred to as the multiplicative rebalancing method. Application of Eq. (9) to the example presented above provides a CAR of positive 11.57%, which is consistent with the actual rebalancing CAR.

The cumulative abnormal return during the rank period is calculated by

$$\mathrm{CAR}_i = \prod_{t=-35}^{0} R_{i,t} - \prod_{t=-35}^{0} R_{\mathrm{m},t}. \tag{10}$$

The equivalent approach to Eq. (4) assuming a buy and hold strategy is then calculated by

$$\mathrm{CAR}_{p,z,T} = \frac{1}{N} \sum_{i=1}^{N} \left(\prod_{t=1}^{T} R_{i,t} - \prod_{t=1}^{T} R_{\mathrm{m},t} \right). \tag{11}$$

[3] See Dissanaike (1994) for a discussion of and empirical demonstration of the merits of various alternative methods of calculating returns in this type of study.

3. Results

3.1. Brailsford rebalancing method

Table 1 presents the results of using the method employed by Brailsford, to rank and test winner and loser performance. The results are broadly consistent with those of Brailsford (1992) with both portfolios showing significant negative CARs at the conclusion of the test period and no significant difference between the performance of the two portfolios is evident. There is also no pattern in the test period CARs of the intermediate portfolios that would support the overreaction hypothesis.

3.2. Multiplicative rebalancing method

In distinct contrast, use of the multiplicative rebalancing method (Eq. (9) and Table 2) provides result consistent with those observed generally in other markets. The rank period loser portfolio becomes the test period winner portfolio and vice versa, with a significant positive CAR for the loser portfolio and a significant negative CAR for the winner portfolio. The test period performance of the intermediate portfolios appears also to be broadly consistent with a reversal of their rank period performance. Table 3 shows the period-by-period performance of loser and winner portfolios and indicates that the performance reversal (denoted by a reversal of sign) is evident across all but two time periods (1974–1976, 1977–1979).

3.3. Multiplicative buy and hold method

The rebalancing method is the approach typically used in measuring long-term abnormal returns in studies of market overreaction. This method may not provide a realistic portrayal of the profitability of the contrarian strategy, as it assumes that each portfolio is rebalanced each month such that equal amounts are invested in each stock throughout the test period. Such an approach would incur significant transaction costs, which are not estimated in the results previously presented. In addition, Blume and Stambaugh (1983) argue that the rebalancing method generates long-term portfolio returns, which are biased due to bid–ask biases in individual returns. This bias is significantly reduced by computing returns using a buy and hold strategy. Roll (1983) reaches similar conclusions. However, Fama (1998) argues that the rebalancing (CAR or AAR) method should be used in preference to the buy and hold method (BHAR) because bad-model problems are most acute with long-term buy and hold returns and because AARs and CARs present fewer theoretical and statistical problems that long-term BHARs[4].

[4] Dissanaike (1994) suggests that the buy and hold approach may cause portfolios to suffer from a reduction in diversification, which may occur over long buy and hold periods.

Table 1
Brailsford rebalancing method — performance through test period
All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. A market-adjusted abnormal return is computed for each stock and all stocks are ranked and placed into decile (10) portfolios based on this amount. The worst performing 10% of stocks constitute the Loser (L) portfolio and the best performing 10% constitute the Winner (W) portfolio. The market-adjusted abnormal return (CAR) of each portfolio is computed over the subsequent 36-month (test) period 1977–1979. This process is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. This table presents the average CARs (ACAR) across the seven test periods for each of the 10 portfolios as well as the ACAR for the arbitrage portfolio (L–W). Return calculations are performed using the ‘rebalancing’ method employed by Brailsford and detailed in Eqs. (1)–(8) (t-statistics in parentheses).

Portfolio	Months elapsed in test period					
	6	12	18	24	30	36
$ACAR_{L,t}$	−0.19 (−3.29)[a]	−0.20 (−2.65)[a]	−0.28 (−3.30)[a]	−0.46 (−4.78)[b]	−0.57 (−4.67)[b]	−0.67 (−4.95)[b]
$ACAR_{2,t}$	−0.15 (−3.77)[b]	−0.27 (−5.20)[b]	−0.35 (−4.32)[b]	−0.45 (−4.59)[b]	−0.50 (−4.63)[b]	−0.60 (−6.45)[b]
$ACAR_{3,t}$	−0.17 (−4.19)[b]	−0.25 (−4.74)[b]	−0.36 (−5.47)[b]	−0.45 (−4.96)[b]	−0.49 (−4.64)[b]	−0.57 (−7.29)[b]
$ACAR_{4,t}$	−0.15 (−3.41)[a]	−0.25 (−4.07)[b]	−0.36 (−5.35)[b]	−0.44 (−4.05)[b]	−0.44 (−2.97)[a]	−0.55 (−3.35)[a]
$ACAR_{5,t}$	−0.13 (−2.55)[a]	−0.26 (−4.22)[b]	−0.39 (−4.31)[b]	−0.47 (−3.99)[b]	−0.52 (−3.74)[b]	−0.60 (−4.03)[b]
$ACAR_{6,t}$	−0.12 (−4.30)[b]	−0.23 (−4.29)[b]	−0.33 (−8.83)[b]	−0.40 (−8.37)[b]	−0.46 (−5.06)[b]	−0.55 (−5.20)[b]
$ACAR_{7,t}$	−0.08 (−2.18)	−0.19 (−3.92)[b]	−0.26 (−4.28)[b]	−0.32 (−4.97)[b]	−0.37 (−4.13)[b]	−0.47 (−4.96)[b]
$ACAR_{8,t}$	−0.06 (−2.31)	−0.15 (−6.26)[b]	−0.26 (−6.63)[b]	−0.35 (−7.49)[b]	−0.43 (−6.94)[b]	−0.54 (−7.26)[b]
$ACAR_{9,t}$	−0.06 (−1.70)	−0.14 (−4.71)[b]	−0.28 (−3.96)[b]	−0.37 (−4.26)[b]	−0.45 (−4.68)[b]	−0.57 (−6.86)[b]
$ACAR_{W,t}$	−0.04 (−1.08)	−0.16 (−4.61)[b]	−0.31 (−7.17)[b]	−0.50 (−10.03)[b]	−0.64 (−7.51)[b]	−0.74 (−6.69)[b]
$ACAR_{L-W,t}$	−0.15 (−2.12)	−0.04 (−0.45)	0.03 (0.35)	0.04 (0.37)	0.07 (0.46)	0.07 (0.38)

[a] Significant at the 5% level using a two-tailed test.
[b] Significant at the 1% level using a two-tailed test.

Table 2
Multiplicative rebalancing method — performance through test period
All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. A market-adjusted abnormal return is computed for each stock and all stocks are ranked and placed into decile (10) portfolios based on this amount. The worst performing 10% of stocks constitute the Loser (L) portfolio and the best performing 10% constitute the Winner (W) portfolio. The market-adjusted abnormal return (CAR) of each portfolio is computed over the subsequent 36-month (test) period 1977–1979. This process is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. This table presents the average CARs (ACAR) across the seven test periods for each of the 10 portfolios as well as the ACAR for the arbitrage portfolio (L–W). Return calculations are performed using the multiplicative rebalancing method suggested by Dissanaike (1994) and detailed in Eqs. (9) and (10) (*t*-statistics in parentheses).

Portfolio	Months elapsed in test period					
	6	12	18	24	30	36
$ACAR_{L,t}$	0.00 (−0.04)	0.26 (1.63)	0.54 (3.02)[a]	0.51 (2.92)[a]	0.75 (3.14)[a]	1.02 (2.97)[a]
$ACAR_{2,t}$	−0.05 (−1.65)	−0.11 (−2.13)	−0.03 (−0.53)	0.01 (0.12)	0.12 (0.77)	0.23 (0.78)
$ACAR_{3,t}$	−0.09 (−1.58)	−0.14 (−1.39)	−0.16 (−2.06)	−0.19 (−2.29)	−0.12 (−1.05)	−0.11 (−0.48)
$ACAR_{4,t}$	−0.11 (−2.15)	−0.19 (−2.06)	−0.27 (−4.76)[b]	−0.29 (−5.85)[b]	−0.22 (−2.22)	−0.39 (−2.30)
$ACAR_{5,t}$	−0.10 (−1.54)	−0.23 (−2.38)	−0.31 (−4.39)[b]	−0.34 (−3.51)[a]	−0.36 (−2.43)	−0.49 (−2.17)
$ACAR_{6,t}$	−0.09 (−2.45)[a]	−0.22 (−2.25)	−0.33 (−4.04)[b]	−0.39 (−3.05)[a]	−0.41 (−2.51)[a]	−0.56 (−3.04)[a]
$ACAR_{7,t}$	−0.04 (−0.91)	−0.13 (−1.69)	−0.21 (−2.09)	−0.21 (−1.22)	−0.21 (−0.93)	−0.36 (−1.44)
$ACAR_{8,t}$	−0.02 (−0.74)	−0.10 (−2.43)	−0.23 (−2.78)[a]	−0.33 (−2.23)	−0.39 (−2.01)	−0.50 (−2.83)[a]
$ACAR_{9,t}$	−0.02 (−0.64)	−0.06 (−1.07)	−0.26 (−2.13)	−0.37 (−1.77)	−0.46 (−1.89)	−0.63 (−2.64)[a]
$ACAR_{W,t}$	0.04 (0.66)	−0.01 (−0.18)	−0.15 (−1.44)	−0.40 (−2.98)[a]	−0.49 (−3.38)[a]	−0.55 (−3.28)[a]
$ACAR_{L-W,t}$	−0.05 (−0.45)	0.27 (1.55)	0.69 (3.34)[b]	0.90 (4.13)[b]	1.24 (4.44)[b]	1.57 (4.12)[b]

[a] Significant at the 5% level using a two-tailed test.
[b] Significant at the 1% level using a two-tailed test.

Table 3
Multiplicative rebalancing method — performance by rank period
All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. A market-adjusted abnormal return is computed for each stock and all stocks are ranked and placed into decile (10) portfolios based on this amount. The worst performing 10% of stocks constitute the Loser (L) portfolio and the best performing 10% constitute the Winner (W) portfolio. The market-adjusted abnormal return (CAR) of each portfolio is computed over the subsequent 36-month (test) period 1977–1979. This process is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. This table presents the CARs for each of the seven test periods for each of the 10 portfolios. Return calculations are performed using the multiplicative rebalancing method suggested by Dissanaike (1994) and detailed in Eqs. (9) and (10).

Rank period	Portfolio size	Loser	2	3	4	5	6	7	8	9	Winner
1974–1976	41	2.04	0.12	−1.08	−1.03	−1.60	−1.17	−1.34	−0.66	−1.33	0.05
1977–1979	44	−0.19	0.06	−0.24	−0.30	−0.69	−0.54	−0.20	−0.51	−0.13	−0.64
1980–1982	40	1.20	−0.48	−0.55	−0.51	−0.39	−0.56	−0.02	−0.62	−0.43	−0.76
1983–1985	53	0.11	0.52	0.22	0.13	0.21	0.13	0.43	0.34	−0.01	−0.03
1986–1988	59	2.21	−1.81	0.92	−0.35	−0.27	−0.58	−0.54	−0.58	−0.44	−0.93
1989–1991	42	1.07	−0.41	−0.05	−0.81	−0.71	−1.12	−1.12	−1.22	−1.71	−1.13
1992–1994	55	0.68	−0.04	−0.01	0.16	0.03	−0.07	0.24	−0.26	−0.38	−0.42
ACAR		1.02	0.23	−0.11	−0.39	−0.49	−0.56	−0.36	−0.50	−0.63	−0.55

Where a buy and hold approach is used in this study, stocks are purchased at the start of the test period and are simply held until the conclusion of the test period, 36 months later. The added complication with the buy and hold approach[5] is that when a stock is delisted during the test period, we must explicitly reinvest the proceeds of that stock in some way.[6] There are three alternative approaches. First, reinvest equally among remaining stocks. Second, reinvest in remaining stocks according to the value of each stock. Third, reinvest the proceeds in the market index. In this paper, the first approach is used.

The results of the buy and hold strategy are presented in Table 4. While the change in approach has little impact on the winner portfolio, the test period cumulative abnormal return to the loser portfolio has been significantly reduced such that there is no longer a significant difference between the performance of the winner and loser portfolios. This demonstrates that the rebalancing of the loser portfolio during the test period perhaps serves to reinforce the underlying strategy of selling winners and buying losers. Dissanaike (1994, p. 1086) suggests that this may be the case where reversals for individual stocks do not take place at the same

[5] When the rebalancing method is used and a stock is delisted during the test period, the stock is simply dropped from any further calculations. This implicitly assumes reinvestment of the proceeds in the remaining stocks in the portfolio.

[6] Because the ultimate fate and exact proceeds of the delisted stock are not available, the amount to be reinvested is assumed to be the amount available after the final recorded price relative.

Table 4

Multiplicative buy and hold method — performance through test period

All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. A market-adjusted abnormal return is computed for each stock and all stocks are ranked and placed into decile (10) portfolios based on this amount. The worst performing 10% of stocks constitute the Loser (L) portfolio and the best performing 10% constitute the Winner (W) portfolio. The market-adjusted abnormal return (CAR) of each portfolio is computed over the subsequent 36-month (test) period 1977–1979. This process is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. This table presents the average CARs (ACAR) across the seven test periods for each of the 10 portfolios as well as the ACAR for the arbitrage portfolio (L–W). Return calculations are performed using the multiplicative buy and hold method detailed in Eq. (11) (*t*-statistics in parentheses).

Portfolio	Months elapsed in test period					
	6	12	18	24	30	36
$ACAR_{L,t}$	−0.07 (−1.05)	0.12 (1.15)	0.04 (0.30)	−0.21 (−2.57)[a]	−0.22 (−1.89)	−0.10 (−0.26)
$ACAR_{2,t}$	−0.06 (−1.36)	−0.13 (−2.90)[a]	−0.19 (−5.16)[a]	−0.26 (−3.28)[a]	−0.30 (−2.37)	−0.40 (−3.55)[b]
$ACAR_{3,t}$	−0.12 (−2.35)	−0.21 (−2.31)	−0.24 (−3.16)[a]	−0.31 (−3.81)[b]	−0.34 (−2.73)[a]	−0.45 (−3.01)[a]
$ACAR_{4,t}$	−0.12 (−2.40)	−0.25 (−2.79)[a]	−0.34 (−5.93)[b]	−0.41 (−4.58)[b]	−0.36 (−2.82)[a]	−0.60 (−3.07)[a]
$ACAR_{5,t}$	−0.10 (−1.56)	−0.26 (−2.72)[a]	−0.37 (−5.51)[b]	−0.44 (−3.77)[b]	−0.48 (−2.85)[a]	−0.60 (−2.86)[a]
$ACAR_{6,t}$	−0.10 (−2.43)	−0.24 (−2.50)[a]	−0.37 (−4.40)[b]	−0.45 (−4.02)[b]	−0.44 (−3.53)[a]	−0.64 (−3.66)[a]
$ACAR_{7,t}$	−0.04 (−0.87)	−0.16 (−1.94)	−0.24 (−2.06)	−0.30 (−1.89)	−0.18 (−0.89)	−0.10 (−0.33)
$ACAR_{8,t}$	−0.01 (−0.49)	−0.08 (−1.91)	−0.19 (−1.67)	−0.36 (−3.04)[a]	−0.44 (−2.93)[a]	−0.57 (−3.98)[b]
$ACAR_{9,t}$	−0.02 (−0.48)	−0.02 (−0.23)	−0.24 (−2.11)	−0.40 (−2.03)	−0.48 (−2.02)	−0.64 (−2.74)[a]
$ACAR_{W,t}$	0.02 (0.36)	−0.03 (−0.47)	−0.16 (−1.57)	−0.40 (−3.51)[a]	−0.52 (−3.74)[b]	−0.57 (−2.67)[a]
$ACAR_{L-W,t}$	−0.09 (−1.01)	0.15 (1.20)	0.20 (1.15)	0.19 (1.33)	0.30 (1.67)	0.47 (1.07)

[a] Significant at the 5% level using a two-tailed test.

[b] Significant at the 1% level using a two-tailed test.

time. ‘‘In such circumstances, an investor would be selling stocks whose prices have risen, and purchasing more of those securities whose prices have yet to recover.’’

3.4. Risk adjustment

It is important to assess the strategy studied here after controlling for the risk associated with each of the portfolios. Brailsford (1992) asserts that risk-adjusted returns cannot reliably be calculated because market model parameters estimated from the period immediately preceding the test period will be biased owing to the extreme performance of each portfolio during that preceding period. Chan (1988) overcomes this potential bias by estimating market model parameters from within the test period itself. Chan’s procedure is not itself free of potential bias as the risk-adjusted returns are computed with reference to future test period returns. However, the potential bias is likely to be far less severe than if the extreme rank period returns are used. Consistent with Chan (1988), we assume that expected returns are generated by the Sharpe–Lintner CAPM and that the presence of abnormal returns can be tested by examining the value of α in the following equation:

$$r_{i,t} - r_{\mathrm{f},t} = \alpha_i = \beta_i (r_{\mathrm{m},t} - r_{\mathrm{f},t}) + \varepsilon_{i,t} \tag{12}$$

To examine the change in risk (if any) from the rank to the test period and the presence of abnormal returns in the rank and the test period, the preceding equation is modified to:

$$\begin{aligned} r_{i,t} - r_{\mathrm{f},t} = {} & \alpha_{1i}(1 - D_t) + \alpha_{2i} D_t + \beta_i (r_{\mathrm{m},t} - r_{\mathrm{f},t}) \\ & + \beta_{iD}(r_{\mathrm{m},t} - r_{\mathrm{f},t}) D_t + \varepsilon_{i,t} \end{aligned} \tag{13}$$

where $t = 1$ to 72, $r_{i,t}$ is the continuously compounded return on portfolio i at time t, $r_{\mathrm{m},t}$ is the equally weighted CRIF index, $r_{\mathrm{f},t}$ is the risk-free rate, the dummy variable D_t is equal to zero in the rank period $(t < 37)$ and is equal to one in the test period $(t > 36)$. $\hat{\alpha}_{1i}$ gives the rank period abnormal return, $\hat{\alpha}_{2i}$ gives the test period abnormal performance, $\hat{\beta}_i$ is the rank period beta and $\hat{\beta}_{iD}$ is the change in beta from the rank to the test period. Thus, the test period beta is $\hat{\beta}_i + \hat{\beta}_{iD}$. Coefficients are estimated using OLS regression (Table 5) with the regression line forced through the origin in order to estimate $\hat{\alpha}_{1i}$.

Following Chan (1988), the regression parameters for the entire period are the weighted averages of the parameters for individual test periods, where the weights are proportional to the length of the test periods. In our case, the test periods are the same length in each case (36 months). The aggregate t statistic is given by

$$U = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} t_i \sqrt{(T_i - 3)/(T_i - 1)} \tag{14}$$

where N is the number of test periods (7), T is the number of observations (36) and t_i is the individual test periods t-statistics.

Table 5
Multiplicative rebalancing method with risk adjustment — by rank period
All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. A market-adjusted abnormal return is computed for each stock and all stocks are ranked and placed into decile (10) portfolios based on this amount. The worst performing 10% of stocks constitute the Loser (L) portfolio and the best performing 10% constitute the Winner (W) portfolio. The following equation is then estimated: $r_{i,t} - r_{f,t} = \alpha_{1i}(1 - D_t) + \alpha_{2i} D_t + \beta_i(r_{m,t} - r_{f,t}) + \beta_{iD}(r_{m,t} - r_{f,t})D_t + \varepsilon_{i,t}$ where $t = 1$ to 72, $r_{i,t}$ is the continuously compounded return on portfolio i at time t, $r_{m,t}$ is the equally weighted CRIF index, $r_{f,t}$ is the risk-free rate, the dummy variable D_t is equal to zero in the rank period ($t < 37$) and is equal to one in the test period ($t > 36$). $\hat{\alpha}_{1i}$ gives the rank period abnormal return, $\hat{\alpha}_{2i}$ gives the test period abnormal performance, $\hat{\beta}_i$ is the rank period beta and $\hat{\beta}_{iD}$ is the change in beta from the rank to the test period. Thus, the test period beta is $\hat{\beta}_i + \hat{\beta}_{iD}$. Coefficients are estimated using OLS regression with the regression line forced through the origin in order to estimate $\hat{\alpha}_{1i}$. Portfolio returns are calculated using the multiplicative rebalancing method suggested by Dissanaike (1994). This process is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. Coefficient estimates for the loser, winner and arbitrage portfolio are presented here by rank period and in aggregate for all rank periods.

Rank period	Loser				Winner				Loser–Winner			
	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$
1974–1976	−0.0276	−0.0044	1.252	0.284	0.0257	−0.0137	1.375	0.086	−0.0531	0.0093	−0.118	0.190
	(−4.92)[a]	(−0.58)	(11.52)[a]	(1.36)	(4.37)[a]	(−1.69)	(12.05)[a]	(0.39)	(−7.70)[a]	(0.98)	(−0.90)	(0.77)
1977–1979	−0.0262	−0.0019	0.819	0.086	0.0032	−0.0187	2.579	−0.722	−0.0297	0.0184	−1.685	0.756
	(−4.24)[a]	(−0.43)	(5.75)[a]	(0.54)	(0.29)	(−2.38)[b]	(10.26)[a]	(−2.56)[b]	(−2.33)[b]	(1.98)	(−5.97)[a]	(2.38)[b]
1980–1982	−0.0491	−0.0121	2.056	−0.070	0.0224	−0.0079	1.324	−0.321	−0.0727	−0.0053	0.714	0.240
	(−5.51)[a]	(−1.27)	(14.23)[a]	(−0.31)	(4.32)[a]	(−1.42)	(15.79)[a]	(−2.45)[b]	(−6.94)[a]	(−0.47)	(4.31)[a]	(0.94)
1983–1985	−0.0559	−0.0006	1.863	−0.320	0.0324	−0.0017	1.182	0.098	−0.0890	−0.0002	0.657	−0.342
	(−7.29)[a]	(−0.08)	(13.43)[a]	(−1.97)	(5.30)[a]	(−0.29)	(10.68)[a]	(0.75)	(−8.26)[a]	(−0.02)	(3.55)[a]	(−1.52)
1986–1988	−0.0400	0.0225	1.360	0.170	0.0343	−0.0226	1.142	−0.539	−0.0753	0.0437	0.248	0.653
	(−3.94)[a]	(2.22)[b]	(11.21)[a]	(0.79)	(7.14)[a]	(−4.70)[a]	(19.87)[a]	(−5.29)[a]	(−6.02)[a]	(3.50)[a]	(1.54)	(2.47)[a]
1989–1991	−0.0368	−0.0044	1.505	0.020	0.0468	−0.0108	0.786	0.095	−0.0847	0.0056	0.698	−0.075
	(−4.69)[a]	(−0.52)	(10.96)[a]	(0.10)	(5.52)[a]	(−1.17)	(5.29)[a]	(0.46)	(−7.28)[a]	(0.44)	(3.57)[a]	(−0.28)
1992–1994	−0.0440	0.0092	1.199	0.144	0.0337	−0.0102	1.564	−0.411	−0.0774	0.0192	−0.348	0.550
	(−7.72)[a]	(1.75)	(13.31)[a]	(0.97)	(4.90)[a]	(−1.61)	(14.40)[a]	(−2.29)[b]	(−8.29)[a]	(2.23)[b]	(−2.47)[b]	(2.29)[b]
Aggregate	−0.0399	0.0012	1.436	0.045	0.0284	−0.0122	1.422	−0.245	−0.0683	0.0134	0.014	0.290
	(−14.06)[a]	(0.40)	(29.50)[a]	(0.54)	(11.69)[a]	(−4.87)[b]	(32.42)[a]	(−4.03)[a]	(−17.08)[a]	(3.27)[b]	(1.24)	(2.59)[b]

[a] Significant at the 1% level using a two-tailed test.
[b] Significant at the 5% level using a two-tailed test.

As is expected from the construction of the loser and winner portfolios, $\hat{\alpha}_{1i}$ (rank period mean abnormal return) is significantly negative for the loser portfolio and significantly positive for the winner portfolio. While the winner portfolio displays a significant aggregate performance reversal during the test period ($\hat{\alpha}_{2i} = -0.0122$), there is no significant reversal for the loser portfolio. However, the significant test period abnormal return to the arbitrage portfolio (loser–winner) of 0.0134 is consistent with the expectations of the overreaction hypothesis.

Table 6 presents aggregate risk-adjusted returns for all intermediate portfolios. As expected, the rank period abnormal return, $\hat{\alpha}_{1i}$, decreases monotonically from loser to winner portfolio. There is some evidence that this pattern of abnormal returns reverses during the subsequent test period. Table 7 demonstrates that this result is generally robust to alternative rank/test period lengths. However, the abnormal performance of the arbitrage portfolio is most significant over the 3-year horizon.

Table 6
Multiplicative rebalancing method with risk adjustment — by portoflio
All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. A market-adjusted abnormal return is computed for each stock and all stocks are ranked and placed into decile (10) portfolios based on this amount. The worst performing 10% of stocks constitute the Loser (L) portfolio and the best performing 10% constitute the Winner (W) portfolio. The following equation is then estimated: $r_{i,t} - r_{f,t} = \alpha_{1i}(1 - D_t) + \alpha_{2i} D_t + \beta_i (r_{m,t} - r_{f,t}) D_t + \varepsilon_{i,t}$ where $t = 1$ to 72, $r_{i,t}$ is the continuously compounded return on portfolio i at time t, $r_{m,t}$ is the equally weighted CRIF index, $r_{f,t}$ is the risk-free rate, the dummy variable D_t is equal to zero in the rank period ($t < 37$) and is equal to one in the test period ($t > 36$). $\hat{\alpha}_{1i}$ gives the rank period abnormal return, $\hat{\alpha}_{2i}$ gives the test period abnormal performance, $\hat{\beta}_i$ is the rank period beta and $\hat{\beta}_{iD}$ is the change in beta from the rank to the test period. Thus, the test period beta is $\hat{\beta}_i + \hat{\beta}_{iD}$. Coefficients are estimated using OLS regression with the regression line forced through the origin in order to estimate $\hat{\alpha}_{1i}$. Portfolio returns are calculated using the multiplicative rebalancing method suggested by Dissanaike (1994). This process is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. Aggregate coefficient estimates across all six periods are presented here for each of the decile portfolios and for the arbitrage portfolio.

Portfolio	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$
Loser	−0.0399 (−14.06)[a]	0.0012 (0.40)	1.436 (29.50)[a]	0.045 (0.54)
2	−0.0241 (−11.00)[a]	−0.0012 (−0.57)	1.299 (35.00)[a]	−0.056 (−0.98)
3	−0.0144 (−7.26)[a]	−0.0020 (−0.60)	1.149 (32.37)[a]	−0.002 (−0.16)
4	−0.0093 (−5.89)[a]	−0.0035 (−1.54)	0.936 (34.18)[a]	−0.022 (−0.13)
5	−0.0058 (−4.05)[a]	−0.0026 (−1.42)	0.973 (34.58)[a]	−0.146 (−3.47)[b]
6	−0.0013 (−1.09)	−0.0027 (−1.49)	0.871 (32.55)[a]	−0.141 (−2.96)[b]
7	0.0027 (1.62)	−0.0002 (−0.01)	0.815 (28.30)[a]	−0.060 (−1.18)
8	0.0060 (3.37)[b]	−0.0040 (−2.25)	0.934 (30.91)[a]	−0.131 (−2.91)[b]
9	0.0098 (6.03)[a]	−0.0052 (−3.20)[b]	0.996 (34.68)[a]	−0.197 (−4.50)[a]
Winner	0.0284 (11.69)[a]	−0.0122 (−4.87)[a]	1.422 (32.42)[a]	−0.245 (−4.03)[a]
Loser–Winner	−0.0683 (−17.08)[a]	0.0134 (3.27)[b]	0.014 (1.24)	0.290 (2.59)[b]

[a] Significant at the 1% level using a two-tailed test.
[b] Significant at the 5% level using a two-tailed test.

Table 7

Multiplicative rebalancing method with risk adjustment — varying rank/test period lengths

All Australian stocks with a complete set of returns over varying 1–5-year (N) rank periods are identified. A market-adjusted abnormal return is computed for each stock and all stocks are ranked and placed into decile (10) portfolios based on this amount. The worst performing 10% of stocks constitute the Loser (L) portfolio and the best performing 10% constitute the Winner (W) portfolio. The following equation is then estimated: $r_{i,t} - r_{f,t} = \alpha_{1i}(1 - D_t) + \alpha_{2i} D_t + \beta_i(r_{m,t} - r_{f,t}) + \beta_{iD}(r_{m,t} - r_{f,t})D_t + \varepsilon_{i,t}$ where $t = 1$ to N, $r_{i,t}$ is the continuously compounded return on portfolio i at time t, $r_{m,t}$ is the equally weighted CRIF index, $r_{f,t}$ is the risk-free rate, the dummy variable D_t is equal to zero in the rank period $(t < N/2 + 1)$ and is equal to one in the test period $(t > N/2)$. $\hat{\alpha}_{1i}$ gives the rank period abnormal return, $\hat{\alpha}_{2i}$ gives the test period abnormal performance, $\hat{\beta}_i$ is the rank period beta and $\hat{\beta}_{iD}$ is the change in beta from the rank to the test period. Thus, the test period beta is $\hat{\beta}_i + \hat{\beta}_{iD}$. Coefficients are estimated using OLS regression with the regression line forced through the origin in order to estimate $\hat{\alpha}_{1i}$. Portfolio returns are calculated using the multiplicative rebalancing method suggested by Dissanaike (1994). This process is repeated for the other rank periods. Aggregate coefficient estimates across all periods are presented here for the loser, winner and arbitrage portfolio.

Rank period (year)	Loser				Winner				Loser–Winner			
	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$
1	−0.0717	−0.0016	1.279	0.352	0.0606	−0.0160	1.809	−0.606	−0.1322	0.0143	−0.497	0.908
	(−26.01)[a]	(−0.98)	(24.42)[a]	(4.51)[a]	(24.94)[a]	(−5.43)[a]	(36.10)[a]	(−7.63)[a]	(−30.18)[a]	(2.89)[a]	(−6.89)[a]	(7.37)[a]
2	−0.0504	0.0006	1.4587	0.1395	0.0415	−0.0113	1.4673	−0.3035	−0.0920	0.0113	−0.0079	0.4403
	(−18.90)[a]	(−0.39)	(30.60)[a]	(2.11)	(17.37)[a]	(−4.31)[a]	(31.99)[a]	(−4.44)[a]	(−22.65)[a]	(2.40)[b]	(0.14)	(4.06)[a]
3	−0.0399	0.0012	1.436	0.045	0.0284	−0.0122	1.422	−0.245	−0.0683	0.0134	0.014	0.290
	(−14.06)[a]	(0.40)	(29.50)[a]	(0.54)	(11.69)[a]	(−4.87)[a]	(32.42)[a]	(−4.03)[a]	(−17.08)[a]	(3.27)[b]	(1.24)	(2.59)[b]
4	−0.0362	0.0035	1.5188	−0.1578	0.0211	−0.0084	1.4160	−0.2429	−0.0574	0.0119	0.1028	0.0851
	(−11.83)[a]	(0.50)	(28.84)[a]	(−2.21)	(8.47)[a]	(−2.93)[b]	(30.10)[a]	(−3.75)[b]	(−13.53)[a]	(2.28)	(1.76)	(0.77)
5	−0.0291	0.0038	1.6248	−0.1874	0.0157	−0.0107	1.3995	−0.2455	−0.0449	0.0145	0.2253	0.0581
	(−7.81)	(0.52)	(25.40)[b]	(−2.74)	(5.54)	(−3.72)	(27.41)[a]	(−4.13)	(−8.89)	(2.59)	(2.60)	(−0.02)

[a] Significant at the 1% level using a two-tailed test.
[b] Significant at the 5% level using a two-tailed test.

The rank period beta is estimated by $\hat{\beta}_i$ and the test period beta is estimated by $\hat{\beta}_i + \hat{\beta}_{iD}$. The loser portfolio is more risky during the test period than in the rank period for durations of 1 to 3 years and is less risky for durations of 4 and 5 years. The winner portfolio is less risky during the test period than during the rank period over all rank/test period lengths. As expected, the loser portfolio is more risky than the winner portfolio during the test period for all durations. However, the differential risk does not account completely for the different test period performances of the loser and winner portfolios.

Table 8 presents the regression coefficients for the loser, winner and arbitrage portfolio assuming the use of a buy and hold strategy. Consistent with the early non-risk-adjusted results, the winner portfolio is barely affected but the loser portfolio experiences a significant reduction in test period abnormal returns. Consequently, the abnormal test period return to the arbitrage portfolio is no longer significant.

3.5. The role of size

Zarowin (1990, p. 113), among others, argues that ‘the tendency for losers to outperform winners is not due to investor overreaction, but to the tendency for losers to be smaller-sized firms than winners.’ However, Brailsford finds the average size of loser companies to actually be greater than that of winner companies and the average size of the loser and winner portfolios to significantly exceed that of all other companies. This section seeks to further explore the role of size in the results presented in Section 3.4.

Table 9 presents the average size of each portfolio for each independent rank/test period at the last month of the rank period, along with the average size across all periods. It is quite clear that within each period and across all periods, the loser portfolio is significantly smaller than both the winner portfolio and the remainder of the data set. While the winner portfolio is slightly larger overall than the average portfolio size, it is still smaller than the largest capitalisation portfolios, 6 through 9. Table 10 tracks the size of each portfolio through both the rank and test period. As expected, the loser portfolio experiences a significant loss of size during the rank period and the winner portfolio experiences exactly the reverse. This effect is such that the loser and winner portfolios start the rank period with comparable average size (loser = \$49.3 million, winner = \$73.79 million) and end the rank period with vastly different average sizes (loser = \$17.15 million, winner = \$250.28 million). During the test period, the loser portfolio appreciates by about 40% and the winner portfolio by about 10%. Despite the greater rate of growth during the test period, the loser portfolio remains significantly smaller than all other portfolios at the end of the test period.

This data suggests that the differential performance of the loser and winner portfolios may actually be driven by the well-known size effect. Table 11 shows

Table 8

Buy and hold method with risk adjustment — by rank period

All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. A market-adjusted abnormal return is computed for each stock and all stocks are ranked and placed into decile (10) portfolios based on this amount. The worst performing 10% of stocks constitute the Loser (L) portfolio and the best performing 10% constitute the Winner (W) portfolio. The following equation is then estimated: $r_{i,t} - r_{\mathrm{f},t} = \alpha_{1i}(1 - D_t) + \alpha_{2i} D_t + \beta_i (r_{\mathrm{m},t} - r_{\mathrm{f},t}) + \beta_{iD}(r_{\mathrm{m},t} - r_{\mathrm{f},t}) D_t + \varepsilon_{it}$ where $t = 1$ to 72, $r_{i,t}$ is the continuously compounded return on portfolio i at time t, $r_{\mathrm{m},t}$ is the equally weighted CRIF index, $r_{\mathrm{f},t}$ is the risk-free rate, the dummy variable D_t is equal to zero in the rank period ($t < 37$) and is equal to one in the test period ($t > 36$). $\hat{\alpha}_{1i}$ gives the rank period abnormal return, $\hat{\alpha}_{2i}$ gives the test period abnormal performance, $\hat{\beta}_i$ is the rank period beta and $\hat{\beta}_{iD}$ is the change in beta from the rank to the test period. Thus, the test period beta is $\hat{\beta}_i + \hat{\beta}_{iD}$. Coefficients are estimated using OLS regression with the regression line forced through the origin in order to estimate $\hat{\alpha}_{1i}$. Portfolio returns are calculated using the buy and hold method. This process is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. Coefficient estimates for the loser, winner and arbitrage portfolio are presented here by rank period and in aggregate for all rank periods.

Rank period	Loser				Winner				Loser–Winner			
	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$
1974–1976	−0.0418	0.0009	1.190	0.178	0.0127	−0.0127	1.347	0.177	−0.0545	0.0137	−0.157	0.001
	(−5.40)[a]	(0.09)	(7.90)[a]	(0.62)	(1.78)	(−1.29)	(9.71)[a]	(0.67)	(−6.45)[a]	(1.17)	(−0.96)	(0.00)
1977–1979	−0.0274	−0.0090	0.672	0.291	0.0049	−0.0241	2.090	−0.204	−0.0322	0.0152	−1.417	0.495
	(−3.73)[a]	(−1.69)	(3.97)[a]	(1.53)	(0.37)	(−2.52)[a]	(6.83)[a]	(−0.60)	(−2.19)[b]	(1.43)	(−4.17)[a]	(1.30)
1980–1982	−0.0733	−0.0308	2.209	−0.066	0.0069	−0.0070	1.508	−0.550	−0.0802	−0.0238	0.700	0.483
	(−7.98)[a]	(−3.12)[b]	(14.82)[a]	(−0.29)	(1.05)	(−0.99)	(14.05)[a]	(−3.28)[a]	(−8.06)[a]	(−2.23)[b]	(4.34)[a]	(1.92)
1983–1985	−0.0751	−0.0133	1.937	−0.180	0.0197	−0.0083	1.229	0.218	−0.0948	−0.0050	0.708	−0.398
	(−9.36)[a]	(−1.80)	(13.35)[a]	(−1.06)	(3.01)[a]	(−1.37)	(10.40)[a]	(1.58)	(−8.61)[a]	(−0.50)	(3.56)[a]	(−1.71)
1986–1988	−0.0713	−0.0160	1.477	0.037	0.0235	−0.0143	1.490	−0.954	−0.0948	−0.0017	−0.012	0.991
	(−5.68)[a]	(−1.28)	(9.85)[a]	(0.14)	(4.01)[a]	(−2.45)[b]	(21.26)[a]	(−7.68)[a]	(−6.53)[a]	(−0.12)	(−0.07)	(3.22)[a]
1989–1991	−0.0677	−0.0151	1.067	0.293	0.0312	−0.0159	0.892	0.054	−0.0989	0.0008	0.175	0.239
	(−6.36)[a]	(−1.31)	(5.73)[a]	(1.12)	(4.09)[a]	(−1.91)	(6.66)[a]	(0.29)	(−7.57)[a]	(0.05)	(0.77)	(0.75)
1992–1994	−0.0580	0.0012	1.122	0.201	0.0150	−0.0102	1.433	−0.345	−0.0730	0.0113	−0.311	0.546
	(−8.98)[a]	(0.19)	(11.00)[a]	(1.19)	(1.83)	(−1.34)	(11.06)[a]	(−1.61)	(−7.12)[a]	(1.20)	(−1.92)	(2.04)[b]
Aggregate	−0.0592	−0.0117	1.382	0.108	0.0163	−0.0132	1.427	−0.229	−0.0755	0.0015	−0.045	0.337
	(−17.43)[a]	(−3.27)[b]	(24.45)[a]	(1.20)	(5.92)[a]	(−4.36)[a]	(29.35)[a]	(−3.90)[a]	(−17.07)[a]	(0.37)	(0.57)	(2.76)

[a] Significant at the 1% level using a two-tailed test.

[b] Significant at the 5% level using a two-tailed test.

Table 9
Mean size ($M) for all companies at the last month of the rank period
All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. A market-adjusted abnormal return is computed for each stock and all stocks are ranked and placed into decile (10) portfolios based on this amount. The worst performing 10% of stocks constitute the Loser (L) portfolio and the best performing 10% constitute the Winner (W) portfolio. This process is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. The average size of each portfolio in $M at the last month of the rank period is presented.

Portfolio	Dec-76	Dec-79	Dec-82	Dec-85	Dec-88	Dec-91	Dec-94	Mean
Loser	5.887	24.692	16.167	9.986	6.833	19.223	36.648	17.155
2	16.343	66.652	24.738	46.738	22.105	14.163	240.894	66.336
3	29.236	52.324	154.714	113.107	46.917	52.569	754.154	185.446
4	26.277	122.559	84.078	151.595	89.578	41.516	678.069	185.254
5	25.194	128.712	61.481	190.886	59.388	264.571	521.416	186.321
6	36.985	101.037	128.699	201.64	176.025	365.892	1475.864	385.396
7	128.767	52.802	79.578	171.921	434.35	721.567	653.606	334.666
8	39.977	45.805	122.653	120.081	467.885	825.981	372.611	292.559
9	31.704	50.83	93.014	136.802	655.292	1106.107	272.685	343.185
Winner	47.17	49.785	73.742	347.171	473.416	612.617	81.124	250.292
Mean	38.754	69.565	83.857	149.25	243.179	405.056	508.415	224.661

the relative size composition of each portfolio. To achieve this, at the end of the rank period each security is ranked by rank period return and by market capitalisation (i.e. smallest one-third, middle one-third, largest one-third). Each security is

Table 10
Mean size ($M) for all companies throughout the entire test period
All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. A market-adjusted abnormal return is computed for each stock and all stocks are ranked and placed into decile (10) portfolios based on this amount. The worst performing 10% of stocks constitute the Loser (L) portfolio and the best performing 10% constitute the Winner (W) portfolio. This process is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. The average size of each portfolio in $M at 12-month intervals throughout the rank and test period is presented.

Portfolio	Rank period (month)				Test period (month)		
	1	12	24	36	48	60	72
Loser	49.93	55.17	24.53	17.15	24.29	29.73	33.14
2	86.29	91.07	82.40	66.33	79.59	102.88	110.27
3	203.65	225.47	225.45	185.44	243.36	253.63	324.23
4	144.28	154.25	183.30	185.24	240.11	269.94	356.11
5	145.72	145.59	176.01	186.31	238.60	313.25	367.79
6	273.98	299.30	360.91	385.39	479.82	543.11	633.35
7	235.04	292.90	331.09	334.66	426.27	505.53	589.56
8	155.66	202.99	244.17	292.55	386.26	424.49	407.52
9	161.54	220.50	256.11	343.18	403.73	458.33	552.07
Winner	73.79	128.35	169.55	250.28	347.66	349.59	383.18

Table 11
Percentage of small, medium, and large firms in each of the 10 rank period return portfolios
All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. This is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. At the end of the rank period, each security is ranked by rank period return and by market capitalisation (i.e. smallest one-third, middle one-third, largest one-third). Each security is then first assigned to 1 of 10 portfolios based on rank period return, then each of the 10 portfolios is broken into three size portfolios. The percentage of small, medium and large firms in each portfolio is presented.

	Small (%)	Medium (%)	Large (%)
Loser	74.1	19.7	6.1
2	57.2	29.0	13.8
3	41.0	31.7	27.2
4	27.1	38.8	34.0
5	31.4	35.8	32.8
6	22.4	34.4	43.2
7	20.4	35.4	44.2
8	23.5	32.3	44.2
9	18.7	35.0	46.3
Winner	17.0	41.5	41.5

then first assigned to 1 of 10 portfolios based on rank period return, then each of the 10 portfolios is broken into three size portfolios. Three out of every four firms in the loser portfolio comes from the smallest of the three size portfolios and there is almost no representation in the loser portfolio from those firms classified as large. Small firms comprise less than one in five firms in the winner portfolio.

Table 12 presents the risk adjusted abnormal returns attributable to the size sub-portfolios described in the previous paragraph. Of the three size portfolios, the small size portfolio provides results closest to that observed prior to sub-classifying on size. While the absolute values of the test period abnormal return are stronger for the loser, winner, and arbitrage portfolios, their statistical significance is reduced due to the smaller sample sizes. Table 11 indicates that the number of firms in the small/winner portfolio is to be very limited, as is the number of firms in the large/loser portfolio. These results suggest that the positive abnormal returns observed for the full sample arbitrage portfolio are largely due to the prevalence of small firms in the loser portfolio.

To obtain a slightly different view of the role of size, the size portfolios can be created before rather than after creating the portfolios based on rank period returns. That is, three size portfolios (i.e. smallest one-third, middle one-third, largest one-third) are created using market capitalisation data at the end of the rank period. Then, within each size portfolio, 10 portfolios are created based on rank period performance. Using this approach, an approximately equal number of firms are obtained in each portfolio. The implication is, then, that the loser/large firm portfolio will have a greater rank period return and the winner/small firm portfolio will have a smaller rank period return using this approach than the

Table 12
Multiplicative rebalancing method with risk adjustment — by size sub-portfolio. Securities assigned to portfolios by rank period return then by size
All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. This is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. At the end of the rank period, each security is ranked by rank period return and by market capitalisation (i.e. smallest one-third, middle one-third, largest one-third). Each security is then first assigned to 1 of 10 portfolios based on rank period return, then each of the 10 portfolios is broken into three size portfolios. The following equation is then estimated: $r_{i,t} - r_{\mathrm{f},t} = \alpha_{1i}(1 - D_t) + \alpha_{2i} D_t + \beta_i (r_{\mathrm{m},t} - r_{\mathrm{f},t}) + \beta_{iD}(r_{\mathrm{m},t} - r_{\mathrm{f},t}) D_t + \varepsilon_{i,t}$ where $t = 1$ to 72, $r_{i,t}$ is the continuously compounded return on portfolio i at time t, $r_{\mathrm{m},t}$ is the equally weighted CRIF index, $r_{\mathrm{f},t}$ is the risk-free rate, the dummy variable D_t is equal to zero in the rank period ($t < 37$) and is equal to one in the test period ($t > 36$). $\hat{\alpha}_{1i}$ gives the rank period abnormal return, $\hat{\alpha}_{2i}$ gives the test period abnormal performance, $\hat{\beta}_i$ is the rank period beta and $\hat{\beta}_{iD}$ is the change in beta from the rank to the test period. Thus, the test period beta is $\hat{\beta}_i + \hat{\beta}_{iD}$. Coefficients are estimated using OLS regression with the regression line forced through the origin in order to estimate $\hat{\alpha}_{1i}$. Portfolio returns are calculated using the multiplicative rebalancing method suggested by Dissanaike (1994). Aggregate coefficient estimates across all six periods are presented here for each of the size sub-portfolios within the loser, winner and arbitrage portfolio.

Rank period	Small				Medium				Large			
	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$
Loser	−0.0399	0.0030	1.511	0.145	−0.0445	−0.0086	1.185	−0.194	−0.0520	−0.0153	1.405	−0.475
	(−11.47)[a]	(0.89)	(25.75)[a]	(1.37)	(−9.61)[a]	(−1.52)	(15.08)[a]	(−1.85)	(−8.54)[a]	(−2.55)[b]	(13.45)[a]	(−2.67)[b]
Winner	0.0316	−0.0128	1.780	−0.345	0.0248	−0.0117	1.350	−0.245	0.0244	−0.0132	1.228	−0.167
	(3.98)[a]	(−1.60)	(14.31)[a]	(−2.34)	(8.98)[a]	(−4.09)[a]	(23.79)[a]	(−2.59)[b]	(8.99)[a]	(−4.39)[a]	(25.04)[a]	(−3.01)[b]
Loser–	−0.0715	0.0158	−0.269	0.490	−0.0693	0.0031	−0.165	0.052	−0.0764	−0.0024	0.177	−0.306
Winner	(−8.56)[a]	(1.84)	(−1.78)[a]	(2.61)[b]	(−11.92)[a]	(0.68)	(−1.17)	(0.38)	(−10.01)[a]	(0.03)	(0.79)	(−1.30)

[a] Significant at the 1% level using a two-tailed test.
[b] Significant at the 5% level using a two-tailed test.

Table 13
Multiplicative rebalancing method with risk adjustment — by size sub-portfolio. Securities assigned to portfolios by size then by rank period return

All Australian stocks with a complete set of returns over the 36-month (rank) period 1974–1976 are identified. This is repeated for a further six rank periods beginning 1977–1979 and ending 1992–1994. At the end of the rank period, each security is ranked by rank period return and by market capitalisation (i.e. smallest one-third, middle one-third, largest one-third). Each security is then *first* assigned to one of into three size portfolios then each of the three size portfolios is broken into 10 portfolios based on rank period return. The following equation is then estimated: $r_{i,t} - r_{f,t} = \alpha_{1i}(1 - D_t) + \alpha_{2i} D_t + \beta_i(r_{m,t} - r_{f,t}) + \beta_{iD}(r_{m,t} - r_{f,t})D_t + \varepsilon_{i,t}$ where $t = 1$ to 72, $r_{i,t}$ is the continuously compounded return on portfolio i at time t, $r_{m,t}$ is the equally weighted CRIF index, $r_{f,t}$ is the risk-free rate, the dummy variable D_t is equal to zero in the rank period ($t < 37$) and is equal to one in the test period ($t > 36$). $\hat{\alpha}_{1i}$ gives the rank period abnormal return, $\hat{\alpha}_{2i}$ gives the test period abnormal performance, $\hat{\beta}_i$ is the rank period beta and $\hat{\beta}_{iD}$ is the change in beta from the rank to the test period. Thus, the test period beta is $\hat{\beta}_i + \hat{\beta}_{iD}$. Coefficients are estimated using OLS regression with the regression line forced through the origin in order to estimate $\hat{\alpha}_{1i}$. Portfolio returns are calculated using the multiplicative rebalancing method suggested by Dissanaike (1994). Aggregate coefficient estimates across all six periods are presented here for each of the size sub-portfolios within the loser, winner and arbitrage portfolio.

Rank period	Small				Medium				Large			
	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$	$\hat{\alpha}_{1i}$	$\hat{\alpha}_{2i}$	$\hat{\beta}_i$	$\hat{\beta}_{iD}$
Loser	−0.0515	0.0037	1.526	0.287	−0.0353	−0.0035	1.096	−0.178	−0.0280	−0.0107	1.067	−0.197
	(−9.52)[a]	(0.48)	(16.84)[a]	(1.91)	(−10.66)[a]	(−0.99)	(20.18)[a]	(−2.34)	(−9.84)[a]	(−3.33)[b]	(21.53)[a]	(−2.18)
Winner	0.0251	−0.0099	1.736	−0.368	0.0278	−0.0102	1.386	−0.195	0.0280	−0.0143	1.196	−0.107
	(4.97)[a]	(−1.91)	(19.85)[a]	(−2.66)[b]	(8.69)[a]	(−3.26)[b]	(22.25)[a]	(−1.94)	(9.03)[a]	(−4.25)[a]	(23.16)[a]	(−2.15)
Loser–	−0.0766	0.0136	−0.210	0.655	−0.0631	0.0068	−0.290	0.017	−0.0560	0.0036	−0.129	−0.090
Winner	(−10.61)[a]	(1.84)	(−0.88)	(3.32)[b]	(−12.94)[a]	(1.33)	(−1.31)	(−0.05)	(−13.87)[a]	(0.91)	(−1.48)	(−0.32)

[a] Significant at the 1% level using a two-tailed test.
[b] Significant at the 5% level using a two-tailed test.

previous approach to portfolio construction. The results are presented in Table 13 and are largely consistent with those of Table 12.

4. Conclusion

Using an extended Australian data set and a rebalancing approach to calculating market-adjusted test period portfolio returns, this study finds evidence of performance reversal for both the rank period loser and winner portfolios and positive abnormal returns for the arbitrage (loser–winner) portfolio. However, consistent with Brailsford (1992), this result largely disappears when a buy and hold strategy is employed.

After an appropriate adjustment for risk, the performance reversal experienced by the loser portfolio using the rebalancing approach is considerably reduced. Despite this, a significant positive abnormal return to the arbitrage portfolio is still evident. However, this again disappears when a buy and hold approach is used.

Further analysis indicates that the loser portfolio has an average capitalisation significantly smaller than the remainder of the data set and that the loser portfolio is dominated by small firms. While the results presented here suggest that a small firm effect may be driving the positive abnormal returns to the arbitrage portfolio, further research is required to disentangle the small firm effect from any overreaction effect. Regardless of the underlying source of the abnormal returns, the results here suggest that these abnormal returns are not exploitable in the Australian equity market due to the lack of liquidity associated with small capitalisation stocks and the transaction costs associated with monthly portfolio rebalancing.

While this paper has gone some way to explaining the results of earlier Australian research by considering the impact of alternative methodologies on the visibility and genuineness of price reversals in the Australian equity market, there remains a fundamental difference between Australian and US studies of this phenomena. That is, when using the basic DeBondt and Thaler (1985) methodology where no adjustments are made for risk, size or other factors, US studies consistently demonstrate price reversal in the winner and loser portfolios whereas Australian studies do not.

It is possible that this may at least partly be explained by the relatively short and recent period used in Australian studies. While the data set used here covers the period from 1974 to 1997, comprehensive US studies go back to 1926. Chen and Sauer (1997) find that price reversal is not consistent over that long period of time when raw returns are analysed. Dividing the time period into four sub-periods (pre-war, 1940s–1950s, pre-energy crisis, post-energy crisis), they find evidence of significant price reversals in the pre-war and pre-energy crisis periods but not in the other two periods. The post-energy crisis period (1971–1992), for which Chen and Sauer found little evidence of price reversal, corresponds closely with the period studied here using Australian data. When viewed against the results of

Chen and Sauer for the corresponding period, the Australian and US results based on raw returns are quite consistent.

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