Available online at www.sciencedirect.com
ScienceDirect
Pacific-Basin Finance Journal 15 (2007) 315–328
PACIFIC-BASIN FINANCE JOURNAL
www.elsevier.com/locate/pacfin

SMB — Arousal, disproportionate reactions and the size-premium ☆

Robert B. Durand *, Alex Juricev, Gary W. Smith

Accounting and Finance, M250, University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009, Australia

Received 25 October 2004; accepted 26 September 2006
Available online 16 January 2007

Abstract

This paper examines SMB (small minus big), the mimicking portfolio in Fama and French's [Fama, E., French, K., 1993. Common risk factors in the returns on stocks and bonds, Journal of Financial Economics 33, 3–56] three-factor asset pricing model. We do not examine whether SMB is a factor in explaining the cross-section of returns. This paper's focus is why *S* is greater than *B*. After controlling for market-pervasive effects, we argue that the small-firm premium is driven by both investors' emotional arousal (proxied by the turnover ratio) and their disproportionate reactions to arousing stimuli.

JEL classification: G12
Keywords: Size-premium; Arousal; Overreaction; Underreaction

1. Introduction

This paper examines SMB (small minus big), the mimicking portfolio in Fama and French's (1993) three-factor asset pricing model, which aims to capture the returns associated with firm size. Gaunt et al. (2000) and Durack et al. (2004) have found a pronounced small-firm premium in

☆ We thank Jennifer Cross for her excellent programming assistance and Rick Newby for helpful comments. Our thanks to seminar audiences at the 2004 Accounting and Finance Association of Australia and New Zealand Conference, the 2004 Australasian Finance and Banking Conference, the University of Glasgow, Murdoch University, and an anonymous referee for helpful comments. The authors also gratefully acknowledge support provided by the UWA School of Economics and Commerce Research Grant Scheme.
* Corresponding author. Tel.: +61 8 6488 3764; fax: +61 8 6488 1047.
E-mail address: Robert.Durand@uwa.edu.au (R.B. Durand).
URL: http://www.ecom.uwa.edu.au/staff/durand_robert (R.B. Durand).

0927-538X/$ - see front matter
doi:10.1016/j.pacfin.2006.09.004

Australia.[1] In this paper, we use the small firm return (*S*) and big firm return (*B*) data from Durack et al. (2004) to analyze why *S* is different from *B*. We focus on the determinants of the size premium.

The pronounced small firm effect in Australia provides an excellent opportunity to obtain a clear picture of the determinants of the size premium.[2] Our analysis highlights the importance of behavioral forces in determining risk premia. We provide further evidence of the importance of behavioral finance in understanding asset pricing and risk premia. We find clear evidence that the size-premium is driven by the emotional arousal of investors (proxied by the turnover ratio) and their disproportionate reactions to the arousing stimuli. Our analysis introduces emotional arousal into the finance literature. Emotional arousal is an important concept which, we argue, has considerable potential to explain financial phenomena.

There have been many explanations put forward as to why small firms earn higher returns than big firms, both in Australia and internationally. Investors may simply require higher returns from small firms as there is less information about them (Berk, 1995). This hypothesis, however, cannot explain the reverse situation where there are prolonged periods of negative small firm premiums, such as those documented by Dimson and Marsh (1999), when there appears to be no variation in the level of information available to investors. Other explanations, which are based on rational asset pricing theory, have similarly been unable to adequately explain why small firms earn different returns to those of big firms.[3]

Problems associated with these rational explanations led us to consider if behavioral finance can explain why *S* is different from *B*. To inform our analysis, we have considered the US literature on the topic. Kumar and Lee (2002) argued that the small firm effect may be due to fluctuating investor sentiment. Lee and Swaminathan (2000) have suggested that a market-based measure, the turnover ratio, may proxy for investor sentiment and, if this is the case, the turnover ratio may explain why small firms earn higher returns than big firms. Lee and Swaminathan's "sentiment story" is superficially compelling; it is not clear, however, if such an explanation can address Black's (1986) "mystery of noise trading". Black asks why there is so much trading and argues that:

> *"A person with information or insights about individual firms will want to trade, but will realize that only another person with information or insights will take the other side of the trade. Taking the other side's information into account, is it still worth trading? From the point of view of someone who knows what both the traders know, one side or the other must be making a mistake. If the one who is making a mistake declines to trade, there will be no trading on information" (p. 531)*

[1] Durack et al. (2004) also argue that small firm returns, captured by SMB, are a pervasive factor in explaining stock market returns. SMB is found to have a role in several Australian asset pricing studies (Halliwell et al., 1999; Faff, 2001; Gaunt, 2004).

[2] Furthermore, the Australian market is one where the small size of the economy, the large internal dispersion of consumers, and the geographical isolation from the rest of the world combine in many sectors to encourage high levels of concentration (Business Council of Australia, 2004). These factors result in a greater distinction between small and large firms as the top 100 listed companies account for approximately three quarters of the overall market capitalization.

[3] These theories include problems with risk estimation (Roll, 1981), return computation errors for small firms (Roll, 1983; Blume and Stambaugh, 1983), a delisting bias in returns (Shumway, 1997; Shumway and Warther, 1999), the tax-loss selling hypothesis (Keim, 1983; Brown et al., 1983; Reinganum and Shapiro, 1987), a liquidity premium for thinly-traded stocks (James and Edmister, 1983; Beedles et al., 1988), and if the small-firm effect is related to monetary policy (Jensen et al., 1997, 1998)

Lee and Swaminanthan's (2000) case must necessarily surmount this challenge and their argument does not address why "sentiment" should affect both sellers and buyers. For increasing (decreasing) prices over the time frames observed in our study, Lee and Swaminathan's argument requires stimuli which drives both the positive (negative) sentiment on the buy (sell) side and a commensurate negative (positive), or at least neutral, sentiment on the sell (buy) side to meet the buyers' (sellers') demand.[4] Emotional arousal, instead of sentiment, seems to be a more satisfying description. "Arousal is a central process, or behavioral state, that involves coordinated, sustained, state-specific alterations in activity in numerous brain regions, producing coherent patterns of behavioral…output…" (Foote, 2000, p. 237). Investors can be aroused by the same stimuli yet have different responses to it. In financial markets, "flight or fight" is replaced by the choice of buy, sell or hold.[5] An alternative descriptive characterization of high and low turnover ratio stocks would be to denote them as high and low arousal stocks, respectively. The turnover ratio would therefore be greatest in those stocks where a stimulus (or stimuli) is arousing investors who choose to buy or sell.

Kaufman (1999) links emotional arousal and bounded rationality. He argues that there is an increased propensity to rely on heuristic tools in decision making (a function of bounded rationality) associated with increased arousal. A link between heuristics and arousal is pertinent. Investors relying on heuristics may overreact. Overreaction, as well as underreaction, as we discuss below, has been associated with the presence of momentum in stock market returns.[6] Jegadeesh and Titman (2001) ascribed the momentum effect to overreaction. They found that the returns from winners tend to reverse in the post-holding period. Overreaction (and underreaction) is taken to be a reaction to stimuli, for example a positive return that is "corrected" by a negative return at some time following the initial reaction. Conversely, Hong et al. (2000) have argued that the momentum effect is driven by underreaction. Consideration of whether momentum is a function of overreaction or underreaction, or both, is beyond the scope of the current analysis. As both might be sources of momentum, we remain agnostic and denote both effects as disproportionate reactions. Disproportionate reactions, that is, either overreaction or underreaction, to arousing stimuli will be proxied by the winner and loser portfolios we utilize in our analysis.

The structure of the remainder of this paper is as follows. In Section 2, we begin by confirming that S is indeed greater than B. Following this we will address the question of why S is greater than B in Section 3 of this paper. We regress the returns of S and B (which have been orthogonalized to remove covariation due to movements in the market as a whole), using a range of candidate variables to examine the potential determinants of their returns. Section 4 concludes the paper.

2. Are *S* returns greater than *B* returns?

We use the small and big firm spanning portfolios from Durack et al. (2004), which were constructed using share prices from SIRCA's Core Research Database and the market capitalization

[4] In the short-term, positive (negative) sentiment on buy (sell) side trading may be supplied by existing liquidity (e.g., current limit orders). Over the longer-term horizons we examine, however, such an explanation will not, we believe, explain variations in trading volume.

[5] Such an interpretation is consistent with models linking trading volume to disagreement (Varian, 1989; Harris and Raviv, 1993; Kandel and Pearson, 1995; Odean, 1998). Disagreement is, in itself, arousing.

[6] The analysis of momentum as a priced variable is in its infancy in Australia. Demir et al. (2004) argue that a momentum effect is present in Australian returns but their analysis is not necessarily convincing because they do not consider if the "abnormal" returns would still exist when tested against in a Fama-French framework.

figures from the AGSM's Share Price Relative Database.[7] The portfolios are formed from all fully-paid Australian stocks listed on the ASX, excluding investment trusts, real estate trusts, banks and insurers. Small firms are defined as those ranked in the bottom 30% of market capitalization and big firms as those firms ranked in the top 30%.[8] The value-weighted portfolios are rebalanced monthly.

Table 1 provides the summary statistics for the *S* and *B* value-weighted price relatives (P_t/P_{t-1}), where *P* is adjusted for dividends and changes in capital structure. The summary statistics for medium firms, defined as the middle 40% of firms (MID), are also provided. *S* has a higher mean and median monthly price relative to both *B* and MID, with small firms outperforming big firms by an average of 4.12% per month and outperforming medium firms by an average of 3.60% per month. While the middle 40% of stocks are not the focus of our study, it is noteworthy that MID outperforms *B*. The Wilcoxon signed ranks test rejects the null hypothesis of equality of returns between the *S* and *B* portfolios. Therefore, in contrast to some of the recent international evidence in the UK (Dimson and Marsh, 1999) and in the US (Booth and Keim, 1998), which showed that big firms have higher returns than small firms, the results show that in Australia the size premium was present over our entire sample period (January 1990 to December 2001).

Furthermore, while *S* has a higher total risk, as measured by standard deviation, it still has a higher Sharpe (1966) ratio. This shows that *S* has a higher reward to total risk trade-off than *B*.[9] We also considered if there are positive alphas when the CAPM is used to model excess returns of *S* and *B*. We found that our inference about the returns of *S* being greater than *B* (made on the basis of average returns and the Sharpe ratio reported in Table 1) is supported by this analysis. The null hypothesis that the CAPM-alpha for *B* is equal to zero could be rejected but the alpha for *S* was found to be positive and statistically significant.[10]

Table 1 also suggests that the price relatives of *S* conform to a different distribution than those of *B*. In the value-weighted sample *S* is positively skewed whilst *B* is negatively skewed. However, the Jarque-Bera test indicates that it is only *S* which is not normally distributed. Table 1 also shows that *S* has significant positive autocorrelation in its first three lags.

In using *S* and *B* from Durack et al. (2004) in Table 1, our analysis focuses on value-weighted portfolios. It may be that value-weighting distorts the analysis — perhaps by amplifying the size-premium. We considered this possibility by recreating the analysis in Table 1 using equal-weighted metrics. The results of this analysis confirm the inferences we made on the basis of the value-weighted indices. We also found that the analysis reported in Table 1 was not driven by events peculiar to a time period by running the analysis for sub-periods.

Our study focuses on the top 30% and bottom 30% of stocks following Durack et al. (2004). The value-weighted analysis conducted in Table 1 is repeated with different portfolio bin sizes to examine the sensitivity of our results to the way we divide the market. Table 2 provides the summary statistics for the analysis based on deciles (in this Table, *S* is the bottom 10% of stocks

[7] SIRCA's Core Research Database allowed the creation of daily values of the spanning portfolios. The spanning portfolios used in Durack et al. (2004) and, consequently, the spanning portfolios analyzed in the present study, are derived from these daily return series.

[8] Inspection of the composition of the portfolios did not reveal clustering amongst particular industry groups.

[9] Shumway (1997) and Shumway and Warther (1999) argue that smaller sized firms delist more often than larger firms, and that when they delist the reason is most likely related to performance, which could introduce an upward bias into the calculation of the small firm portfolio returns. Our reported results in Table 1 only include stocks which have a full month of price data, i.e. there may be a delisting bias. We repeated the analysis using different assumptions on the treatment of delisted stocks and found that our results were robust to these differing assumptions. These analyses may be obtained from the corresponding author's web page.

[10] Interested readers may find details of this analysis, as well as all the robustness checks we discuss in this paper, on the corresponding author's website.

Table 1
Summary statistics for S, MID and B value-weighted spanning portfolios January 1990 to December 2001

Portfolio	Mean	Median	Standard Deviation	Skewness	Kurtosis	Jarque-Bera	*p*-value	Sharpe ratio	Wilcoxon	*p*-value
S	1.0501	1.0421	0.0884	0.5750	3.2331	8.2622	0.0161	0.5051	−5.1792	0.0000
MID	1.0141	1.0134	0.0540	−0.1515	3.9684	6.1778	0.0456	0.1607		
B	1.0089	1.0100	0.0405	−0.0852	2.8492	0.3107	0.8561	0.0839		
T-bill	1.0055	1.0047	0.0021	1.7489	5.3716	107.1551	0.0000			

Portfolio	Autocorrelation at lag								
	1			2			3		
	Coefficient	Ljung-Box	*p*-value	Coefficient	Ljung-Box	*p*-value	Coefficient	Ljung-Box	*p*-value
S	0.1969	5.6972	0.0170	0.1164	7.7039	0.0210	0.1006	9.2143	0.0270
MID	0.1731	4.4064	0.0360	0.0264	4.5096	0.1050	0.1695	8.7911	0.0320
B	−0.1294	2.4601	0.1170	0.0427	2.7298	0.2550	−0.0008	2.7299	0.4350

This table provides the summary statistics for the monthly value-weighted price relatives of small, big and middle Australian firms. At the start of each month all fully-paid Australian stocks listed on the ASX, excluding investment trusts, real estate trusts, banks and insurers are ranked in ascending order based on their market capitalization figure. Market capitalization is calculated by multiplying a firm's share price by the number of shares it has outstanding. The firms ranked in the bottom 30% of market capitalization are assigned to the *S* portfolio, those in the middle 40% are assigned to the MID portfolio and those in the top 30% are assigned to the *B* portfolio. Portfolios are rebalanced monthly. Price relatives are calculated using discrete daily price relatives converted to form a monthly index. The Jarque-Bera tests the null hypothesis that the portfolio is normally distributed. The Sharpe ratio is calculated as follows: $(R_{\text{Portfolio}} - R_{\text{T-bill}})/\text{Standard Deviation}_{\text{Portfolio}}$. Wilcoxon is the Wilcoxon Signed Ranks Test which tests the null hypothesis that the median difference between the individual matched pairs of the *S* and *B* portfolios is zero. Ljung-Box tests the joint hypothesis that all the autocorrelations up to the specified lag are simultaneously equal to zero.

and *B* the top 10%) and Table 3 provides the results for quintiles (in Table 3, *S* is the bottom 20% of stocks and *B* the top 20%). Both tables show that the smallest stocks outperform the largest stocks, although the change in performance when moving from small to large is not strictly monotonic.

We analyze the returns of our *S* and *B* portfolios (that is, the portfolios analyzed in Table 1) on a month-by-month basis in Table 4. Small firms outperformed big firms during the sample period, earning their highest mean and median returns in July and their lowest mean and median returns in June. The finding that small firms also earn considerably higher mean and median returns in January and February rules out the tax-loss hypothesis as a complete explanation for the small firm effect. These results are consistent with earlier findings by Brown et al. (1983) in relation to the seasonality of small firm returns.

3. Why are the *S* returns greater than *B* returns?

Having confirmed the existence of the size premium in Australia, we consider why the returns of *S* are greater than those of *B*. *S* and *B* are self-evidently integral to the market as a whole. As such, they are jointly subject to market-wide fluctuations and determinants. In order to understand why *S* is different from *B*, the pervasive effect of the market must be "stripped out" to leave us with the "pure-play" size-premium. In this study, we orthogonalize *S* and *B* (as well as the other market-based metrics we utilize, i.e. the turnover ratio and momentum) by regressing each variable on the market portfolio using GMM. From these regressions, the residuals are used to form factors that are orthogonal to the market: S^O and B^O. This then allows for a "pure" analysis of the determinants of the "unique" small-firm premium in the subsequent regression analyses we report.

Table 5 presents the results from the regressions of the market against both small and big firm spanning portfolios. Unsurprisingly, both *S* and *B* have a strong relationship with the overall market. Furthermore, *S* has a higher market coefficient which is consistent with CAPM-inspired expectations that higher performing portfolios have higher betas, *ceteris paribus*.

Recognizing we are dealing with a system, we analyze S^O and B^O simultaneously, utilizing Full-Information Maximum Likelihood estimation in our analysis. The results are presented in Table 6. We report only the equations where every candidate explanation variable is included: the removal of insignificant variables did not result in better equations or different inferences. Under the heading Wald test, we also report *z*-statistics testing the null hypothesis that the coefficient estimated for each variable is equal in both equations and a χ^2 statistic testing the null that all coefficients estimated for both equations are equal. The results of these tests support the contentions we make below when we argue that the variables we examine have different effects on S^O and B^O. The χ^2 statistic is statistically significant and, in those instances where we highlight that the effects of the coefficients are different for both equations, the ratio of the estimated *z*-statistic to the standard error is greater than two, indicating that the null of equality can be rejected.

We have four market-based metrics, i.e. high and low turnover ratio spanning portfolios (TR-High and TR-low) and two momentum spanning portfolios (winner and loser).[11] Each metric is

[11] We do not include glamour and growth (high and low book-to-market) portfolios for two reasons. Firstly, and most importantly, there is, at best, only mixed evidence that the book-to-market factor is priced in Australia (Durack et al., 2004; Durand et al., 2006). Secondly, even if book-to-market was priced in Australia, it is not clear what this variable might capture. Debate still rages in the U.S. about why this factor is priced. Chan and Chen (1991), Fama and French (1995) and Dichev (1998) argue that the book-to-market effect is related to firm distress while Cohen et al. (2003) provide evidence against this. Liew and Vassalou (2000) and Vassalou (2003) argue that book-to-market captures exposure to economic risk. De Bondt and Thaler (1985), Lakonishok et al. (1994), La Porta (1996), Rozeff and Zaman (1998) and Ali et al. (2003) argue that the effect is driven by investors' overreaction.

Table 2
Summary statistics for ten size-based portfolios using value-weighted returns January 1990 to December 2001

Portfolio	Mean	Median	Standard Deviation	Skewness	Kurtosis	Jarque-Bera	*p*-value	Sharpe ratio	Wilcoxon	*p*-value
S	1.1079	1.0820	0.1303	1.2425	5.3578	70.4061	0.0000	0.7864	−8.1009	0.0000
D2	1.0582	1.0394	0.1189	1.4494	8.1088	207.0168	0.0000	0.4435		
D3	1.0302	1.0228	0.0819	0.4687	3.8178	9.2865	0.0096	0.3027		
D4	1.0247	1.0166	0.0724	0.2034	3.9117	5.9805	0.0503	0.2655		
D5	1.0124	1.0106	0.0670	0.2518	4.6050	16.9771	0.0002	0.1031		
D6	1.0143	1.0071	0.0634	0.5108	4.3631	17.4093	0.0002	0.1399		
D7	1.0128	1.0076	0.0578	0.5792	6.1883	69.0442	0.0000	0.1265		
D8	1.0111	1.0123	0.0489	−0.5300	3.8959	11.5579	0.0031	0.1153		
D9	1.0092	1.0091	0.0458	−0.3647	3.0232	3.1961	0.2023	0.0820		
B	1.0088	1.0081	0.0417	−0.0008	2.7824	0.2841	0.8676	0.0797		
T-bill	1.0055	1.0047	0.0021	1.7489	5.3716	107.1551	0.0000			

Portfolio	Autocorrelation at lag								
	1			2			3		
	Coefficient	Ljung-Box	*p*-value	Coefficient	Ljung-Box	*p*-value	Coefficient	Ljung-Box	*p*-value
S	0.1114	1.8257	0.1770	0.1616	5.6908	0.0580	0.1122	7.5670	0.0560
D2	0.1985	5.7910	0.0160	0.1172	7.8257	0.0200	0.1900	13.2063	0.0040
D3	0.1449	3.0872	0.0790	0.0077	3.0959	0.2130	0.0051	3.0999	0.3760
D4	0.2191	7.0556	0.0080	0.1217	9.2499	0.0100	0.1613	13.1312	0.0040
D5	0.0892	1.1693	0.2800	−0.0550	1.6169	0.4460	0.0494	1.9800	0.5770
D6	0.1006	1.4867	0.2230	−0.0391	1.7132	0.4250	0.1162	3.7274	0.2920
D7	0.1603	3.7754	0.0520	0.0777	4.6693	0.0970	0.1419	7.6702	0.0530
D8	0.1840	4.9798	0.0260	−0.0304	5.1170	0.0770	0.0733	5.9183	0.1160
D9	0.0904	1.2017	0.2730	0.0285	1.3221	0.5160	0.0140	1.3512	0.7170
B	−0.1537	3.4714	0.0620	0.0413	3.7237	0.1550	−0.0043	3.7264	0.2930

This table provides the summary statistics for the monthly value-weighted price relatives of small and big Australian firms. At the start of each month all fully-paid Australian stocks listed on the ASX, excluding investment trusts, real estate trusts, banks and insurers, are ranked in ascending order based on their market capitalization figure. Market capitalization is calculated by multiplying a firm's share price by the number of shares it has outstanding. The firms ranked in the bottom 10% of market capitalization are assigned to the *S* portfolio, those in the middle 80% are assigned to portfolios D2 to D9 and those in the top 10% are assigned to the *B* portfolio. Portfolios are rebalanced monthly. Price relatives are calculated using discrete daily price relatives converted to form a monthly index. The Jarque-Bera tests the null hypothesis that the portfolio is normally distributed. The Sharpe Ratio is calculated as follows: $(R_{\text{Portfolio}} - R_{\text{T-bill}})/\text{Standard Deviation}_{\text{Portfolio}}$. Wilcoxon is the Wilcoxon Signed Ranks Test which tests the null hypothesis that the median difference between the individual matched pairs of the *S* and *B* portfolios is zero. Ljung-Box tests the joint hypothesis that all the autocorrelations up to the specified lag are simultaneously equal to zero.

Table 3
Summary statistics for five size-based portfolios using value-weighted returns January 1990 to December 2001

Portfolio	Mean	Median	Standard Deviation	Skewness	Kurtosis	Jarque-Bera	*p*-value	Sharpe ratio	Wilcoxon	*p*-value
S	1.0737	1.0599	0.1130	1.1490	5.7615	77.4372	0.0000	0.6043	−6.4037	0.0000
Q2	1.0270	1.0225	0.0713	0.1069	3.3260	0.9122	0.6337	0.3020		
Q3	1.0136	1.0134	0.0593	−0.0090	3.5694	1.9473	0.3777	0.1372		
Q4	1.0116	1.0120	0.0481	−0.4718	4.1265	12.9555	0.0015	0.1272		
B	1.0088	1.0095	0.0409	−0.0587	2.8191	0.2790	0.8698	0.0820		
T-bill	1.0055	1.0047	0.0021	1.7489	5.3716	107.1551	0.0000			

Portfolio	Autocorrelation at lag								
	1			2			3		
	Coefficient	Ljung-Box	*p*-value	Coefficient	Ljung-Box	*p*-value	Coefficient	Ljung-Box	*p*-value
S	0.1929	5.4712	0.0190	0.1471	8.6744	0.0130	0.1710	13.0353	0.0050
Q2	0.2108	6.5306	0.0110	0.0987	7.9721	0.0190	0.1076	9.6986	0.0210
Q3	0.0911	1.2211	0.2690	−0.0487	1.5716	0.4560	0.1024	3.1360	0.3710
Q4	0.2081	6.3666	0.0120	0.0221	6.4387	0.0400	0.1132	8.3502	0.0390
B	−0.1381	2.8056	0.0940	0.0433	3.0828	0.2140	−0.0066	3.0893	0.3780

This table provides the summary statistics for the monthly value-weighted price relatives of small and big Australian firms. At the start of each month all fully-paid Australian stocks listed on the ASX, excluding investment trusts, real estate trusts, banks and insurers, are ranked in ascending order based on their market capitalization figure. Market capitalization is calculated by multiplying a firm's share price by the number of shares it has outstanding. The firms ranked in the bottom 20% of market capitalization are assigned to the *S* portfolio, those in the middle 60% are assigned to portfolios Q2 to Q4 and those in the top 20% are assigned to the *B* portfolio. Portfolios are rebalanced monthly. Price relatives are calculated using discrete daily price relatives converted to form a monthly index. The Jarque-Bera tests the null hypothesis that the portfolio is normally distributed. The Sharpe Ratio is calculated as follows: $(R_{\text{Portfolio}} - R_{\text{T-bill}}) / \text{Standard Deviation}_{\text{Portfolio}}$. Wilcoxon is the Wilcoxon Signed Ranks Test which tests the null hypothesis that the median difference between the individual matched pairs of the *S* and *B* portfolios is zero. Ljung-Box tests the joint hypothesis that all the autocorrelations up to the specified lag are simultaneously equal to zero.

Table 4
Monthly mean and median price relatives for S and B value-weighted spanning portfolios January 1990 to December 2001

Month	*S* Mean	*t*-value	Median	B Mean	*t*-value	Median	Wilcoxon	*p*-value
January	1.0881	5.1567**	1.0820	1.0072	−0.4949	1.0144	−2.7456	0.0060
February	1.0911	5.5620**	1.0918	1.0044	−1.3250	1.0106	−2.7456	0.0060
March	1.0286	−2.9184**	1.0039	1.0025	−1.8760*	0.9988	−0.0784	0.9375
April	1.0293	−2.8214**	1.0326	1.0289	5.9470**	1.0446	0.0000	1.0000
May	1.0419	−1.1154	1.0338	1.0038	−1.5041	1.0074	−1.4905	0.1361
June	0.9747	−10.2386**	0.9751	1.0067	−0.6293	1.0017	−2.1181	0.0342
July	1.1329	11.2387**	1.1230	1.0143	1.6053	1.0116	−2.6672	0.0076
August	1.0339	−2.2018*	1.0267	0.9930	−4.6967**	0.9924	−2.4318	0.0150
September	1.0272	−3.1061**	1.0554	0.9990	−2.9250**	0.9960	−1.7258	0.0844
October	1.0445	−0.7599	1.0461	1.0138	1.4719	1.0261	−1.0198	0.3078
November	1.0638	1.8673*	1.0494	1.0012	−2.2746*	1.0065	−2.4318	0.0150
December	1.0452	−0.6632	1.0314	1.0315	6.7016**	1.0261	−1.0983	0.2721
All months	1.0501		1.0421	1.0089		1.0100		

*Indicates significance at 5%; ** indicates significance at 1%.
This table provides the per month mean and median price relatives for *S* and *B* spanning portfolios analyzed in Table 1 (where the portfolio formation is described in detail).

formed on the basis of ranking winners and losers over a 3-month formation period and holding those securities for a 1-month period. As with *S* and *B*, the portfolios are value-weighted, re-weighted monthly and orthogonalized to the market. Unlike many other studies, we do not form combined long/short portfolios (i.e., high minus low turnover and winners minus losers) as each component of these portfolios captures different aggregate affective states and the sensitivity to each individual state may not be proportional.

Table 6 shows that both S^O and B^O are affected by the turnover ratio. The coefficient for TR-high is positive and significant for both S^O and B^O although its value is much higher for S^O (0.5566 for S^O *vs.* 0.0251 for B^O; the *p*-values are 0 and 0.0202 respectively). In contrast, the coefficient for TR-low is negative and statistically significant for S^O (-0.5298; $p \approx 0.0526$) but positive for B^O (0.8511; $p \approx 0$). As we have argued, high (low) investor arousal is proxied by a

Table 5
Orthogonalization of *S* and *B* value-weighted spanning portfolios against the market

Variable Coefficient	*S* Intercept	Market	B Intercept	Market
Estimate	−0.0272	1.0679	−0.0156	1.0156
t-statistic	−0.1945	7.5874	−0.2942	19.4874
p-value	0.8461	0.0000	0.7690	0.0000
R-squared	0.1872		0.8050	
Durbin–Watson	1.6449		1.8388	
J-statistic	0.0000		0.0000	

This table presents Generalized Method of Moments regression results for the following model:

$$\mathrm{PR}_{it} = c_0 + c_1 \mathrm{Market}$$

PR_{it} is the price relative of the relevant portfolio of small and big firm portfolios (*S* and *B*) analyzed in Table 1 (where the portfolio formation is described in detail). "Market" represents the value-weighted price relatives of all fully-paid Australian stocks listed on the ASX excluding investment trusts, real estate trusts, banks and insurers.

high (low) turnover ratio. Thus, returns of low arousal stocks have opposing effects on the small firm premium. Positive returns decrease the premium and *vice versa* for negative returns. It is perhaps when arousal is lowest that the small firm premium is lowest. Indeed, in extreme low arousal states, the coefficients suggest that the size premium might become negative. Arousal theory suggests that the pervasive characteristics of market participants in such situations would be depression and boredom (Eisenberg et al., 1998).

It appears that the small firm premium is influenced by investors' disproportionate reactions. The coefficient for winner is positive and statistically significant for S^{O} ($c_{\mathrm{winner}}=0.2132$; $p\approx 0.0169$) but insignificant for B^{O}. Both S^{O} and B^{O} have positive and significant coefficients ($c_{\mathrm{loser}}=0.2668$ and 0.0265 respectively, p-values are 0.0011 and 0.0353) for the loser portfolio. Thus, it is investors' disproportionate reactions to both winners and losers which influence the size-premium. That c_{loser} for S^{O} is almost ten times as great as the estimated coefficient of B^{O} suggests that the small firm premium is highly sensitive to returns of the worst performing stocks.

We also control for tax loss selling by incorporating a dummy variable taking the value of 1 if the return is in July and zero if otherwise (D_{jul}). The variable D_{jul} is significant and positive for S^{O} (0.0610, $p\approx 0$) and insignificant for B^{O}. Thus, the seasonal effect found in Table 4 "survives" the orthogonalization to Rm. The behavioral determinants we have uncovered do not account for the seasonality associated with the tax-effect hypotheses.

Three aspects of the analysis in Table 6 present, for us, unexpected results. The first of these aspects relates to our control for interest rates (the variable T-bill), the second to the effect of the US market (S&P$_{\mathrm{t}}$ and S&P$_{t-1}$) and the third relates to the intercept term c_{o} for B^{O}.

Changes in the returns of the 90-day T-bill[12] are used as a proxy for changes in the discount rate. Jensen et al. (1997, 1998) find that a small firm premium exists only when the government adopts an expansive monetary policy. Therefore, changes in the discount rate may be a factor determining small firm returns when the interest rate policy is expansionary. We do not find any effect for S^{O}: the estimate for B^{O} is negative (−0.52) and statistically significant. A finding such as this is consistent with a "flight-to-quality" effect (Barsky, 1989). If such an explanation holds, however, why this effect does not pertain to S^{O} is puzzling. The effect is possibly asymmetric or it may be the case that the investors flying to quality were not those who are investing in small stocks?

Durand and Scott (2003) found that Australian stock market returns are driven by overreaction to US stock market returns. The strong links between the returns in these markets are also documented in the works of Ragunathan et al. (1999), Durand et al. (2001) and Durand et al. (2006). It is useful to consider if the link between the Australian and US markets may have a role in explaining why S is different from B. The coefficients for returns on the US market (S&P$_t$ and S&P$_{t-1}$) are insignificantly different from zero. We believe that the effect documented in the literature on the relationship of Australian to American returns "disappears" in the orthogonalization.

The intercept term for B^{O}, c_{o}, is positive (0.5477) and statistically significant ($p\approx 0.0343$). Merton (1973) argued that a well specified asset-pricing model should have an intercept equal to zero for excess returns. It is not clear how this criterion might apply to the orthogonalized portfolio we are studying (especially when the intercept term in the orthogonalizing equation – reported in Table 6 – is insignificantly different from zero and the distribution of error terms is i.i.d.). The positive intercept may indicate that further research is required to determine variables which may be incorporated to better explain B^{O}.

[12] These variables are obtained from the Reserve Bank of Australia's website: www.rba.gov.au.

Table 6
Modeling *S* and *B* stock market returns Full-Information Maximum Likelihood System results using the turnover ratio, momentum, interest rates and *S&P* 500 metrics January 1990 to December 2001

Coefficient	c_0	$c_{\text{TR-low}}$	$c_{\text{TR-high}}$	c_{winner}	c_{loser}	c_{djul}	c_{tbill}	$c_{\text{S\&P}}$	$c_{\text{S\&P}(-1)}$
S^{O}									
Estimate	2.3583	−0.5298	0.5566	0.2132	0.2668	0.0610	−2.2959	−0.0335	−0.0209
z-statistic	1.0256	−1.9383	9.3735	2.3896	3.2592	5.0429	−1.0041	−0.2987	−0.1597
p-value	0.3051	0.0526	0.0000	0.0169	0.0011	0.0000	0.3153	0.7652	0.8731
R-squared	0.6551								
Ljung-Box	2.7262								
p-value	0.0987								
B^{O}									
Estimate	0.5477	0.8511	0.0251	0.0148	0.0265	−0.0026	−0.5200	0.0007	−0.0250
z-statistic	2.1161	22.1285	2.3233	0.9675	2.1053	−0.8090	−1.9820	0.0390	−1.6590
p-value	0.0343	0.0000	0.0202	0.3333	0.0353	0.4185	0.0475	0.9689	0.0971
R-squared	0.8669								
Ljung-Box	2.8100								
p-value	0.0937								
Wald test									
Chi-square	254.1816								
p-value	0.0000								
Z-statistic	1.7990	−1.3812	0.5315	0.1985	0.2404	0.0636	−1.7644	−0.0340	0.0041
Standard error	1.9011	0.2278	0.0678	0.1194	0.0888	0.0180	1.8541	0.0874	0.0810
System									
Log-likelihood	758.7090								
AIC	−10.4265								
SIC	−10.4177								

This table presents Full-Information Maximum Likelihood System regression results starting with the following two systems:

$$S^{\text{o}}_{it} = c_0 + c_1\text{TR}_{\text{Low}} + c_2\text{TR}_{\text{High}} + c_3\text{Winner} + c_4\text{Loser} + c_5 D_{\text{jul}} + c_6\text{T-bill} + c_7 S\&P + c_8 S\&P(-1)$$

$$B^{\text{o}}_{it} = c_0 + c_1\text{TR}_{\text{Low}} + c_2\text{TR}_{\text{High}} + c_3\text{Winner} + c_4\text{Loser} + c_5 D_{\text{jul}} + c_6\text{T-bill} + c_7 S\&P + c_8 S\&P(-1)$$

Here, S^{o}_{it} is the orthogonalized price relative of the small firm spanning portfolio, $B^{\text{o}}{}_{it}$ is the orthogonalized price relative of the big firm spanning portfolio, TR_{Low} represents the price relative of the low turnover ratio spanning portfolio, TR_{High} represents the price relative of the high turnover ratio spanning portfolio, Winner represents the price relative of the momentum winner spanning portfolio, Loser represents the price relative of the momentum loser spanning portfolio, D_{jul} is a dummy variable for the month of July, T-bill is the monthly 90-day Australian Treasury bill price relative and S&P is the price relative series of the US Standard & Poor 500 Index. S&P(−1) is *S&P* at lag one month. TR_{Low}, TR_{High}, Winner and Loser are orthogonalized to the market (in the same way that S^{o} and B^{o} have been orthogonalized in this analysis). Ljung-Box tests the joint hypothesis that the autocorrelation of the residuals at lag one is equal to zero. AIC is the Akaike Information Criterion. SIC is the Schwarz Information Criterion. The null of the Wald Test is that the estimated coefficients for $S^{\text{o}}{}_{it}$ equal those estimated for B^{o}_{it}.

To evaluate the robustness of the inferences we have made on the basis of the analysis reported in Table 6, we analyzed the data from two sub-periods (January 1990 to December 1995 and January 1996 to December 2001) and found that the results were not driven by events particular to a specific period of time. We also considered if the regression results reported in Table 6 are sensitive to the orthogonolization procedure we adopted. First, we simply subtracted the monthly market return from the returns of our portfolios. Second, we repeated this analysis without orthogonalizing. These analyses confirmed that the inferences we made on the basis of the analysis reported in Table 6 are robust to those variations in methodology. Additionally, we then considered if the analysis was robust to our definition of liquidity. We re-analyzed our data using liquidity metrics calculated using the number of shares traded and also the dollar volume of shares traded; our results are robust to these alternative definitions of liquidity. Details of all the robustness tests we discuss may be downloaded from the corresponding author's website.

4. Conclusion

Similar to the equity risk-premium (Rm-Rf), the size-premium, SMB, is an important component of the empirically derived models of the cross-section of returns.[13] Using Australian data from January 1990 to December 2001, we confirm that the size premium has been, on average, positive and statistically significant. Our analyses confirm that the portfolio of the smallest 30% of stocks outperformed the portfolio of the largest 30% of stocks as measured by market capitalization.

We also examined why small firms earn a premium over large firms. In Section 3 of the paper, after orthogonalizing S and B to remove market-pervasive influences, we regressed these variables against variables which we hypothesize may explain the premium. We find that portfolios formed using the turnover ratio (which captures investor arousal) and momentum (which has been associated with investors' disproportionate reactions) have considerable explanatory power for small firm returns.

Our findings point to the small firm premium being determined by behavioral factors. Small firm returns are highest for firms which investors have the greatest arousal. Small firm returns also appear to be fuelled by investors' disproportionate reactions to arousing stimuli.

References

Ali, A., Hwang, L., Trombley, M., 2003. Arbitrage risk and the book-to-market anomaly. Journal of Financial Economics 69, 355–373.

Barsky, R.B., 1989. Why don't the prices of stocks and bonds move together? American Economic Review 79, 1132–1145.

Beedles, W., Dodd, P., Officer, R., 1988. Regularities in Australian share returns. Australian Journal of Management 13, 1–29.

Berk, J.B., 1995. A critique of size related anomalies. Review of Financial Studies 9, 275–286.

Black, F., 1986. Noise. Journal of Finance 41, 529–543.

Blume, M., Stambaugh, R., 1983. Biases in computed returns: an application of the size effect. Journal of Financial Economics 12, 387–404.

Booth, D., Keim, D., 1998. Is there still a January effect? In: Keim, D., Ziemba, W. (Eds.), Security Market Imperfections in World Wide Equity Markets. Cambridge University Press, Cambridge, pp. 169–178.

Brown, P., Keim, D., Kleidon, A., Marsh, T., 1983. Stock return seasonalities and the tax-loss selling hypothesis; analysis of the arguments and Australian evidence. Journal of Financial Economics 12, 105–127.

Business Council of Australia, 2004. Preliminary Submission to Productivity Commission Review of National Competition Policy Arrangements. http://www.bca.com.au/2004.

Chan, K., Chen, N., 1991. Structural and return characteristics of small and large firms. Journal of Finance 46, 1467–1484.

Cohen, R., Polk, C., Vuolteenaho, T., 2003. The value spread. Journal of Finance 58, 609–641.

De Bondt, W., Thaler, R., 1985. Does the stock market overreact? Journal of Finance 40, 793–808.

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.

Dichev, I.A., 1998. Is the risk of bankruptcy a systematic risk? Journal of Finance 53, 1131–1147.

Dimson, E., Marsh, P., 1999. Murphy's law and market anomalies. Journal of Portfolio Management 25, 53–69.

[13] Fama and French (1993), Halliwell et al. (1999), Faff (2001), Gaunt (2004), Durack et al. (2004).

Durack, N., Durand, R.B., Maller, R., 2004. A best choice among asset pricing models? The conditional CAPM in Australia. Accounting and Finance 44, 139–162.
Durand, R.B., Scott, D., 2003. iShares Australia: a clinical study in international behavioral finance. The International Review of Financial Analysis 12, 223–229.
Durand, R.B., Koh, K.S., Watson, I., 2001. Who moved Asian-Pacific stock markets? A further consideration of the impact of the US and Japan. Australian Journal of Management 26, 125–145.
Durand, R.B., Limkriangkrai, M., Smith, G., 2006. In America's thrall: the effects of the US market and US security characteristics on Australian stock returns. Accounting and Finance 46, 577–604.
Eisenberg, A.E., Baron, J., Seligman, M.E.P., 1998. Individual differences in risk aversion and anxiety, Working Paper, University of Pennsylvania, Department of Psychology.
Faff, R., 2001. An examination of the Fama and French three-factor model using commercially available factors. Australian Journal of Management 26, 1–17.
Fama, E., French, K., 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics 33, 3–56.
Fama, E., French, K., 1995. Size and book-to-market factors in earnings and returns. Journal of Finance 50, 131–155.
Foote, S.L., 2000. Arousal. In: Kazdin, A.E. (Ed.), Encyclopedia of Psychology, vol. 1. Oxford University Press, New York, pp. 237–240.
Gaunt, C., 2004. Size and book to market effects and the Fama French three factor asset pricing model: evidence from the Australian stockmarket. Accounting and Finance 44, 27–44.
Gaunt, C., Gray, P., McIvor, J., 2000. The impact of share price on seasonality and size anomalies in Australian equity returns. Accounting and Finance 40, 33–50.
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.
Harris, M., Raviv, A., 1993. Differences of opinion make a horse race. Review of Financial Studies 6, 473–506.
Hong, H., Lim, T., Stein, J.C., 2000. Bad news travels slowly: size, analyst coverage, and the profitability of momentum strategies. Journal of Finance 55, 265–295.
James, C., Edmister, R.O., 1983. The relation between common stock returns trading activity and market value. Journal of Finance 38, 1075–1086.
Jegadeesh, N., Titman, S., 2001. Profitability of momentum strategies: an evaluation of alternative explanations. Journal of Finance 41, 699–720.
Jensen, G.R., Johnson, R.R., Mercer, J.M., 1997. New evidence on size and price-to-book effects in stock returns. Financial Analysts Journal 53, 34–42.
Jensen, G.R., Johnson, R.R., Mercer, J.M., 1998. The inconsistency of small-firm and value-stock premiums. Journal of Portfolio Management 24, 27–36.
Kandel, E., Pearson, N.D., 1995. Differential interpretation of public signals and trade in speculative markets. Journal of Political Economy 103, 831–872.
Kaufman, B.E., 1999. Emotional arousal as a source of bounded rationality. Journal of Economic Behavior and Organization 38, 135–144.
Keim, D., 1983. Size related anomalies and stock return seasonality (further empirical evidence). Journal of Financial Economics 25, 75–97.
Kumar, A., Lee, C., 2002. Individual investor sentiment and comovement in small stock returns, Working Paper, Cornell University.
La Porta, R., 1996. Expectations and the cross section of returns. Journal of Finance 51, 3–53.
Lakonishok, J., Shleifer, A., Vishny, R., 1994. Contrarian investment, extrapolation and risk. Journal of Financial Economics 49, 1541–1578.
Lee, C., Swaminathan, B., 2000. Price momentum and trading volume. Journal of Finance 55, 2017–2069.
Liew, J., Vassalou, M., 2000. Can book-to-market, size and momentum be risk factors that predict economics growth? Journal of Financial Economics 57, 221–245.
Merton, R.C., 1973. An intertemporal capital asset pricing model. Econometrica 41, 867–888.
Odean, T., 1998. Volume, volatility, price and profit when all traders are above average. Journal of Finance 53, 1887–1934.
Ragunathan, V., Faff, R., Brooks, R.D., 1999. Correlations, business cycles and integration. Journal of International Financial Markets Institutions and Money 9, 75–95.
Reinganum, M., Shapiro, A., 1987. The anomalous stock market behavior of small firms in January: empirical tests for the tax-loss selling effects. Journal of Business 60, 281–295.
Roll, R., 1981. A possible explanation of the small firm effect. Journal of Finance 36, 879–888.
Roll, R., 1983. On computing mean returns and the small firm premium. Journal of Financial Economics 12, 371–386.

Rozeff, M., Zaman, M., 1998. Overreaction and insider trading: evidence from growth and value portfolios. Journal of Finance 53, 701–716.

Sharpe, W., 1966. Mutual fund performance. Journal of Business 39, 119–138.

Shumway, T., 1997. The delisting bias in CRSP data. Journal of Finance 52, 327–340.

Shumway, T., Warther, V.A., 1999. The delisting bias in CRSP's Nasdaq Data and its implications for the size effect. Journal of Finance 54, 2361–2379.

Varian, J.R., 1989. Differences of opinion in financial markets. In: Stone, C. (Ed.), Financial Risk: Theory, Evidence and Implications: Proceedings of the 11th Annual Economic Policy Conference of the Federal Reserve Bank of St. Louis. Kluwer, Boston, MA, pp. 3–37.

Vassalou, M., 2003. News related to future GDP growth as a risk factor in equity returns. Journal of Financial Economics 68, 47–73.