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What should investors know about the stability of momentum investing and its riskiness? The case of the Australian Security Exchange.

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ABSTRACT

This paper investigates Australian momentum strategies and their performance stability separately employing two samples a) the S&P/ASX 200 constituents and b) all market securities; for different time periods and market states. To avoid transaction intensive strategies, non-overlapping portfolios are employed. Results show that momentum performance is not sample specific and is positive in all cases, yet at varying magnitudes for different states and years. The profits are robust to univariate and multivariate risk considerations, seasonality (which is however present), and to different starting months.

JEL Classification: G1 (G10, G11, G14)

Keywords: Momentum; Fama-French model; Australian Security Exchange

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1. Introduction

Momentum strategies that short worst performing securities to take long positions on top performing ones have established consistent profitability over the short to medium term. This is contrary to the existing paradigm in the literature, and is supported by a plethora of studies at an international level. For recent examples beyond U.S., see Galariotis et al. (2007) for the London Stock Exchange, and Griffin et al. (2003) for all continents.

Momentum profitability, classified as a major unresolved puzzle by Chan et al. (1996), remains so nearly two decades after Jegadeesh and Titman's (1993) seminal paper. More specifically, the literature is short of an unambiguous rationalisation of the profitability or of evidence that could provide a further set of conditions for future momentum performance (Swinkels, 2004). This solicits new evidence on more markets not only to allow for comparisons with existing ones, but because as Demir et al. (2004) suggest, universal elements of momentum in different markets could potentially support the inclusion of the momentum factor in asset pricing models (Carhart, 1997).

The momentum rationalisation dialectic has recently focused around multivariate risk propositions, such as the one by Fama and French (1993, 1996), yet, to the best of my knowledge there is shortage of evidence on this model for momentum in Australia. This market offers fertile research ground for a plethora of other reasons, the most important of which is that Australian momentum strategies have not been extensively researched, while existing evidence is contradictory. For example, Demir et al. (2004) and Durand et al. (2006a) report dramatically different results despite a substantial sample overlap in their studies, possibly due to methodological differences and/or time-dependant momentum performance in Australia. In addition, recent momentum evidence by Bettman et al. (2009) can be sample specific if one considers the evidence of Gaunt and Grey (2003). More specifically, Bettman et al. (2009) use daily Australian data for large stocks and results for this market are sensitive to the size of the examined firms due to correlation properties, as well as to the time frequencies employed. For example, such characteristics can explain the inconsistency of the findings of Durnad et al. (2006a) and Demir et al. (2007).

This paper contributes to the literature in several ways. It first confirms that the findings of Bettman et al. (2009) are robust to different data frequencies and periods, using monthly data to deal with this potential methodological problem. Specifically, intermediate-horizon momentum returns persist in the most recent period with a higher magnitude relative to other markets, consistent with Demir et al. (2004). Based on the work of Gaunt and Grey (2003), that reveals positive (negative) autocorrelation for large (small and medium) Australian securities, I control for the possibility that the momentum evidence by Hurn and Pavlov (2003) and of Bettman et al. (2009) are sample specific. To achieve this, at a later stage, I consider all Australian securities that exist between 2000 and the end of 2009. The evidence demonstrates that despite sensitivity of winner and loser performance to market capitalisation, their combination, i.e. the hedge portfolio profitability, is not sample specific. The findings of the two aforementioned papers are thus extended for a different pool of securities, including an out of sample period. Moreover, the paper attempts to answer the question of whether risk-based explanations can account for the above profits in both a univariate and multivariate context. The findings show that consistent with the extant literature, CAPM fails to explain momentum returns, but the Fama and French three factor model offers mixed results. For instance, although it reduces the number of statistically significant returns, these uphold their economic significance, with for example returns of 9.6% per year for the 6X6 momentum strategy. The paper also examines the stability of momentum performance across different states of the world for different starting periods. These tests and microstructure considerations reveal that although the average profitability of momentum investing is positive and statistically significant, the magnitude of the returns generated is not stable, while there is some evidence of seasonality. Finally, while the extant literature employs overlapping portfolios, in an attempt to make the study even more relevant to practitioners, I adopt the less intensive hence less costly non-overlapping approach.

The results should also be of interest to the investment community, given the involvement of institutional investors, mainly mutual funds and brokerage firms, in momentum trading (Burch and Swaminathan, 2001). For example, the results suggest that although it is profitable to invest in all Australian stocks, it may be optimal for a momentum trader to focus on a few and larger liquid stocks. At the same time, although momentum performance is positive, it is not so in every investment year, while the magnitude of profits and their driving forces are sensitive to the market states. These are particularly relevant in the current world setting as the market recovers from the current economic situation.

The rest of the paper is organised as follows. Section 2 provides a brief review of the relevant literature, while section 3 presents the data and the testing methodologies. Section 4 discusses the results and implications for different considerations and samples, and section 5 concludes the paper.

2. Brief review of the literature

Jegadeesh and Titman's (1993) paper on momentum set the benchmark for research and proved to be very influential in terms of methodology, with their most representative 6X6 strategy taking centre stage in contemporary research. The findings of the above paper are upheld by Conrad and Kaul (1998) for a wider range of U.S. strategies over a longer period (1926-1989), with evidence of positive abnormal returns (excluding the 1926-1947 period). More recent papers also suggest positive and significant momentum trading returns for the U.S. and an indicative summary is provided in the list below, where as can be seen momentum strategies return a statistically and economically significant amount ranging from above 9% per year to about 18%.

Some selected research on U.S. momentum

Author(s) and year of publication	Momentum (%)	t-value	Sample period	Formation X Holding period
Grudny and Martin (2001)	0.86	(2.45)	1978-1995	6X1 [a]
Jegadeesh and Titman (2001)	1.39	(4.71)	1990-1998	6X6
Chordia and Shivakumar (2002)	0.73	(2.51)	1963-1994	6X6
Chordia and Shivakumar (2006)	0.76	(2.48)	1972-1999	6X6
Liu et al. (2006)	0.77	(4.19)	1960-2004	6X6 [b]
Avramov et al. (2007)	1.49	(3.48)	1985-2003	6X6 [b]
Rachev et al. (2007)	1.30	N/A	1996-2003	6X6

This list presents raw momentum-strategy monthly payoffs documented in recent literature. The formation and holding periods are measured in months. The letter "a" reflects a one-week delay between formation and holding period while the letter "b" implies a one-month delay. T-values are in parentheses, while the last one was not available in the original paper.

Motivated by the lack of non U.S. evidence, Rouwenhorst (1998) explores momentum in an international context, unveiling monthly excess returns of 1.16% for internationally-diversified portfolios in 11 out of 12 European markets he investigates from 1980 through to

1995. A number of recent papers suggest similar evidence in other international markets, but not consistently especially for developing ones, possibly due to data quality and methodological disparities. Although comparisons between developed and developing markets are difficult to perform, Swinkels (2004) suggests that emerging market evidence seem to point in the same direction as that of developed markets. For instance, in another study, Rouwenhorst (1999) finds that 6 out of the 20 developing markets he examines exhibit significant positive momentum returns of 0.58% per month. Hart et al. (2005) report similar results with 6X6 momentum excess returns ranging from 0.59% to 0.74% per month. In contrast, Griffin et al. (2003) (from the indicative list provided below) publicise weak and statistically insignificant emerging market momentum results that in some cases (China and Pakistan) are negative, suggesting the need for further research.

Some selected research on International momentum

Authors and Year of publication	Sample period	Number of countries examined (region covered)	Number of countries with statistically significant price momentum
Bird and Whitaker (2003)	1990-2002	7 (European countries)	5 (Germany, Italy, The Netherlands, Switzerland, UK)
Griffin et al. (2003)	1975-2000	40 (countries from all continents)	20 (including South Africa, Chile, New Zealand, Austria, Belgium, Finland, Greece, Ireland, etc)
Hurn and Pavlov (2003)	1973-1998	1 (Australia)	1 (Australia)
Doukas and McKnight (2005)	1988-2001	13 (European countries)	7 (Belgium, Germany, France, The Netherlands, UK, Denmark, and Norway)
Antoniou et al. (2007)	1977-2002	3 (European countries)	3 (UK, Germany and France)
Galariotis et al. (2007)	1964-2005	1 (UK)	1 (UK)

Two streams of research attempt to rationalise momentum; one is risk-based, while the other stems from behavioural finance. The first argues that momentum investing entails significant risks, hence receives higher payoffs (Conrad and Kaul, 1998; Berk et al., 1999; Fama and French, 1996; Avramov and Chordia, 2006); while the latter postulates that psychological and other biases result in systematic underreaction leading to momentum (Barberis et al., 1998; Hong and Stein, 1999; Hong et al., 2000; Doukas and McKnight 2005). It is imperative that before one subscribes to the latter camp, mainstream risk based explanations are exhausted, hence the emphasis placed on them by recent literature. Jegadeesh and Titman (1993) discard risk as an explanation for momentum in a univariate context, while Fama and French (1996) follow suit in a multivariate one. However Conrad and Kaul (1998), attribute momentum to cross-sectional dispersion in unconditional mean returns, but their work is criticised by Jegadeesh and Titman (2002)[1]. In general, the question of whether momentum is risk related remains open to debate and more evidence from different markets is required.

[1] While some papers use conditional modelling (Antoniou et al., 2007; Avramov et al., 2007), others reject connections of macroeconomic risk and momentum profits (Griffin et al., 2003; Liu et al., 2006). Although conditional models outperform unconditional ones, they are not bias-free. Daniel and Titman (2006) suggest that conditional models apparent success can be attributed to the low statistical power of the test used. Hence, further research should be performed in this field, especially to derive an appropriate methodology to test the models.

3. Methodology

3.1. Data

The paper is at first based on the constituents of the S&P/ASX 200 Index, motivated by the fact that this sample is representative of the market as it includes the 200 largest stocks listed in the Australian Security Exchange and covers 80% or more of the Australian equity market capitalisation. This sample also precludes a number of potential explanatory factors for the performance of such strategies such as the small firm effect, illiquidity and risk. More specifically the index is recognised globally as representative, liquid, tradable, and an easily replicable index allowing widespread use by institutional investors, managers of mutual funds and financial advisors. Hurn and Pavlov (2003) indicate, for example that one particular characteristic of the Australian equity market is the low liquidity encountered for small stocks, while according to Demir et al. (2004) stocks within the S&P/ASX 200 Index are larger and more easily tradable than other non-index stocks. This consequently prevents momentum investors, who often engage in frequent rebalancing, from excessive costs such as commissions and bid-ask spreads.

The sample period for the S&P/ASX 200 data is from July 2000[2] up to April 2007. During this period one encounters sub-periods of stability as well as bull and bear markets, allowing the examination of momentum performance in Australia under different market states. The sample contains monthly observations of market capitalisation, market to book values and stock returns downloaded from DataStream International and measured in Australian dollars adjusted for dividends. The index returns and the nominal risk free rate are proxied by the S&P/ASX 200 Index adjusted for dividends, and the 1-month Australian Dealer Bill[3], respectively. To avoid survivorship bias, the sample includes active and dead stocks[4]. Furthermore, to ensure that this index is realistic as regards constituent changes, the sample is rebalanced every 3 months and its components are adjusted in accordance to the Index Committee decisions[5]. Companies are included in the sample for the whole time they remain part of the index. As equities enter and exit the S&P/ASX 200 Index, the inclusion of a particular stock depends on whether it remains on the constituent list for a sufficient period of time (the entire ranking period plus one month in the post-formation period). Following Demir et al. (2004), where a stock exits the list before the culmination of the strategy, the returns are determined for the period of time when it is on the list and the stock is considered to be held in the form of cash afterwards. Finally, in order to avoid any backfilling bias, historical data for lately-included equities is not incorporated into the sample set. As a result, the sample is constructed so that there are approximately 200 active stocks at any point in time, though the whole sample consists of 349 firms overall.

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[2] The S&P/ASX 200 Index was introduced in April 2000. For analytical purposes, this study starts its investigation in July 2000 which is the first month of the financial year in Australia. Nonetheless, using January instead of July shows that the results are here not sensitive to the choice of starting month.

[3] The sample period and type of firms for this part of the paper is similar to Bettman et al. (2009) although they use daily data, and we also examine the effect of different states on performance. Note that I later repeat tests extending the sample period and sample stocks.

[4] Information about stocks, changes of company names, mergers and acquisitions, inclusion, etc., is based on DataStream International, the Australian Security Exchange and the Australian Shareholder's Association websites (http://www.asx.com.au/resources/codes/changes/2001.htm, also http://www.delisted.com.au/)

[5] The Index Committee reviews the list of the constituents every quarter (reviews take place on the third Friday of December, March, June and September) in order to ensure appropriate market capitalization and liquidity. An assessment of both characteristics is based upon the former six months' worth of data.

The above sample selection aspires at securing results that are not driven by the inclusion of small, less transparent, illiquid, and more expensive to trade securities. Likewise, such a sample makes the paper relevant, in that it examines realistic and executable trading strategies that are of interest to the investment community. However, for Australia, Gaunt and Grey (2003) find that positive autocorrelation, which is a necessary condition for momentum profits, is an explicit characteristic of large stocks, while smaller and medium ones are negatively correlated. The implication is that results here and for earlier papers by Hurn and Pavlov (2003) and Bettman et al. (2009) that are based on large stocks can be biased favourably towards finding momentum. To deal with this, the paper also tests All Australian firms for momentum for the same and for an extended out of sample period up to the end of 2009. Similar data-types as for the earlier sample are downloaded for all active and dead firms, leading to a sample of 2214 securities that adhere to the inclusion criteria. More details on the inclusion criteria, the sample and its characteristics are given in the relevant section.

3.2. Methodology

This study investigates momentum strategies in the spirit of Jegadeesh and Titman (1993, 2001), deviating in that it does not implement overlapping portfolios arguing that frequent rebalancing leads to high transaction costs and less attractive strategies for professional traders and the market place. Stock selection for portfolio inclusion is based on returns over the previous 1 to 4 quarters, referred to as *J*-month ranking periods[6]. Similarly, the holding, post-formation, periods examined, are denominated in *K*-month intervals that vary from 1 to 4 quarters. This leads to 16 strategies in total, with each strategy examined and tested separately. At the end of each formation period, stocks are sorted to quintiles, in descending order, based on their total return over the previous *J* months. More specifically, the top quintile includes stocks that performed best over the relevant formation period and as one moves to lower quintiles performance is progressively worsening, with the very worst performers forming the bottom quintile. The top portfolio is called the winners' portfolio (*W*), while the bottom one is called the losers' portfolio (*L*) and the momentum zero cost (winner minus loser, *WML*) portfolio shorts *L* to long *W* for the next *K* months. At the end of each holding period both positions are closed, stocks are ranked again based on the new set of the past *J* months, new portfolios are created, and new positions are taken for the next *K* months. For example, for the 6X6 strategy, portfolios are constructed in the following manner: the first ranking period starts in July 2000[7] and lasts to December 2000 (*J*=6). At the end of December 2000 stocks are ranked to top and bottom portfolios. Then, positions are taken accordingly and held from January till the end of June 2001 (*K*=6). The whole process is then repeated starting from January 2001 as the first month of the next ranking period and so on. There are various other tests and robustness checks that are performed and these will be explained in the subsections that the relevant results are presented to avoid complication.

[6] Regarding portfolio formation, strategies are implemented without (with) a delay between the ranking and holding periods for the S&P/ASX 200 (full) sample. Results are robust, and if anything, skipping a month increases profitability dealing with the bid-ask bounce, consistent with the literature. This study is also based on monthly returns that are less sensitive. In addition it researches the largest and most liquid Australian stocks when focusing on the S&P/ASX 200, hence the bid-ask bounce is less important for that sample. Once the full sample that includes less liquid and smaller stocks (hence more sensitive to this problem) is employed, the paper does skip a month between ranking and holding windows.

[7] Note that test are repeated for different starting months and results are robust to this.

4. Results

4.1. Evidence of relative strength portfolio performance

This section discusses the performance of momentum strategies applied to the largest and most liquid stocks in the Australian Security Exchange, for the period between July 2000 and April 2007. Table 1 presents the average returns of the different buy and sell portfolios, as well as zero cost portfolios, reporting the results for 16 strategies (all possible combinations of the 4 different formation and holding periods). The most successful strategy is the one that selects stocks based on their performance over the previous 9 months and holds them for the next 6 months, with gains of 2.7% per month (t-statistic: 3.62). For all different combinations of *J* and *K*, hedge portfolios generate positive, and statistically significant returns, that are greater compared to other developed markets. For example, the most successful hedge portfolio of Jegadeesh and Titman (1993) yields 1.31% per month, while returns documented by Grundy and Martin (2001) and Chordia and Shivakumar (2006) are lower at 0.86% and 0.76%, respectively. Nonetheless, results are similar to those presented by Antoniou et al. (2007), with magnitudes of 2.10%, 1.82% and 1.44% for the U.K., Germany and France, respectively. Most importantly, the findings are in line with Australian momentum evidence of Demir et al. (2004) with monthly returns of 2.83% and Hurn and Pavlov (2003), who document a return of 2.73%. However the results stand at odds with Durand et al. (2006a) who do not find a significant difference between winners' and losers' performance. Interestingly, this is not due to methodology discrepancies since all cases closely follow Jegadeesh and Titman (1993). It is possible that this relates to performance instabilities mentioned earlier, as the studies examine different sample periods. Demir et al. (2004) conduct their tests for 1991 to 2001, while Durand et al. (2006a) examine 1980 to 2001. Even though these two periods overlap for nearly 10 years, the results reported are dramatically different, suggesting a significant negative influence of the period between 1980 and 1991, i.e. that momentum is not consistently profitable in all periods, intuitively reducing its desirability. Hence, the question formerly expressed on the temporal persistence of momentum, gains further importance under these results. Another interesting finding also discussed later on, is that given the insignificant loses for short positions, profits seem to be driven by winners.

[INSERT TABLE 1 ABOUT HERE]

Table 2, presents average monthly returns of two specific horizons for five different portfolios (P1 to P5), where P1 consists of top past winners, P2 of the second best performance group, and so on, all the way down to P5 with the extreme losers. The choice of which horizons to analyse due to space limitations is done as follows. The 6X6 horizon is selected because it is extensively used as a representative case of momentum strategies, allowing more informed and accurate comparisons with the extant research. The 9X6 strategy, is the most profitable one identified in this study, and from an investor's perspective, it is the one that calls for further analysis. In general, the table reveals a direct monotonic relationship between returns and different momentum ranks similar to Jegadeesh and Titman (2001) for the 6X6 strategies. Results are similar for the other strategy with P3 breaking the monotony. The difference between the returns of the two extreme portfolios (P5-P1) is reliably different from zero at 2.52% and 2.70% for the 6X6 and the 9X6 strategy respectively.

[INSERT TABLE 2 ABOUT HERE]

4.2. Evidence on the stability of performance

Having established the average profitability of momentum strategies for the S&P/ASX 200 sample, it is now important to investigate whether this a stable occurrence across time or more pertinent to different periods as implied by aforementioned sample period related discrepancies. To test for this, the sample period is divided into several sub-periods and Table 3 presents average monthly returns of winner, loser and zero cost portfolios for the two strategies that were analysed in Table 2, with respect to different time periods. The full sample period for the S&P/ASX 200 firms (denoted in the table as “All”) has been divided into two sub-periods. The first period is between January 2001 and March 2003 and is characterised by stability for the Australian market with some occasional downward movements. The second period consists of the remaining 49 months during which the market experienced continuously significant upward drift. Analysis of these two periods for Australia can reveal whether momentum profits are associated or not with expansionary and/or stable market states. The table also analyses annual performance, and presents the average performance of an equally-weighted index (*EWI*) of all 200 securities, and the percentages by which winners (losers) outperform (under perform) the *EWI*.

Both the 6X6 and 9X6 strategies reveal similar results. Momentum profits appear to be much stronger out of book periods. More specifically, the first relatively stable 27 months, return a statistically significant 5.24% and 5.39% for the 6X6 and the 9X6 strategies respectively. During the next 49 months, when Australia is characterized by a distinct boom, momentum profits are much lower, yet remain positive and statistically significant at 1.02% (t-statistic: 2.12) for the 6X6 strategy and 1.38% (t-statistic: 2.60) for the 9X6 strategy. This is consistent with Antoniou et al. (2007) who also find higher returns during worst market periods for other economies. This would be explained if losers consistently contributed more to momentum profits than winners did. Antoniou et al. (2007, p. 962) find that “except in the case of France, a large portion of momentum profits comes from loser stocks”, contradictory to Jegadeesh and Titman (2001). Looking at the winner and loser columns in conjunction to the last two columns verifies that profits for both strategies in the first 27 month period can only be driven by the short position that has a higher *EWI* differential and return. This is corroborated by the fact that the 49 month period where profits are reduced, coincides with lower loser differentials and higher winner returns. Overall, the differences of the sub-period analysis and the results for the full period show that although winners seem (as in Tables 1 and 2) to be driving profits across time, this may not be the case at all times depending on market performance, with implications for the extant research.

Interestingly, yearly profitability analysis demonstrates that returns are lower after the first two years, and in 2003 and 2005 they are statistically and to some extent economically insignificant as well. In other words momentum does not generate unconditional profits in all years. For example, for the 6X6 strategy, both winners and losers generate positive returns of similar magnitudes in 2003, i.e. momentum investors experience profits in their long positions that are cancelled out by positive returns in their short positions that picked up in value. Consequently, momentum investment yields negative returns for the 6X6 strategy (where losses on losers exceed profits from winners), or insignificant positive returns for the 9X6 strategy (where losses on losers almost completely absorb profits from winners). During the next three years momentum profits are higher again.

[INSERT TABLE 3 ABOUT HERE]

4.3. Evidence on seasonality

Jegadeesh and Titman (1993, 2001), Antoniou et al. (2007) and Durand et al. (2006a), find notable seasonality in momentum profits for the U.S., Europe, and Australia respectively. Analytically, Jegadeesh and Titman (1993, 2001) report that winners outperform losers in all months except January when profits are smaller or negative compared to other months. Antoniou et al. (2007) results are similar albeit not negative. Durand et al. (2006a) focus on both January and July returns in order to capture the strong influence of the U.S. market for January[8] and to emphasize the role of July as the first month of the financial year in Australia (to mimic the U.S. January effect). They find significant negative returns for July, which parallels the U.S. January effect. This could potentially explain some of the performance differentials found previously; hence this section addresses the issue of seasonality. Following the above paper I examine January and July returns, while at a later section I check the performance for each calendar month with the expanded sample.

Table 4 presents average monthly returns for winner, loser and momentum portfolios for both the 6X6 and 9X6 strategies with respect to the individual months of January and July and outside these months. Results are similar to Jegadeesh and Titman (1993, 2001), and Antoniou et al. (2007), yet not sturdily, as January returns may be lower relative to other months but here the difference is not economically significant. Un-tabulated results show that they are also statistically insignificant for both strategies (6X6 t-statistic: -0.89; and 9X6 t-statistic: -0.915). Furthermore, contrary to Durand et al. (2006a), findings of this paper do not report negative returns in July but document relatively high yet statistically insignificant average payoffs instead.

[INSERT TABLE 4 ABOUT HERE]

4.4. Evidence of abnormal returns

Motivated by the continuing debate in the literature regarding risk based propositions for different investment styles this subsection questions whether the results reported thus far are due to risk. If risk explains momentum performance in Australia, then momentum strategies are likely to select stocks with high sensitivity to general equity market movements. In this case the higher returns found so far are not abnormal but reward investors for bearing this additional risk. The paper resorts to single and multiple risk considerations given the lack of evidence on multifactor momentum considerations for Australia. In addition, motivated by the existence of a downside risk premium for the U.S. (Ang et al., 2006), and following Van der Hart et al. (2005), I examine whether different market states affect the risk and return characteristics of momentum strategies. The analysis begins with the CAPM model regression:

$$R_{p,t} - R_{f,t} = \alpha + \beta_M (R_{M,t} - R_{f,t}) + \varepsilon_t \qquad (1)$$

where $R_{p,t}$ is the monthly return on the equally-weighted hedge portfolio (*WML*) of the particular *JXK* strategy, $R_{M,t}$ is the corresponding monthly return on the S&P/ASX 200 index that proxies for market returns, and $R_{f,t}$ is the 1-month Australian Dealer Bill rate that proxies for the nominal risk free rate.

[8] For more information about the influence of U.S. stocks on Australian stocks see Durand et al. (2001) and Durand et al. (2006b).

Results for the zero cost portfolios are presented in Table 5. As can be seen, for all strategies, returns adjusted for market risk as measured by the intercept α are positive and statistically significant with one exception, that of the 12X12 portfolio. The abnormal returns estimated from these regressions are also economically significant and actually very close to the raw returns presented in Table 1. Hence, either market risk does not explain results, or this model, or factor proxy, are inappropriate for capturing risk in a multifaceted world.

[INSERT TABLE 5 ABOUT HERE]

It is also evident in the results that for all strategies the β's are negative probably due to a difference in the loadings of the extreme portfolios, i.e. if this is correct, momentum portfolios act as a hedge to market movements consistent with earlier findings of a somewhat inverse relationship of momentum performance and market states. This is confirmed by Table 6 that analyses the results for all quintiles of the two key strategies analysed so far (6X6 and 9X6). As can be seen, extreme losers have a higher loading on market risk than winners in both cases. Analytically, the β loading of losers for the 6X6 strategy is 1.34 compared to 0.82 for winners, while for the 9X6 strategy the loser's β loading at 1.28 is double to that of winners. This is not in line with the results of Jegadeesh and Titman (2001) for the U.S., but is consistent with De Bondt and Thaler (1987), as market betas of losers (winners) are above (below) 1. For both strategies, winners are less risky than losers. This however cannot explain abnormal returns, given that the alphas of the zero cost strategies are statistically and economically significant, as well as all the alphas of the quintiles with the exception of P4, i.e. excess returns seem not to be a compensation for carrying excessive market risk.

[INSERT TABLE 6 ABOUT HERE]

Our results so far have shown that there are higher momentum returns in stable or mildly recessionary periods, and a more significant contribution to momentum profits from losers, who on average are more risky than winners. The question that still remains however is whether these return and risk properties hold at all states. According to De Bondt and Thaler (1987) losers do not have higher loadings consistently, they are actually more (less) sensitive during bull (bear) markets. If that is the case here as well, then risk may be able to explain returns once one differentiates between states using the subsequent model:

$$\begin{aligned} R_{p,t} - R_{f,t} &= \alpha^{-} I_{\{R_{m,t}-R_{f,t}<0\}} + \beta^{-}{}_{M}(R_{M,t} - R_{f,t}) I_{\{R_{m,t}-R_{f,t}<0\}} + \\ &\alpha^{+} I_{\{R_{m,t}-R_{f,t}\geq 0\}} + \beta^{+}{}_{M}(R_{M,t} - R_{f,t}) I_{\{R_{m,t}-R_{f,t}\geq 0\}} + \varepsilon_t \end{aligned} \tag{2}$$

where $R_{p,t}$, $R_{M,t}$ and $R_{f,t}$ are as before. $I_{\{A\}}$ represents a dummy variable depending on the event A, in a way that $I_{\{A\}} = A$, if A occurs, or 0 if it does not. Consequently, estimates of β^{-}_{M} and β^{+}_{M} determine market risk at recession or expansion respectively, and α^{-} and α^{+} quantify excess returns analogously.

Table 7 shows the estimates derived from the above model for winner and loser portfolios of the 6X6 and 9X6 strategies, under different market conditions. It is worth noting that the difference between downside and upside betas is relatively high. For example, the downside beta for winners is 1.10 compared to an upside value of 0.78 for the 6X6 strategy, similarly for losers of the 9X6 strategy, implying that they are possibly exposed to excessive downside Australian equity market risk. When analysing excess returns (α^{-}, α^{+}) it is clear that the strategies can still exhibit positive excess returns that are not explained by this relationship

In addition it seems that the 9X6 strategy benefits from this in both up and down markets as opposed to the 6X6 strategy. For example winners have statistically and economically significant excess returns during market downturns despite their positive exposure to risk, indicating that results are not related to risk. The results presented in Table 7 are not unambiguous and as such their interpretation might be difficult, and most probably as Antoniou et al. (2006) indicate they may be due to inappropriate risk measurement.

[INSERT TABLE 7 ABOUT HERE]

The above ambiguity and the potential for risk mis-measurement reinforce the need at this stage to examine whether an alternative model is more appropriate for this market. In other words, can the returns described so far as abnormal be rewards for bearing risk associated with the Fama and French excess market returns index, market capitalization differences, and book-to-market differences? And if so, why these factors and not other, especially given that the extant literature (Fama and French, 1996; Jegadeesh and Titman; 2001) have failed to rationalise momentum using this model?

The answer is that we are unaware of the performance of this model for momentum research in Australia as there is shortage of evidence[9]. Nonetheless, Halliwell et al. (1999), Faff (2004), Gaunt (2004), Durand et al. (2006b,) have all shown that for other areas of research to the one here, these factors are pertinent to Australia, especially for large stocks like the S&P/ASX 200 constituents. For example, Halliwell et al. (1999) find that the level and statistical significance of Fama and French factor sensitivities are similar to those documented by Fama and French (1993). This model attempts to explain portfolio excess returns by sensitivities to the market returns in excess of risk free rate, $R_{M,t}$ - $R_{f,t}$, the difference between the returns generated by portfolios of small and big stocks (*SMB*), and the difference between the returns on portfolios of equities with high and low book-to-market values (*HML)*:

$$R_{p,t} - R_{f,t} = \alpha + \beta_M (R_{M,t} - R_{f,t}) + \beta_{SMB} SML_t + \beta_{HML} HML_t + \varepsilon_t \tag{3}$$

Estimates of the above regression presented in Table 8 for all 16 hedge portfolios reveal that only 4 of them (9X3, 9X6, 12X3, 12X9) yield statistically significant risk-adjusted returns. This suggests that the model may capture some of the momentum profitability for this market. Comparing the estimates with the CAPM ones in Table 5, they are much weaker economically. The higher magnitude of the adjusted R^2 clearly shows that the Fama and French model is superior to CAPM, consistent with previous studies (Avramov and Chordia, 2006). In line with the above, most hedge portfolios load heavily on *SMB* and *HML* factors, while the market factor is insignificant. In all cases, *SMB* sensitivities are significantly negative consistent with U.S. evidence by Jegadeesh and Titman (2001), and international evidence by Rouwenhorst (1998). *HML* factor loadings are all positive and statistically significant with exceptions in Panel D where *J=12*. This stands in contrast to previous studies (Fama and French, 1996), and might be the reason for which the model appears more relevant here compared to momentum studies in other markets.

[INSERT TABLE 8 ABOUT HERE]

[9] Please note that although Demir et al. (2004) do not examine whether their reported returns are abnormal using a widely accepted model such as the Fama and French model (1993), they do consider the effects of both size and liquidity on momentum.

The implications of the above findings will be fortified or weakened following the analysis of the 6X6 and 9X6 strategies in Table 9. More specifically, if they are consistent with the above findings then they will indicate that for this market the model works, and perhaps further longer window tests will be required to make a case of this. If however the results are mixed, then at best one could argue for the fact that this model is superior to the CAPM, yet imperfect.

As can be seen, the in-depth analysis reveals results that are inconsistent with the general ones in the previous table, given that in the majority of returns are still economically (albeit less so) and statistically significant after orthogonalisation to the three factors. Perhaps the answer as to the previous table's results rests in the fact that loser returns are now insignificant, explained by the fact that the losers load more heavily on *SMB* and *HML*. If losers consistently drive momentum profitability for large Australian stock momentum strategies, then the momentum strategies will not deliver abnormal returns after adjusting for these factors, hence α values appear insignificant in the previous table. Returning to table 9, the model does not work equally well for any other portfolio (P1 to P4) which may explain the discrepancy of the results here with literature on other markets.

To summarise, we apply two models to control for risk, namely the CAPM and the Fama French model. The first fails to explain abnormal returns with minor exceptions in individual portfolio analysis. The Fama French model offers superior, yet mixed results. At first it seems to be doing a better job with higher adjusted R^2 values and a few significant α's. However, four strategies remain profitable after the adjustment, including the 9X6 strategy, i.e. one of the two strategies analysed in depth in this paper, while the other (6X6) seems to be rationalised. On closer inspection of the two individual strategies however it is noticeable that even when strategies appear to have their returns rationalised, these remain economically significant. For example the 6X6 strategy returns are at 0.8% (see Table 9). In addition, the results of the individual strategies in Table 9 do not support the findings of Table 8, as only the loser returns appear to be rationalised for both strategies, consistent with he earlier findings of loser driven results. The question that comes out however is why does one become insignificant while the other remains significant after the adjustment? The answer is that perhaps only the returns of the 6X6 strategy are really driven by losers. This is corroborated by Table 7, which shows that for the 9X6 strategy there are winner abnormal returns for up-markets as well as in down markets, so perhaps the difference comes from different market states. The fact that only the returns of the 6X6 strategy are really driven by losers is hidden when looking in raw returns in Table 1, but in Table 6 the extreme portfolio CAPM α values are very different for the 6X6 strategy but not for the 9X6 strategy[10]. This shows that in the first case the loser's contribution is much larger than the winner's one. Therefore, if the additional two Fama French Factors, capture the loser's contribution, then they should render only the loser-driven 6X6 strategy unprofitable, consistent with the actual results and the literature (Fama and French, 1996).

[INSERT TABLE 9 ABOUT HERE]

4.5. Evidence from an extended sample and sample period

The paper has so far considered the constituents of the S&P/ASX 200 index for the Australian market to perform an analysis of the performance of momentum strategies between

[10] More specifically, the winner's (P1) and loser's (P5) returns are very different for the 6X6 strategy at -1.78% and 0.95%. At the same time, the 9X6 strategy values of the extreme portfolios are very close at -1.53% for (P5) and 1.46% for (P1).

2000 and April 2007. Although concentrating on the largest most traded firms for most markets would normally suffice in dealing with a major part of the effects related to the small firm anomaly and the related hazards such as low analyst coverage, low transparency, low information diffusion, hence higher trading costs and risk, as well as thin trading and other microstructure biases. However, for the Australian market, the selection of the largest firms to test for momentum can bias the results. More specifically, Gaunt and Gray (2003) show that large stock autocorrelation is positive up to twelve months, contrary to that of small and medium stocks that appears to be negative. If the largest 200 stocks are positively autocorrelated, while the rest are negatively autocorrelated, one can expect that results so far, including those of Hurn and Pavlov (2003) and of Bettman et al. (2009), can be associated to firm selection, since all three examine largest firms' momentum. In addition, Durand et al. (2006a) do not support momentum in Australia converse to Demir et al. (2004) due to sample differences. It therefore seems that the performance of momentum strategies in Australia may be specific to the sample period and stock selection criteria.

To this end, this section extends the sample to include all Australian firms so as to assess the potential effect of the findings of Gaunt and Gray (2003). In addition all existing studies end their sample in 2007, so as to check if momentum profits are sample specific, the paper extends the sample period to the end of 2009, in a way providing an indirect out of sample test. More specifically, data are downloaded from DataStream International on live and dead firms. Stocks are included in the sample for periods that they trade at prices above 50 cents (Durand et al., 2006a, Demir et al., 2004). Firms that do not trade for 3 or more consecutive months are not included in the tests for that particular period. I end up with a sample of stocks that is in total 2214 stocks. As can be seen in Table 10, the number of firms available at any one year ranges from 1026 firms at the start of 2000 to 1835 at the start of 2008. The table also shows a decrease in the number of firms for the first time in 2009. More specifically, from the start of 2008 to the end of 2009 there is a decrease of firms by 125, or about 7%, possibly due to the crisis. A number of firms that stop trading during the last year, but have enough data to be included to the sample (based on the criteria set at the start of the paper consistent with the extant literature) are not deleted, but if so, the decrease in the number of firms would be even larger.

[INSERT TABLE 10 ABOUT HERE]

The methodology applied here is the same as for Table 1, with one exception. In Table 1 the paper does not skip a month between the formation and post-formation periods. This choice was made because the data frequency used (monthly) and the stock sample used (S&P/ASX 200 constituents) of the largest and most liquid Australian stocks mitigate the effect of the bid-ask bounce. If anything this effect would bias the results against finding momentum profits due to the spurious negative autocorrelation it induces, which should not be a problem since the paper found profits. In this section however, the sample also includes smaller firms, i.e. the effect of not skipping a month between the ranking and holding periods can be more dominant and therefore this section skips a month. As expected, skipping is relevant for this sample and actually increases profitability. For example, in un-tabulated results, when looking in the 3x3 momentum strategy without skipping a month between portfolio ranking and holding, momentum returns are insignificant compared to when a month is skipped[11]. In addition, the ranking periods so far commence in July (i.e. the start of the financial year in Australia), hence results may be specific to the starting month of July 2000,

[11] More specifically, momentum portfolio returns *WML* are economically and statistically insignificant at 0.2% (t-statistic: 0.44), with loser returns equal to -1.1% (t-statistic: -1.46) and winner returns equal to -0.9% (t-statistic: -1.31). Compare this to tables 11 and 12 where a month is skipped and returns are significant.

and since it is not typical in momentum studies, this section's ranking periods commence in January 2000 to show whether the results are robust to different starting months.

Table 11 presents the average returns of the different long and short portfolios, as well as the zero cost portfolios for all Australian firms over the extended period to the end of 2009, reporting results for all 16 strategies (as in Table 1). In Table 1, all momentum strategies deliver statistically significant returns, driven by past winners. Table 11 shows that when all firms are considered for an extended period by skipping a month between *J* and *K* the results change mainly in three respects. Firstly, the highest return now comes from the 6X9 strategy with a monthly average return of 1.5% (t-statistic: 4.58), compared to Table 1, where the best performing strategy was the 9X6 with an average return of 2.7% per month (t-statistic: 3.62). Secondly, as is the case above, for the majority of strategies the profits are economically less significant compared to those in Table 1. For example, momentum returns for the three month ranking period for all *K*s in Table 11 range between 0.6% and 1.0%, while in Table 1, they assume values between 1.95% and 2.53%, i.e. for these strategies, the lowest value in Table 1, is about three (two) times higher than the lowest (highest) value of table 11. Thirdly, by looking at the economical and statistical significance of the overall short and long positions, the profitability of the hedge portfolios is now driven by the short position in losers, compared to Table 1, where the long position in winners appeared to be responsible for momentum returns[12]. More specifically, here the returns of the overall losers (winners) are statistically and economically significant (insignificant), leading to positive yet weaker momentum performance. This difference can be attributed to either the change of the firms included in the sample, i.e. moving from large to all firms, or of the extension of the sample period and more specifically the financial crisis.

[INSERT TABLE 11 ABOUT HERE]

To determine which of the two above possibilities is liable for the discrepancies between Tables 1 and 11 all strategies are repeated excluding the time period 2007-2009 (also pertinent to the financial crisis). If results qualitatively revert back to the ones in Table 1, then the change can be attributed to the sample period. Furthermore, by also comparing the results with those of Bettman et al. (2009), it is possible to assess the effect of the additional sample firms, given that both studies share similar sample periods, but now different sample firms.

Table 12 presents the same results as Table 11 for All Australian firms but for a sample period equal to that of Table 1. As can be seen, when the sample is restricted to 2007, the findings change. Momentum profits remain significant like before, but increase their economic significance when the crisis is excluded. For example the highest monthly return now in 1.9% and is significant at the 1% level, and the majority of returns are around or above 1.5%. Another interesting finding is that the results are not driven any more by the short positions in losers (as was the case in Table 11), but mostly by the long positions in winners (similar to Table 1). More distinctively all 9X*K* and 12X*K* winner returns become statistically significant (as in Table 1), while all losers for all 16 strategies deliver insignificant returns (as in Table 1). This result is consistent with not only our results in Table 1, but also with Bettman et al. (2009), who find a higher winner contribution compared to losers.

[INSERT TABLE 12 ABOUT HERE]

Results so far indicate that during (out of) the 2007-2009 period losers (winners) drive momentum results. Overall, Australian momentum strategies remain profitable during the

[12] Note that this is with reference to the general case here and not to the specific analysis of the 6X6 and 9X6 strategies where the dynamics appeared to be different, as can be for any individual strategy.

crisis, yet they are less economically significant. Durand et al. (2006a) in a carefully conducted study use monthly data, find negative results for momentum between 1980 and the end of 2001, but they "…find a strong seasonal regularity associated with July, the first month of the Australian financial year" (p. 361). At this stage the paper tests whether controlling for the above can alter results. If this is the case, the findings of Durand et al. (2006a) are valid out of sample. Note that as them, I use monthly data on all Australian companies.

Table 13 presents the average seasonal returns of the 6X6 and 9X6 long and short portfolios, as well as the zero cost portfolios for all Australian firms. The results are consistent with Durand et al. (2006a), i.e. their seasonality findings are valid many years out of sample. More specifically, as for them, results for January for both the 6X6 (Panel A) and 9X6 (Panel B) strategies are negative and statistically insignificant, and the results for July are both negative and statically significant, with losers displaying large positive returns. Any differences between Table 4 and these, as well as the results of Durand et al. (2006a) are not related to the sample period but sample selection i.e. larger firms in Australia are not seasonal.

According to table 13, performance (profits and losses) are driven by short positions in losers. According to Panel A, the only time when winners returns are significant at the 5% level yet negative at -2.8%, is June, but *WML* June profits are high at 3.9% (t-statistic: 3.85) driven by the significant high negative short position returns of 6.7%. Overall 6x6 momentum strategies have significant positive (negative) returns in four (one) out of twelve months. Columns 6 to 9 of Panel A, where the returns for all other months are presented, verify that winner returns are not contributing to the 6x6 strategy performance (consistent with earlier arguments relevant to the three factor model findings). As seen in the last column, results are significant when hedge portfolio returns are positive at more than 65% of times. Panel B performs the same analysis for the 9x6 strategy with similar results, i.e. positive and statistically significant returns in four cases (albeit not for identical months), with statistically significant losses in July. The hedge portfolio returns for any 11 month period (columns 6 to 9) are positive and statistically significant, driven again by losers, ranging from 0.86% to 1.64%, with 10 out of 12 cases giving a return higher than 1% per month. When simultaneously excluding both January and July, contrary to Durand et al. (2006a), momentum profits are significant for both strategies, becoming insignificant only when 6 of 12 months (January and all significant months) are excluded. It is thus difficult to argue that profits are due to seasonality, but easier to support that performance varies across months.

[INSERT TABLE 13 ABOUT HERE]

Table 14, presents results of the Fama and French three factor model regressions (as in Table 8) using the full sample of Australian equities for the period January 2000 to December 2009. As in Table 8, the results show that the model fails to control for momentum, consistent with the existing literature. Hedge portfolio returns remain statistically significant at 7 of 16 strategies, while they are in cases economically significant even when statistically insignificant. For example, the 3X3 and 6X6 strategy returns are at 0.9% and 0.73%. The adjusted R^2 values of the model also appear to be lower than before.

[INSERT TABLE 14 ABOUT HERE]

5. Conclusions

This paper investigates momentum strategies in the context of the Australian market for two security samples and two sample periods. The first sample consists of the S&P/ASX

200 Index constituents, and the second one consists of All Australian firms. The analysed period is from 2000 to 2007, and then includes an out of sample period up to the end of 2009.

According to the findings there exist intermediate-horizon momentum returns in the Australian stock market. All 16 momentum strategies examined experience positive and statistically significant returns, ranging from 1.58% to 2.70%. Results are consistent with the extant literature internationally, but the momentum returns documented here are higher than the majority of developed markets.

The above profits are robust not only to different starting months, but also to sample selection. Specifically, momentum profits are present irrespective of the market capitalisation of the firms considered, however their magnitude is greater for the largest firms. Considering that trading on the universe of Australian securities is more labour-intensive, with higher transaction costs and bid-ask spreads intuitively suggests that focusing only on the largest 200 Australian stocks would be optimal for momentum traders.

Regarding the stability of results during different states there are three cases analysed falling, rising, or more stable markets. Even in crisis, momentum strategies remain profitable, yet comparative tests from 2000-2007 and 2000-2009 reveal that a) they are less economically significant b) driven by the very bad performance of the short positions in losers. Given liquidity, shorting and trading spreads in crisis periods, real momentum profits will be reduced further. The other two cases of boom markets, and stable markets with some negative adjustments, both deliver profits, yet more so in the latter case. Overall results seem to support Bettman et al's (2009) conclusion that momentum profits are pervasive through time in Australia. Nonetheless, this paper also shows that the economic significance and the driving forces of profits vary across different states. Moreover, when performing a stability analysis of year-by-year performance, it is clear that a momentum investor can expect profits under any state on average, but not from each year of trading. This implies that occasional or short horizon momentum investors exiting early, are taking on more risks than it seems at first. Longer presence of investors and longer horizons increase average performance.

Momentum strategies also perform differently in different calendar months, consistent with Durand et al. (2006a), with particularly strong negative returns in July. Nonetheless, when simultaneously excluding January and July, profits remain significant until half of the sample months are removed. This cannot be really labelled as seasonality in the standard connotation, but as perhaps "varying performance", especially after observing that different strategies don't share all good and bad months.

Performance is unexplained by risk controls by the CAPM and a version of it that allows the distinction of downside/upside market risk. The Fama French model is superior to CAPM, yet it cannot be claimed that it rationalises momentum returns, as there are strategies that remain statistically profitable after multifactor adjustment for both the S&P/ASX 200 sample and the full sample of Australian securities. In addition, even for strategies where the model captures statistical significance, profits remain economically significant. The model however seems able to explain the losers returns, therefore the performance of loser-driven strategies, consistent with the literature (Fama and French, 1996).

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References

Ang, A., Chen, J., Xing, Y., 2006. Downside Risk. The Review of Financial Studies 19, 1191-1239.

Antoniou, A., Galariotis, E.C., Spyrou, S.I., 2006. Short-term Contrarian Strategies in the London Stock Exchange: Are They Profitable? Which Factors Affect Them? Journal of Business Finance and Accounting 33, 839-867.

Antoniou, A., Lam, H.Y.T., Paudyal, K., 2007. Profitability of momentum strategies in international markets: The role of business cycle variables and behavioural biases. Journal of Banking and Finance 31, 955-972.

Avramov, D., Chordia, T., 2006. Asset Pricing Models and Financial Markets Anomalies. The Review of Financial Studies 19, 1001-1040.

Avramov, D., Chordia, T., Jostova, G., Philipov, A., 2007. Momentum and Credit Rating. The Journal of Finance 62, 2503-2520.

Balaban, E., 1995. January effect, yes. What about Mark Twain effect. [online] available from http://www.tcmb.gov.tr/research/discus/9509eng.pdf.

Barberis, N., Shleifer, A., Vishny, R., 1998. A Model of Investor Sentiment. Journal of Financial economics 49, 307-343.

Berk, J., Green, R., Naik, V., 1999. Optimal Investment, Growth Options, and Security Returns. Journal of Finance 54, 1553-1607.

Bettman, J.L., Maher, T.R.B., Sault, S., 2009. Momentum profits in the Australian equity market: A matched firm approach. Pacific-Basin Finance Journal 17, 565-579.

Bird, R., Whitaker, J., 2003. The performance of value and momentum investment portfolios: Recent experience in the major European markets. Journal of Asset Management 4, 221-246.

Burch, T.R., Swaminathan, B., 2001. Are Institutions Momentum Traders? [online] available at http://ssrn.com/abstract=291643.

Carhart, M.M., 1997. On Persistence in Mutual Fund Performance. Journal of Finance 52, 57-82.

Chan, L.K.C., Jegadeesh, N., Lakonishok, J., 1996. Momentum Strategies. The Journal of Finance 51, 1681-1713.

Chan, K., Hameed, A., Tong, W., 2000. Profitability of Momentum Strategies in the International Equity Markets. Journal of Financial and Quantitative Analysis 35, 153-172.

Chordia, T., Shivakumar, L., 2002. Momentum, Business Cycle, and Time-varying Expected Returns. The Journal of Finance 57, 985-1019.

Chordia, T., Shivakumar, L., 2006. Earnings and Price Momentum. Journal of Financial Economics 80, 627-656.

Conrad, J., Kaul, G., 1998. An Anatomy of Trading Strategies. The Review of Financial Studies 11, 489-519.

Daniel, K., Titman, S., 2006. Testing Factor-Model Explanations of Market Anomalies. Working paper. [online] available from http://www.rhsmith.umd.edu/ finance/pdfs_docs/seminarfall06/Daniel.pdf.

De Bondt W.F.M., Thaler, R.H., 1987. Further Evidence for Investor Overreaction and Stock Market Seasonality. The Journal of Finance 42, 557-581.

Demir, I., Muthuswamy, J., Walter, T., 2004. Momentum returns in Australian equities: The influences of size, risk, liquidity and return computation. Pacific-Basin Finance Journal 12, 143-158.

Doukas, J.A., McKnight, P.J., 2005. European Momentum Strategies, information diffusion and investor conservatism. European Financial Management 11, 313-338.

Durand, R.B., Koh, S.K., Watson, I., 2001. Who moved Asian-Pacific stock markets? A further consideration of the impact of the U.S. and Japan. Australian Journal of Management 26, 125-145.

Durand, R.B., Limkriangkrai, M., Smith, G., 2006a. Momentum in Australia—A Note. Australian Journal of Management 31, 355-364.

Durand, R.B., Limkriangkrai, M., Smith, G., 2006b. In America's Thrall: The Effects of the US Market and US Security Characteristics on Australian Stock Returns. Accounting and Finance 46, 577-604.

Faff, R., 2004. A simple test of the Fama and French model using daily data: Australian evidence. Applied Financial Economics 14, 83-92.

Fama, E.F., French, K.R., 1993. Common Risk Factors in Returns on Stock and Bonds. Journal of Financial Economics 33, 3-56.

Fama, E.F., French, K.R., 1996. Multifactor Explanations of Asset Pricing Anomalies. The Journal of Finance 51, 55-84.

Galariotis, E.C., Holmes, P., Ma S.X., 2007. Contrarian and momentum profitability revisited for the London Stock Exchange over 1964 to 2005. Journal of Multinational Financial Management 17, 349-448.

Gaunt, C., 2004. Size and book to market effects and the Fama French three factor asset pricing model: evidence from the Australian stock market. Accounting and Finance 44, 27-44.

Gaunt, C., Gray, P., 2003. Short-term autocorrelation in Australian equities. Australian Journal of Management 28, 97-117.

Griffin, J.M., Ji, X., Martin, J.S., 2003. Momentum investing and Business Cycle Risk: Evidence from Pole to Pole. The Journal of Finance 58, 2515-2547.

Grundy, B.D., Martin, J.S., 2001. Understanding the Nature of the Risks and the Source of the Rewards to Momentum Investing. The Review of Financial Studies 14, 29-78.

Halliwell, J., Heaney, R., Sawicki, J., 1999. Size and book-to-market effects in Australian share markets: A time series analysis. Accounting Research Journal 12, 122-137.

Hong, H., Stein, J.C., 1999. A Unified Theory of Underreaction, Momentum Trading and Overreaction In Assets Markets. The Journal of Finance 54, 2143-2184.

Hong, H., Lim, T., Stein, J.C., 2000. Bad News Travels Slowly: Size, Analyst Coverage, and the Profitability of Momentum Strategies. The Journal of Finance 55, 265-295.

Hurn, S., Pavlov, V., 2003. Momentum in Australian Stock Returns. Australian Journal of Management 28, 141-155.

Jegadeesh, N., Titman, S., 1993. Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. The Journal of Finance 48, 65-91.

Jegadeesh, N., Titman, S., 2001. Profitability of Momentum Strategies: An Evaluation of Alternative Explanations. The Journal of Finance 56, 699-720.

Jegadeesh, N. Titman, S., 2002. Cross-Sectional and Time-Series Determinants of Momentum Returns. The Review of Financial Studies 15, 143-157.

Liu, L.X.L., Warner, J.B., Zhang, L., 2006. Momentum Profits, Factor Pricing, and Macroeconomic Risk. [online] available from http://ssrn.com/abstract=936747.

Rachev, S., Jašić, T., Stoyanov, S., Fabozzi, F.J., 2007. Momentum Strategies Based on Reward-Risk Stock Selection Criteria. Journal of Banking and Finance 3, 2325-2346.

Rouwenhorst, K.G., 1998. International Momentum Strategies. The Journal of Finance 53, 267-284.

Rouwenhorst, K.G., 1999. Local Return Factors and Turnover in Emerging Stock Markets. The Journal of Finance 54, 1439-1464.

Swinkels, L., 2004. Momentum investing: A survey. Journal of Asset Management 5, 120-143.

Van der Hart, J., De Zwart, G., Van Dijk, D., 2005. The success of stock selection strategies in emerging markets: Is it risk or behavioral bias? Emerging Markets Review 6, 238-262.

Table 1

Payoffs of relative strength strategies (S&P/ASX 200 firms)

Portfolio	J-Months	K-Months			
		3	6	9	12
Winners	3	0.0146	0.0154	0.0130	0.0144
		(3.80)*	(3.56)*	(2.98)*	(3.50)*
Losers	3	-0.0066	-0.0099	-0.0065	-0.0072
		(-0.782)	(-1.18)	(-0.794)	(-0.939)
WML	3	0.0212	0.0253	0.0195	0.0216
		(3.07)*	(3.76)*	(3.27)*	(3.88)*
Winners	6	0.0188	0.0171	0.0155	0.0130
		(4.83)*	(4.42)*	(4.14)*	(3.68)*
Losers	6	-0.0079	-0.0081	-0.0047	-0.0058
		(-0.90)	(-0.97)	(-0.571)	(-0.73)
WML	6	0.0267	0.0252	0.0202	0.0188
		(3.53)*	(3.60)*	(3.08)*	(2.81)*
Winners	9	0.0208	0.0214	0.0167	0.0165
		(5.24)*	(5.77)*	(4.17)*	(4.75)*
Losers	9	-0.0062	-0.0056	-0.0013	-0.0030
		(-0.73)	(-0.72)	(-0.178)	(-0.39)
WML	9	0.0269	0.0270	0.0180	0.0195
		(3.44)*	(3.62)*	(2.77)*	(3.04)*
Winners	12	0.0193	0.0168	0.0186	0.0148
		(4.95)*	(4.38)*	(4.79)*	(3.72)*
Losers	12	-0.0013	0.0010	0.0018	0.0027
		(-0.17)	(0.13)	(0.24)	(0.37)
WML	12	0.0206	0.0158	0.0168	0.0121
		(3.21)*	(2.51)**	(2.76)*	(2.04)**

This table reports the average monthly raw returns for the S&P/ASX 200 firms from the *JXK* strategies where *J* stands for the number of months included in the ranking period and *K* denotes the length of the holding period. Portfolios are rebalanced every *K* period. Based upon total past returns during *J* months, securities are ranked into 5 equally weighted portfolios (in descending order) with the top one called winners (*W*) and the bottom one losers (*L*). The table also shows the average returns for WML (winners minus losers) in addition to the top and bottom portfolios. T-statistics are presented in parentheses, with one or two asterisks indicating significance at the 1% and 5% level respectively.

Table 2

Payoffs of the 6X6 and 9X6 strategies (S&P/ASX 200 firms)

Portfolio	Strategy 6X6		Strategy 9X6	
	Average monthly returns	t-statistics	Average monthly returns	t-statistics
P1 (Past winners)	0.0171	4.42*	0.0214	5.77*
P2	0.0128	3.85*	0.0143	4.25*
P3	0.0124	4.67*	0.0163	5.73*
P4	0.0112	2.67*	0.0139	3.57*
P5 (Past losers)	-0.0081	-0.97	-0.0056	-0.72
WML	0.0252	3.60*	0.0270	3.62*

This table reports the average monthly returns for the portfolios covering the S&P/ASX 200 sample of stocks, that is for all five equally-weighted portfolios from P1 (winners) to P5 (losers). The table documents returns and associated t-statistics for the 6X6 and 9X6 strategies. Analogous findings are also presented for the WML (winners minus losers) portfolio. T-statistics presented with an asterisk indicate significance at the 1% level.

Table 3

Stability of momentum performance (S&P/ASX 200 firms)

Sample period	Panel A: Strategy 6X6				Contribution of Winners vs. Losers to momentum profits		
	Winners	Losers	WML	t-stat for WML	EWI	Outperformance of winners relative to the EWI	Underperformance of losers relative to the EWI
All	0.0171	-0.0081	0.0252	3.60*	0.0076	0.94%	1.57%
27 months	0.0040	-0.0484	0.0524	3.16*	-0.0011	1.49%	3.75%
49 months	0.0243	0.0142	0.0102	2.12**	0.0201	0.42%	0.60%
2001	0.0134	-0.0607	0.0742	2.22**	-0.0092	2.26%	5.15%
2002	-0.0034	-0.0471	0.0437	3.69*	-0.0129	0.96%	3.41%
2003	0.0251	0.0267	-0.0019	-0.11	0.0178	0.74%	-0.89%
2004	0.0232	0.0095	0.0137	1.82***	0.0204	0.28%	1.08%
2005	0.0164	0.0103	0.0060	0.57	0.0145	0.20%	0.41%
2006	0.0278	0.0072	0.0205	2.12**	0.0191	0.86%	1.19%
	Panel B: Strategy 9X6				Contribution of Winners vs. Losers to momentum profits		
	Winners	Losers	WML	t-stat for WML	EWI	Outperformance of winners relative to the EWI	Underperformance of losers relative to the EWI
All	0.0214	-0.0056	0.0270	3.62*	0.0076	0.94%	1.57%
27 months	0.0133	-0.0406	0.0539	2.82*	-0.0011	1.44%	3.95%
49 months	0.0254	0.0116	0.0138	2.60**	0.0201	0.53%	0.85%
2001	0.0144	-0.0366	0.0510	1.14	-0.0002	1.46%	3.64%
2002	0.0138	-0.0495	0.0633	3.43*	-0.0130	2.68%	3.65%
2003	0.0254	0.0181	0.0072	0.46	0.0178	0.76%	-0.04%
2004	0.0262	0.0133	0.0128	1.91***	0.0204	0.59%	0.70%
2005	0.0190	0.0067	0.0123	1.15	0.0145	0.45%	0.77%
2006	0.0269	0.0045	0.0223	1.94***	0.0191	0.78%	1.46%

This table reports the average monthly returns for momentum portfolios based on the S&P/ASX 200 firms with respect to different sample periods, and t-statistics are presented in column 5. The first sample period denoted with "All" stands for the full sample period for the S&P/ASX 200 firms i.e. 2000 to 2007. Furthermore, the table shows returns for Jan 2001- March 2003 (27 months) and April 2003-April 2007 (49 months) separately, followed by a presentation of monthly returns generated during each year (2001 to 2006). Year 2007 is excluded since it has not been completed. The table also reveals returns for the equally weighted index (EWI) created by using the S&P/ASX 200 firms and shows the percentages that help to identify which portfolio (winners or losers) contributes more to momentum profits. Panel A presents results for the 6X6 strategy, while Panel B for the 9X6 strategy. T-statistics presented with an asterisk indicate significance at the 1% level, while two and three asterisks denote significance at the 5 and 10% level respectively.

Table 4

Seasonality and momentum performance (S&P/ASX 200 firms)

Panel A: Strategy 6X6

Period covered	Winners	Losers	WML	t-stat for WML	Percent positive for WML
January	0.0339	0.0071	0.0268	1.28	83%
July	0.0182	-0.0191	0.0372	0.817	50%
Other months (without Jan and July)	0.0151	-0.0087	0.0238	3.36*	68%
All	0.0171	-0.0081	0.0252	3.60*	68%

Panel B: Strategy 9X6

Period covered	Winners	Losers	WML	t-stat for WML	Percent positive for WML
January	0.0313	0.0116	0.0197	1.29	83%
July	0.0186	-0.0219	0.0405	0.79	50%
Other months (without Jan and July)	0.0207	-0.0057	0.0264	3.52*	75%
All	0.0214	-0.0056	0.0270	3.62*	74%

The table reports average monthly returns obtained for the S&P/ASX 200 firms from equally weighted portfolios of extreme winners and losers, as well as from the zero cost portfolio of WML (winners minus losers) with respect to various months. Documented returns are presented for January and July separately. Furthermore, the table shows returns for other months together excluding January and July. T-statistics presented with an asterisk indicate significance at the 1% level. Finally, the table also reports returns from the entire sample period for the S&P/ASX 200 firms, i.e. 2000-2007. Panel A presents results for the 6X6 strategy, while Panel B for the 9X6 strategy.

Table 5

CAPM adjusted returns for zero cost momentum portfolios (S&P/ASX 200 firms)

K-Month	Panel A: WML Price momentum based on past 3- Month Returns				
	α	$t(\alpha)$	β_M	$t(\beta_M)$	R^2
3	0.0188	2.75*	-0.549	-2.02**	0.05
6	0.0224	3.33*	-0.418	-1.57	0.03
9	0.0169	2.89*	-0.519	-2.23**	0.06
12	0.0188	3.40*	-0.437	-1.99**	0.05
	Panel B: WML Price momentum based on past 6-Month Returns				
	α	$t(\alpha)$	β_M	$t(\beta_M)$	R^2
3	0.0244	3.23*	-0.514	-1.73***	0.03
6	0.0230	3.30*	-0.524	-1.92***	0.05
9	0.0179	2.76*	-0.520	-2.04*	0.05
12	0.0168	2.54**	-0.580	-2.23*	0.06
	Panel C: WML Price momentum based on past 9-Month Returns				
	α	$t(\alpha)$	β_M	$t(\beta_M)$	R^2
3	0.0259	3.35*	-0.766	-2.53**	0.08
6	0.0256	3.44*	-0.650	-2.23**	0.07
9	0.0149	2.27**	-0.317	-1.24	0.02
12	0.0170	2.66*	-0.464	-1.85***	0.05
	Panel D: WML Price momentum based on past 12-Month Returns				
	α	$t(\alpha)$	β_M	$t(\beta_M)$	R^2
3	0.0189	3.05*	-0.655	-2.75*	0.10
6	0.0139	2.28**	-0.616	-2.62*	0.09
9	0.0148	2.48**	-0.571	-2.51**	0.08
12	0.0093	1.59	-0.395	-1.75***	0.04

This table reports the risk-adjusted returns for the S&P/ASX 200 firms and for all 16 zero cost momentum portfolios (measured by the alpha coefficients) and portfolios' sensitivities to the market risk (represented by the beta coefficients). Panel A documents the results for WML (winners minus losers) portfolios created based upon 3-month past returns. Panels B, C and D report analogous returns for 6, 9 and 12 ranking periods, respectively. *K* stands for the number of months included in the holding period. The coefficient estimates and associated t-statistics are obtained from the following regression: $R_{p,t} - R_{f,t} = \alpha + \beta_M (R_{M,t} - R_{f,t}) + \varepsilon_t$. R^2s presented in the last column shows the results from goodness of fit and correlation tests of the investigated model. T-statistics presented with one (two) asterisk indicate significance at the 1% and 5% level respectively.

Table 6

CAPM adjusted returns for the 6X6 and 9X6 strategies (S&P/ASX 200 firms)

	Panel A: Strategy 6X6			
	α	$t(\alpha)$	β_M	$t(\beta_M)$
P1 Winners	0.0095	3.05*	0.816	6.70*
P2	0.0055	2.11**	0.712	7.00*
P3	0.0060	2.71*	0.529	6.13*
P4	0.0034	0.99	0.868	6.48*
P5 Losers	-0.0178	-2.35**	1.337	4.50*
WML	0.0230	3.30*	-0.524	-1.92***
	Panel B: Strategy 9X6			
	α	$t(\alpha)$	β_M	$t(\beta_M)$
P1 Winners	0.0146	4.51*	0.632	4.99*
P2	0.0073	2.55**	0.641	5.71*
P3	0.0099	3.86*	0.450	4.45*
P4	0.0065	1.95***	0.725	5.55*
P5 Losers	-0.0153	-2.03**	1.278	4.33*
WML	0.0256	3.44*	-0.650	-2.23**

The table documents risk-adjusted returns (alphas) and market risk-factor loadings (betas) for the S&P/ASX 200 firms portfolios of: winners (P1), portfolios of stocks with the second best past returns (P2) and so on up to portfolios of losers (P5). Results for WML (winners minus losers) portfolios are also reported. The coefficient estimates and related t-statistics are obtained from the single-factor regression: $R_{p,t} - R_{f,t} = \alpha + \beta_M (R_{M,t} - R_{f,t}) + \varepsilon_t$. T-statistics presented with an asterisk indicate significance at the 1% level, while two and three asterisks denote significance at the 5% and 10% level respectively.

Table 7

Downside/upside market risk of winners and losers (6X6, 9X6 for S&P/ASX 200 firms)

Strategy	Portfolio	α^-	$t(\alpha^-)$	β_M^-	$t(\beta^-)$	α^+	$t(\alpha^+)$	β_M^+	$t(\beta^+)$
6X6	Winners	0.0181	2.37**	1.103	4.20*	0.0088	1.29	0.779	2.63*
	Losers	-0.0098	-0.52	1.719	2.67*	-0.0080	-0.46	0.815	1.13
9X6	Winners	0.0221	2.82*	0.861	3.21*	0.0122	1.67***	0.679	2.13**
	Losers	0.0023	0.125	1.967	3.17*	-0.0060	-0.33	0.695	0.94

This table reports coefficient estimates and t-statistics for the S&P/ASX 200 firms from the regression:

$$R_{p,t} - R_{f,t} = \alpha^- I_{\{R_{M,t} - R_{f,t} < 0\}} + \beta^-{}_M (R_{M,t} - R_{f,t}) I_{\{R_{M,t} - R_{f,t} < 0\}} + \alpha^+ I_{\{R_{M,t} - R_{f,t} \geq 0\}} + \beta^+{}_M (R_{M,t} - R_{f,t}) I_{\{R_{M,t} - R_{f,t} \geq 0\}} + \varepsilon_t$$

where α^- and β^- represent risk-adjusted returns and the market risk coefficient related to downward market movements, respectively, while α^+ and $\beta_M{}^+$ stand for risk-adjusted returns and market risk associated with upside market trend, respectively. T-statistics presented with an asterisk indicate significance at the 1% level, while two and three asterisks denote significance at the 5% and 10% level respectively.

Table 8

Three-factor risk-adjusted returns and sensitivities (S&P/ASX 200 firms)

K-Month	Panel A : WML Price momentum based on past 3-Month Returns								
	α	$t(\alpha)$	β_M	$t(\beta_M)$	β_{SMB}	$t(\beta_{SMB})$	β_{HML}	$t(\beta_{HML})$	Adj. R^2
3	0.0004	0.09	0.240	1.30	-1.020	-9.10*	0.872	5.60*	0.63
6	0.0051	1.02	0.320	1.64	-0.939	-7.92*	0.834	5.06*	0.55
9	0.0021	0.52	0.135	0.83	-0.900	-9.16*	0.647	4.74*	0.61
12	0.0053	1.20	0.129	0.74	-0.697	-6.57*	0.674	4.58*	0.49
K-Month	Panel B: WML Price momentum based on past 6-Month Returns								
	α	$t(\alpha)$	β_M	$t(\beta)$	β_{SMB}	$t(\beta_{SMB})$	β_{HML}	$t(\beta_{HML})$	Adj. R^2
3	0.0068	1.31	0.291	1.43	-1.101	-8.91*	0.945	5.30*	0.61
6	0.0079	1.64	0.190	1.01	-1.057	-9.20*	0.727	4.38*	0.60
9	0.0046	1.02	0.128	0.72	-1.006	-9.26*	0.596	3.80*	0.60
12	0.0019	0.38	0.088	0.46	-0.879	-7.51*	0.834	4.93*	0.56
K-Month	Panel C : WML Price momentum based on past 9-Month Returns								
	α	$t(\alpha)$	β_M	$t(\beta)$	β_{SMB}	$t(\beta_{SMB})$	β_{HML}	$t(\beta_{HML})$	Adj. R^2
3	0.0127	2.11**	-0.075	-0.32	-1.093	-7.47*	0.795	3.51*	0.52
6	0.0150	2.51**	-0.040	-0.17	-1.077	-7.51*	0.548	2.47**	0.49
9	0.0045	0.91	0.260	1.34	-0.991	-8.27*	0.558	3.02*	0.51
12	0.0074	1.54	0.085	0.45	-0.979	-8.40*	0.476	2.64*	0.53
K-Month	Panel D: WML Price momentum based on past 12-Month Returns								
	α	$t(\alpha)$	β_M	$t(\beta)$	β_{SMB}	$t(\beta_{SMB})$	β_{HML}	$t(\beta_{HML})$	Adj. R^2
3	0.0122	2.58*	-0.097	-0.513	-1.02	-8.41*	0.306	1.58	0.55
6	0.0079	1.60	-0.102	-0.517	-0.96	-7.62*	0.261	1.31	0.50
9	0.0096	2.10**	-0.087	-0.472	-0.98	-8.36*	0.153	0.83	0.54
12	0.0059	1.24	0.003	0.015	-0.91	-7.42*	-0.008	-0.04	0.46

This table shows the results for the S&P/ASX 200 firms from regressing the monthly returns of WML (winners minus losers) portfolios in excess of the risk free rate on the returns of the S&P/ASX 200 Index in excess of the risk free rate, the excess return of the portfolio of small stocks over the portfolio of large stocks, SMB, and the excess return of the portfolio with high book-to-market stocks over a portfolio of stocks with low book-to-market values, HML. The coefficient estimates and related t-statistics are obtained from the 3-factor regression:

$$R_{p,t} - R_{f,t} = \alpha + \beta_M (R_{M,t} - R_{f,t}) + \beta_{SMB} R_{SMB,t} + \beta_{HML} R_{HML,t} + \varepsilon_t$$

SMB is constructed in the following way: each year all S&P/ASX 200 sample stocks are ranked according to the end of previous year market capitalisation, and the top and bottom 30% of stocks are then used to construct two separate equally-weighted portfolios of big and small size stocks, respectively. The factor is created as the difference of these two portfolios (small minus big). Similarly, HML is created as follows: each year all S&P/ASX 200 sample stocks are sorted according to the end of previous year book-to-market ratio, and the top and bottom 30% of stocks are then chosen to construct two equally-weighted portfolios of high and low book-to-market value stocks. The factor is created as the difference of these two portfolios (high minus low). The table also reveals the results of the adjusted R^2 test. T-statistics presented with an asterisk indicate significance at the 1% level, while two and three asterisks denote significance at the 5% and 10% level respectively.

Table 9

Three-factor risk-adjusted returns and sensitivities (6X6, 9X6 for S&P/ASX 200 firms)

	α	$t(\alpha)$	β_M	$t(\beta_M)$	β_{SMB}	$t(\beta_{SMB})$	β_{HML}	$t(\beta_{HML})$
Panel A: Strategy 6X6								
P1 Winners	0.0119	3.46*	0.698	5.46*	0.187	2.40**	-0.103	-0.92
P2	0.0069	2.52**	0.633	5.94*	0.195	3.00*	0.003	0.03
P3	0.0084	3.70*	0.427	4.78*	0.106	1.96**	-0.166	-2.11**
P4	0.0086	2.67*	0.633	4.98*	0.307	3.97*	-0.296	-2.66*
P5 Losers	-0.0004	-0.10	0.506	2.82*	1.246	11.4*	-0.823	-5.22*
WML	0.0080	1.64	0.190	1.01	-1.057	-9.20*	0.727	4.38*
Panel B: Strategy 9X6								
	α	$t(\alpha)$	β_M	$t(\beta_M)$	β_{SMB}	$t(\beta_{SMB})$	β_{HML}	$t(\beta_{HML})$
P1 Winners	0.0160	4.58*	0.559	4.07*	0.108	1.27	-0.092	-0.70
P2	0.0081	2.65*	0.579	4.81*	0.142	1.92***	-0.001	-0.08
P3	0.0098	3.56*	0.423	3.91*	0.122	1.83***	0.080	0.77
P4	0.0081	2.35**	0.610	4.54*	0.261	3.15*	-0.022	-0.17
P5 Losers	-0.0032	-0.58	0.598	2.79*	1.185	8.96*	-0.632	-3.09*
WML	0.0149	2.51**	-0.0401	-0.17	-1.077	-7.51*	0.548	2.47*

The table documents for the S&P/ASX 200 firms risk-adjusted returns (alphas) and market risk-factor loadings (betas) for portfolios of winners (P1), portfolios of stocks with the second best past returns (P2) and so on up to portfolios of losers (P5). Results for WML (winners minus losers) portfolios are also reported. The coefficient estimates and related t-statistics are obtained from the 3-factor regression: $R_{p,t} - R_{f,t} = \alpha + \beta_M (R_{m,t} - R_{f,t}) + \beta_{SMB} R_{SMB,t} + \beta_{HML} R_{HML,t} + \varepsilon_t$. The SMB and HML factors are constructed as in Table 8. T-statistics presented with an asterisk indicate significance at the 1% level, while two and three asterisks denote significance at the 5% and 10% level respectively.

Table 10

Number of firms per year (All Australian Firms, 2000-2009)

Year	Available firms
2000	1026
2001	1182
2002	1252
2003	1288
2004	1342
2005	1470
2006	1579
2007	1684
2008	1835
2009 start (end)	1756(1710)
Total	2214

The table reports the number of firms that available for inclusion in the momentum portfolios.

Table 11

Payoffs of relative strength strategies, (All Australian Firms, 2000-2009)

Portfolio	J-Months	K-Months			
		3	6	9	12
Winners	3	-0.0038	-0.0049	-0.0045	-0.0058
		(-0.59)	(-0.79)	(-0.66)	(-0.93)
Losers	3	-0.0143	-0.0127	-0.0120	-0.0116
		(-1.92)***	(-1.71)***	(-1.74)***	(-1.62)
WML	3	0.0104	0.0078	0.0076	0.0058
		(2.52)**	(2.29)**	(2.31)**	(1.75)***
Winners	6	-0.0036	-0.0049	-0.0027	-0.0038
		(-0.55)	(-0.77)	(-0.43)	(-0.57)
Losers	6	-0.0140	-0.0137	-0.0177	-0.0162
		(-1.79)***	(-1.86)***	(-2.40)**	(-2.24)**
WML	6	0.0105	0.0088	0.0150	0.0124
		(2.39)**	(2.197)**	(4.58)*	(3.85)*
Winners	9	-0.0016	-0.0013	-0.0032	-0.0026
		(-0.25)	(-0.23)	(-0.54)	(-0.41)
Losers	9	-0.0137	-0.0136	-0.0121	-0.0120
		(-1.70)***	(-1.71)***	(-1.54)	(-1.64)
WML	9	0.0121	0.0122	0.0089	0.0094
		(2.72)*	(3.06)*	(2.09)**	(2.64)*
Winners	12	-0.0016	-0.0043	-0.0050	-0.0073
		(-0.25)	(-0.65)	(-0.73)	(-1.03)
Losers	12	-0.0133	-0.0158	-0.0186	-0.0192
		(-1.623)	(-1.95)***	(-2.35)**	(-2.52)**
WML	12	0.0117	0.0115	0.0137	0.0120
		(2.45)**	(2.43)**	(3.51)*	(2.92)*

This table reports the average monthly raw returns for all Australian firms for the Period 2000 to end of 2009, from the *J/K* strategies between January 2000 and December 31st 2009, where *J* stands for the number of months included in the ranking period and *K* denotes the length of the holding period. Portfolios are formed by skipping a month between the ranking and holding period and are rebalanced every *K* period. Based upon the total past return during *J* months, the sample is ranked in descending order and divided into 5 equally weighted portfolios with the top one called winners and the bottom one losers. The table also shows the average returns for WML (winners minus losers) in addition to the top and bottom portfolios. T-statistics are presented in parentheses, with an asterisk indicating significance at the 1% level, while two and three asterisks denote significance at the 5% and 10% level respectively.

Table 12

Payoffs of relative strength strategies (All Australian Firms, 2000-2007)

Portfolio	J-Months	K-Months			
		3	6	9	12
Winners	3	0.0035	0.0020	0.0034	-0.0058
		(0.59)	(0.34)	(0.59)	(-0.93)
Losers	3	-0.0121	-0.0071	-0.0071	-0.0116
		(-1.55)	(-1.10)	(-1.07)	(-1.62)
WML	3	0.0156	0.0091	0.0105	0.0058
		(3.32)*	(2.50)**	(2.69)*	(1.76)***
Winners	6	0.00762	0.0064	0.0080	0.0064
		(1.54)	(1.30)	(1.66)	(1.37)
Losers	6	-0.0103	-0.0099	-0.0100	-0.0075
		(-1.39)	(-1.40)	(-1.47)	(-1.08)
WML	6	0.0179	0.0162	0.0180	0.0139
		(4.19)*	(4.46)*	(5.28)*	(4.01)*
Winners	9	0.0094	0.0083	0.0081	0.0081
		(1.97)**	(1.68)***	(1.72)***	(1.72)***
Losers	9	-0.0091	-0.0085	-0.0069	-0.0063
		(-1.23)	(-1.18)	(-0.97)	(-0.92)
WML	9	0.0185	0.0168	0.0150	0.0145
		(4.25)*	(4.15)*	(4.09)*	(4.04)*
Winners	12	0.0104	0.0098	0.0082	0.0080
		(2.18)**	(2.08)**	(1.76)***	(1.70)***
Losers	12	-0.0085	-0.0079	-0.0075	-0.0065
		(-1.12)	(-1.04)	(-0.98)	(-0.86)
WML	12	0.0190	0.0177	0.0157	0.0144
		(4.14)*	(4.13)*	(3.72)*	(3.44)*

This table reports the average monthly raw returns for all Australian firms for the Period 2000 to April 2007, from the *J/K* strategies between January 2000 and April 2007, where *J* stands for the number of months included in the ranking period and *K* denotes the length of the holding period. Portfolios are formed by skipping a month between the ranking and holding period and are rebalanced every *K* period. Based upon the total past return during *J* months, the sample is ranked in descending order and divided into 5 equally weighted portfolios with the top one called winners and the bottom one losers. The table also shows the average returns for WML (winners minus losers) in addition to the top and bottom portfolios. T-statistics are presented in parentheses, with an asterisk indicating significance at the 1% level, while two and three asterisks denote significance at the 5% and 10% level respectively.

Table 13

Seasonality and momentum performance (All Australian Firms, 2000-2009)

Panel A: Strategy 6X6

	Specific *k* month performance				Performance of all other *k* months			
Month	Winners	Losers	WML	% of WML > 0	Winners	Losers	WML	% of WML > 0
January	-0.0014	-0.0012	-0.0002	55	-0.0052	-0.0148***	0.0096**	71
February	-0.0069	-0.0479*	0.0410*	89	-0.0047	-0.0107	0.0060	65
March	-0.0163	-0.0328	0.0165	67	-0.0039	-0.0120	0.0081***	67
April	-0.0048	0.0102	-0.0150	78	-0.0049	-0.0157**	0.0109*	66
May	0.0017	-0.0096	0.0113	89	-0.0054	-0.0140***	0.0086**	65
June	-0.0279**	-0.0671*	0.0392*	100	-0.0029	-0.0091	0.0062	64
July	0.0153	0.0408***	-0.0256**	11	-0.0066	-0.0184**	0.0118***	72
August	0.0006	0.0000	0.0006	60	-0.0054	-0.0150**	0.0096**	68
September	-0.0065	-0.0287	0.0222**	80	-0.0047	-0.0122	0.0075***	66
October	-0.0163	-0.0120	-0.0043	40	-0.0038	-0.0138***	0.0101**	70
November	-0.0035	-0.0009	-0.0026	50	-0.0050	-0.0149**	0.0099**	69
December	0.0070	-0.0161	0.0231*	90	-0.0060	-0.0134***	0.0074***	65
All	0.0064	-0.0099	0.0162*	68	--------	----------	-----------	----
Excluding January and July					-0.0092	-0.0217*	0.0125*	73
Excluding 6 months: January and all 5 significant months					-0.0115	-0.0131	0.0016	38

Panel B: Strategy 9X6

Specific month					All other months			
Month	Winners	Losers	WML	% of WML > 0	Winners	Losers	WML	% of WML > 0
January	-0.0017	0.0004	-0.0022	44	-0.0013	-0.0148***	0.0135*	68
February	-0.0023	-0.0475*	0.0452*	100	-0.0013	-0.0105	0.0092**	64
March	-0.0102	-0.0340	0.0238*	78	-0.0005	-0.0117	0.0112*	66
April	0.0044	0.0085	-0.0042	56	-0.0019	-0.0156***	0.0137*	68
May	0.0041	-0.0085	0.0126	78	-0.0018	-0.0140***	0.0122*	66
June	-0.0240**	-0.0755*	0.0515*	100	0.0007	-0.0079	0.0086**	65
July	0.0121	0.0456***	-0.0335*	11	-0.0026	-0.0189**	0.0164*	72
August	0.0064	-0.0061	0.0126	56	-0.0021	-0.0142***	0.01218*	68
September	-0.0048	-0.0155	0.0108	67	-0.0010	-0.0134***	0.0123*	67
October	-0.0121	-0.0083	-0.0039	56	-0.0004	-0.0140***	0.01368*	68
November	0.0002	-0.0043	0.0044	56	-0.0015	-0.0144***	0.0129*	68
December	0.0119	-0.0176	0.0295*	100	-0.0026	-0.0133	0.0106**	64
All	0.0083***	-0.0085	0.0168*	67	---------	---------	---------	----
Excluding January and July					-0.0027	-0.0209*	0.0182*	74
Excluding 6 months: January and all 5 significant months					-0.0011	-0.0070	0.0059	34

This table reports average monthly returns for all Australian firms for the Period 2000 to December 2009, obtained from equally weighted portfolios of extreme winners and losers, as well as from the zero cost portfolio of WML (winners minus losers) with respect to various months. Documented returns are presented for each month separately from January to December in the first 5 columns of each panel. Furthermore, in columns 6 to 9 of each panel, the table presents returns for all other months excluding the month in column one. For example, in the first row columns 1 to 5 present returns for winners, losers and the hedge portfolio, as well as the percentage of times that the hedge portfolio's returns are positive for the month of January. Columns 6 to 9 of row 1 of each panel present the same information but for February to December. T-statistics are not reported due to space restrictions but an asterisk next to an average return figure indicates significance at the 1% level, while two or three asterisks denote significance at the 5% and 10% level respectively. Finally, the table reports: the entire sample returns; the entire sample returns excluding both January and July; and the entire sample returns excluding January and all significant months; in the bottom 3 rows of each panel respectively. Panel A presents results for the 6X6 strategy, while Panel B for the 9X6 strategy.

Table 14

Three-factor risk-adjusted returns and (All Australian Firms, 2000-2009)

K-Month	Panel A : WML Price momentum based on past 3-Month Returns								
	α	$t(\alpha)$	β_M	$t(\beta_M)$	β_{SMB}	$t(\beta_{SMB})$	β_{HML}	$t(\beta_{HML})$	Adj. R^2
3	0.0090	1.41	-0.199	-1.84***	-0.263	-3.20*	-0.165	-0.92	0.09
6	0.0047	0.89	-0.259	-2.92*	-0.184	-2.72*	-0.076	-0.52	0.10
9	0.0013	0.27	-0.005	-0.06	-0.179	2.66*	0.013	0.09	0.03
12	0.0023	0.45	-0.165	-1.85***	-0.135	-2.00**	-0.059	-0.41	0.03
K-Month	**Panel B: WML Price momentum based on past 6-Month Returns**								
	α	$t(\alpha)$	β_M	$t(\beta_M)$	β_{SMB}	$t(\beta_{SMB})$	β_{HML}	$t(\beta_{HML})$	Adj. R^2
3	0,0107	1,73***	-0,205	-1,99**	-0,481	-5,73*	-0,260	-1,50	0,24
6	0,0073	1,277	-0,166	-1,71***	-0,421	-5,31*	-0,192	-1,19	0,22
9	0,0091	2,09**	-0,049	-0,65	-0,456	-7,63*	-0,077	-0,62	0,36
12	-0,0013	-0,29	0,085	1,13	-0,408	-6,78*	0,215	1,71***	0,31
K-Month	**Panel C : WML Price momentum based on past 9-Month Returns**								
	α	$t(\alpha)$	β_M	$t(\beta_M)$	β_{SMB}	$t(\beta_{SMB})$	β_{HML}	$t(\beta_{HML})$	Adj. R^2
3	0.0130	2.26**	-0.259	-2.70*	-0.577	-7.29*	-0.278	-1.71***	0.35
6	0.0108	2.175**	-0.258	-3.15*	-0.550	-8.13*	-0.188	-1.35	0.40
9	0.0089	1.69***	-0.281	-3.23*	-0.599	-8.35*	-0.245	-1.66**	0.42
12	0.0067	1.41	-0.082	-1.05	-0.471	-7.31*	-0.140	-1.06	0.33
K-Month	**Panel D: WML Price momentum based on past 12-Month Returns**								
	α	$t(\alpha)$	β_M	$t(\beta_M)$	β_{SMB}	$t(\beta_{SMB})$	β_{HML}	$t(\beta_{HML})$	Adj. R^2
3	0.0131	2.08**	-0.2585	-2.50**	-0.5942	-6.99*	-0.2877	-1.65*	0.34
6	0.0120	1.89***	-0.2372	-2.21**	-0.5781	-6.62*	-0.3061	-1.69*	0.31
9	0.0044	0.87	-0.0422	-0.48	-0.5239	-7.34*	0.0316	0.21	0.34
12	0.0010	0.17	0.1039	1.00	-0.4741	-5.92*	0.1075	0.63	0.27

This table shows the results for all Australian firms for the Period 2000 to December 2009, from regressing the monthly returns of WML (winners minus losers) portfolios in excess of the risk free rate on the returns of the All Ordinaries Index in excess of the risk free rate, the excess return of the portfolio of small stocks over the portfolio of large stocks, SMB, and the excess return of the portfolio with high book-to-market stocks over a portfolio of stocks with low book-to-market values, HML. The coefficient estimates and related t-statistics are obtained from the 3-factor regression:

$$R_{p,t} - R_{f,t} = \alpha + \beta_M (R_{M,t} - R_{f,t}) + \beta_{SMB} R_{SMB,t} + \beta_{HML} R_{HML,t} + \varepsilon_t$$

The S&P/ASX 200 Index proxies for the market portfolio. SMB is constructed in the following way: each year all Australian firms are ranked according to the end of previous year market capitalisation, and the top and bottom 30% of stocks are then used to construct two separate equally-weighted portfolios of big and small size stocks, respectively. The factor is created as the difference of these two portfolios (small minus big). Similarly, HML is created as follows: each year all Australian firms are sorted according to the end of previous year book-to-market ratio, and the top and bottom 30% of stocks are then chosen to construct two equally-weighted portfolios of high and low book-to-market value stocks. The factor is created as the difference of these two portfolios (high minus low). The table also reveals the results of the adjusted R^2 test. T-statistics presented with an asterisk indicate significance at the 1% level.