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An Examination of Pricing Anomalies for Australian Stocks

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Abstract: The beta coefficient of the capital asset pricing model (CAPM) has been a widely used single factor for determining the returns on risky assets, e.g., company stocks. The other attributing factors are deemed anomalies and assumed to only exist temporarily and not considered as fundamental factors in the determination of returns on risky assets. The purpose of this study is to examine the details of two other pricing factors, in addition to the CAPM beta, in the return characteristics for the Australian stock market. These two factors are the different sizes of firms (SMB) and the ratios between their book values and market values (HML). The study period is from 1st January 2000 through 31st December 2017. The SMB and HML factors are calculated using scientific methodology, which makes a considerable contribution to the Australian stock market literature. The findings suggest that the regression coefficients of both SMB and HML factors are statistically more significant than the beta coefficients. Furthermore, the SMB and HML coefficients co-vary consistently with the returns on most stocks and can explain the residual returns left by the CAPM beta. These findings confirm the presence of SMB and HML effects in the Australian stock market returns, in addition to the CAPM beta returns, and can confirm similar findings for other developed stock markets, e.g., USA, UK.

Keywords: pricing anomalies, capital asset pricing model, Fama-French three-factor model, book value, market value, firm size effect.

对澳大利亚股票定价异常的检验

摘要：资本资产定价模型（CAPM）的贝塔系数已被广泛用于确定风险资产（例如公司股票）的收益的单一因素。其他归因因素被认为是异常因素，并被认为仅是暂时存在的，在确定风险资产收益时不被视为基本因素。这项研究的目的是检查除 CAPM 贝塔以外的其他两种定价因素的详细信息，这些因素是澳大利亚股票市场的回报特征。这两个因素是不同的公司规模（中小型企业）以及它们的账面价值与市场价值之间的比率（HML）。研究期限为 2000 年 1 月 1 日至 2017 年 12 月 31 日。中小型企业和 HML 因子采用科学方法进行计算，这对澳大利亚股票市场文献做出了重大贡献。研究结果表明，中小型企业和 HML 因子的回归系数在统计学上都比贝塔系数显着。此外，中小型企业和 HML 系数与大多数股票的收益一致，并且可以解释 CAPM 贝塔留下的剩余收益。这些发现证实除了 CAPM 贝塔回报外，澳大利亚股票市场回报中还存在中小型企业和 HML 效应，并且可以证实其他发达股票市场（例如美国，英国）的类似发现。

关键词：定价异常，资本资产定价模型，法玛-法国三因素模型，账面价值，市场价值，企业规模效应。

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1. Introduction

The capital asset pricing model (CAPM), since its discovery by [1], [2], has been widely used in pricing risky assets. It became a cornerstone method of assessing stock market risk and has been taught to all finance graduates in universities and colleges. The CAPM assumes that investors hold diversified investment portfolios and should only to be compensated for beta risk, the alpha risk supposedly eliminated by the process of diversification [23, 33]. Thus, stock market betas are considered to exclusively explain ex-post stock returns. However, subsequent studies by [3], [4], [5] found evidence of higher returns for stocks beyond that which was supported by their market betas. The higher returns were attributed to risk premiums related to weaker firms with smaller market capitalization. This was particularly prevalent for stocks of smaller firms (size effect) and firms with a higher book value than their market value (value stocks). It was identified that the extra returns, beyond explanation by stock market betas, were risk premium mainly attributed to smaller organizations. They are linked to size and value risk premiums beyond the market risk premium, which is measure by stock market betas. Following this discovery of an anomaly in the CAPM, literature on finding better explanations for stock returns started to develop. [6], [28] extend the single-factor CAPM with two additional variables, SMB and HML, and after performing robust tests on various sample sets, found evidence to conclude that the three-factor model captures the highest average return anomalies of the CAPM. Their three-factor model includes the CAPM market beta (SMB) for firm size risk, and (HML) for a value risk premium. [7] extends the three-factor model into a four-factor model by including a momentum factor (WML), which presumably compensates for momentum strategy; that is, buying winners and selling losers. Over time, the literature on asset pricing anomalies has grown considerably, with numerous studies attempting to explain returns on stocks beyond stock market beta, with additional variables such as firm size, BV/MV, momentum, seasonality, earnings/price, cash flow/price, percentage change in dividends, percentage change in BV/MV and liquidity factor [8], [9], [10], [11], [12], [13], [14], [15]. However, most of these studies are based on the U.S. market, and out-of-sample evidence, including the Australian market, is still sparse and inconclusive; particularly in demonstrating the consistency and persistence of the non-beta factors in explaining ex-post return variation on stocks.

2. Literature Review

The study aims to provide additional out-of-sample evidence to the U.S. findings on size and BV/MV effects, using Australian data. It is motivated particularly by the limitations and somewhat contrasting Australian findings on stock market anomalies. For example, model [16] did not improve upon the CAPM results for Australian stocks, while [17] showed a more efficient model in explaining the share market returns in Australia. [18] further added to the debate using daily data, and confirmed the significant presence of BV/MV risk factors for Australian stocks. However, [19] finds the presence of size risk factors to be negative. In contrast, [20] finds the size effect in Australia to be significantly positive. [17] and [21] are the two latest studies that examine the size and BV/MV effects in Australian stocks. Both note the shortcomings of previous Australian studies for missing accounting data for determining HML factors, inconsistency in portfolio formation to Fama-French methodology, and insufficient sample size with a bias towards large stocks. Utilizing the AGSM-CRIF database [17] arranges a sample comprising 6,814 companies, and [21] with a sample consisting of 23,098 companies. Both studies confirm the presence of size and value premiums in Australian stocks. This study adds to the literature as follows: First, it extends the study period beyond most of the previous Australian studies. The coverage of the previous studies by [16], [17], and [19] end in 2000. The study period in [21] ends in 2006. This study spans from January 2000 through April 2013, with an observation of 160 monthly returns over a 13-year period. This study period includes the global financial crisis when market risk increased significantly, and provided interesting results on how this additional risk impacts size and BV/MV factors. With the increased market risk, if size and value risk premiums increase as well, an interesting connection with systematic and unsystematic risk could be established for further research.

The study further investigates match returns, prices, market capitalization, and accounting data for all stocks listed under Australian Securities Exchange (ASX) 300 index and form portfolios based on the size and BV/MV factors following the portfolio sorting methods described in pertinent literature [6, 15, 22]. Specifically, diversified portfolios are constructed mimicking size and BV/MV risks for left-hand side (LHS) assets, and SMB and HML factors for right-hand side (RHS) explanatory variables that form a regression model, thus advancing the work conducted in the Australian context, which has suffered from unreliable HML factor estimation due the lack of the accounting data on depreciation and book values. To mitigate this drawback, ASX 300 relied on value and growth styled portfolios for estimating the HML factors. This issue was raised by [15], who highlighted the importance of forming a diversified portfolio prior to incorporating it into their three-factor regression model as LHS assets to fully capture the size and value premiums. According to [15], their model will fail if portfolios are poorly constructed.

The third aim of the present study is to achieve about 80% coverage of the Australian stock market, while excluding infrequently traded and thus less important stocks. The most representative index of the Australian stock market is All Ordinaries 500 index, comprising 6,814 of the 23,098 listed stocks [17, 21]. However, as this index includes smaller and less frequently traded stocks, S&P/ASX 300 index was chosen instead, and the sample selection method adopted by [6] was used to ensure a more meaningful representation of the Australian market. The aim was to avoid volatile returns (statistical measure) that are typical of infrequently traded stocks, which would bias the true mean and would thus distort the size effect in stock returns. The remainder of the paper is organized as follows: In Section 2, the data, portfolio construction, and the testing variables are described before presenting the summary statistics for returns in Section 3. Section 4 is designated for the asset pricing regression model testing and the main results are discussed in Section 5. Although this study expanded sample sizes, extended study periods and improved portfolio construction methods, more rigorous data collection is necessitated for future studies.

3. Methodology

The period in focus of the present investigation spans from is January 1st 2000 to December 31st 2017, resulting 216 monthly observations available for analyses. The data sample includes monthly stock returns of all stocks listed within the S&P/ASX 300 index, namely the large-cap, mid-cap, and small-cap components of the Australian S&P/ASX index family, and represents about 80% of the market capitalization and volume traded. These shares are the investment benchmark for the major investment portfolios and, as they are traded regularly, have a high level of liquidity, thereby avoiding the volatility problem noted earlier. In addition, the sample is considered a good representative of the Australian Share Market. Together with the monthly stock returns, other types of data utilized include stock market capitalization, stock accounting data, the All Ordinaries index, 10-year bond rates, and 90-day bank bill rates. All the data are extracted from the Data Stream electronic files. Following the methodology convention of [6] and [15] starting January 2000, firms are categorized as small, medium, and large each month based on their average monthly market capitalization. The size breaks are decided based on percentile breaks between 33% and 66%, that is, firms with market values below the 33-percentile are classified as small, above 66-percentile as large, and those in between as medium [22]. The percentile breaks are calculated by taking the averages of all firms within the index every 12 months. This allowed about 100 stocks in each size category to move in and out of a category based on changes in their market capitalizations. This sorting produces three size-based portfolios—small, medium, and large. Since these stocks are from the All Ordinaries index family, they are identified as Small Ordinaries (SOrds), Medium Ordinaries (MOrds), and Large Ordinaries (LOrds). Next, all businesses within the ASX 300 index are independently sorted into two groups: book value (BV)/market value (MV). Every month, the monthly book values are then divided by the monthly market capitalization to calculate the equivalent BV/MV ratios. At the book-to-market ratio of one (1.00), the book value is exactly equal to the market value and the stocks are considered to be trading at the equilibrium price, i.e., with an equal book and market value. Ideally, a BV/MV ratio of one (1) was chosen as the breakpoint in dividing stocks into growth and value categories. The two portfolios are identified as Value Ordinaries (VOrds) and Growth Ordinaries (GOrds). The stocks with a book value lower than that of the market are considered to be trading at a premium price, thereby reflecting a characteristic of growth stocks. Investors buy such stocks at an inflated price-to-earnings ratio (low yield) in expectation of future growth in capital values. At the same time, the stocks with higher book value than market value are considered to be trading at a discount price, reflecting the character of value stocks. Investors buy such stocks at a low-price-earnings ratio (high yield) to take advantage of high returns or value premium. Typically, value investors are considered to yield investors. Finally, within each size group, small, medium, and big, stocks are sorted into value and growth categories. This final sort produces another six portfolios, namely small value ordinaries (SVOrds), small growth ordinaries (SGOrds), medium value ordinaries (MVOrds), medium growth ordinaries (MGOrds), large value ordinaries (LVOrds), and large growth ordinaries (LGOrds). The construction of portfolios is depicted in Fig. 1.

The eleven portfolios constructed are as follows: Small Ordinaries (SOrds), Medium Ordinaries (MOrds), Large Ordinaries (LOrds), Value Ordinaries (VOrds), Growth Ordinaries (GOrds), Small Value Ordinaries (SVOrds), Small growth Ordinaries (SGOrds), Medium Value Ordinaries (MVOrds), Medium Growth Ordinaries (MGOrds), Large Value Ordinaries (LVOrds) and Large Growth Ordinaries (LGOrds).

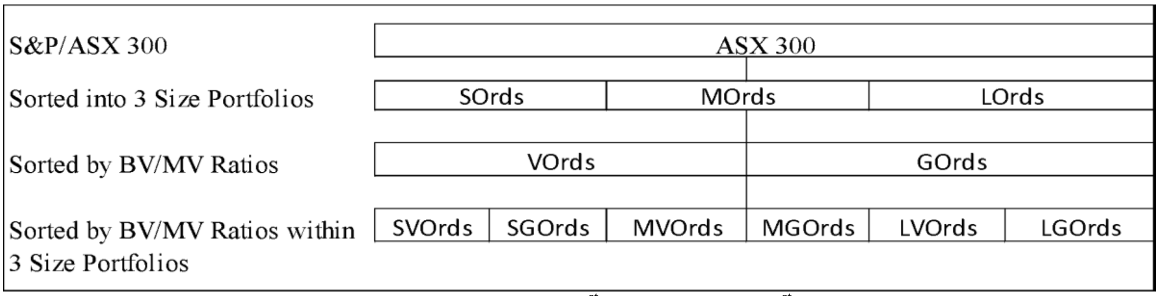

Fig. 1 Portfolios sorted by size and BV/MV ratios: 1st January 2000 – 31st December 2017, 216 months

Following the categorization, monthly rates of return for each stock within each portfolio are calculated as follows:

$R_T = [(P_T - P_{T-1}) + D_T] / P_{T-1}$ (1)

where R_T is the return at period ($_T$), P_T is the price at time ($_T$), P_{T-1} is the price at period ($_{T-1}$), and D_T is dividend at period ($_T$).

The individual monthly returns are weighted by the respective market capitalization, which are summed to calculate monthly value-weighted returns of every portfolio. A value of 1,000 was assigned as the base value for all the portfolios as of January 2000, and the following monthly index values are calculated through December 2017 as follows:

$[(1+R_T) * IV_{T-1})]$ (2)

where R_T is the monthly return at time $_T$, and IV_{T-1} is the index value at time $_{T-1}$.

The 11 portfolios produced by size and BV/MV sorting are used as the LHS assets in the asset pricing regression. Fama and French [22] formed 25 portfolios to use as LHS assets in their analysis. Given the small number of stocks in our sample, producing 25 portfolios will result in very few stocks in each portfolio.

The explanatory variables in the asset pricing regression are the size factor SMB (small minus big) and the BV/MV factor HML (high book value minus low book value). The SMB factor is the average of the returns on SVOrds and SGOrds minus the average returns on LVOrds and LGOrds. The value-growth factor is constructed for small and large stocks and then averaged to produce HML. For example, HML_S = SVOrds – SGOrds, HML_L = LVOrds – LGOrds, and HML is the equal-weighted average of HML_s and HML_L [15].

4. Analyses and Results

216 monthly observations are analyzed over the 18 years from January 1, 2000, through December 31, 2017. The monthly risk premiums (in excess of 90-Day Bank Bill rates) of the 11 portfolios sorted on size and BV/MV factors, together with the monthly risk premiums on the All Ordinaries and 10-year bonds, are subjected to numerous analyses in order to evaluate the size and BV/MV effects for Australian stocks. The risk premiums or excess returns are generally inclusive of cash dividends and appreciations in values (total risk premium). The words *risk premiums* and *excess returns* are used interchangeably in this study. First, summary statistics on returns are presented to describe the data in terms of average returns, standard deviation, skewness, and kurtosis. Coefficients of variation are calculated to make a relative comparison on a risk-adjusted basis. The Jarque-Bera statistics are presented to describe the return distribution. Then the CAPM is employed to evaluate the ex-post return predictability next to the market security line. The Fama and French's three-factor model is used to examine the sensitivity of the stock's monthly risk premiums to the market risk premium, size, and BV/MV premiums. The All Ordinaries index is used as the market index. The dependent variables are the monthly risk premiums on the 11 portfolios formed on size and BV/MV factors. The explanatory variables in the regressions are (i) $\beta_i[RM(t) - RF(t)]$ -coefficients on market risk premium, (ii) $s_i SMB(t)$ -coefficients on size premium, and (iii) $h_i HML(t)$ -coefficients on value premium. The beta coefficients measure the sensitivity of the asset to market risk premium. The coefficients on SMB measure the sensitivity of the asset to the returns on small-cap stocks minus the returns on big-cap stocks. The coefficients on HML measure the sensitivity of the asset to the returns on stocks with high book to market minus low book to market. As small-cap stocks outperform big-cap stocks and stocks with high book to market outperform stocks with low book to market, the SMB and HML return supposedly positive.

4.1. Summary Statistics

Table 1 presents the summary statistics. The mean returns in column 1, Panel 1, and Panel 2 show that small stocks outperform big stocks by 1.25/0.98 and value stocks outperform growth stocks by 1.35/.90, respectively. The risk/return ratios are lower in both cases, 1.86/3.31 and 2.05/3.17, respectively, which suggests that small and value stocks, normally outperform big and growth stocks on a risk-adjusted basis as well. When value premium is combined with the size premium within each size group, the extreme small portfolio, SVOrds, outperforms all other portfolios on a risk-adjusted basis, and noticeably value premium increases for small stocks, especially for the extremely small value portfolio, SVOrds, from extreme large value, LVOrds (Table 1, Panel 3). This finding of increasing value premium in size pattern supports the latest similar findings by [15] in the international stocks. The increase of a value premium in size portfolios from big to small is also apparent in the previous results of several Australian studies for the different periods and with a different data set.

Table 1 presents the mean monthly returns, standard deviation, coefficient of variation, skewness, kurtosis and Jarque-Bera statistics for the 3 portfolios sorted by size; two by BV/MV factors, and six sorted in two ways on BV/MV factors within each of the three size groups. These statistics are also presented for the ASX 300 and 10-year bond indices. 216 monthly observations were analyzed over the 18 years from 1 January 2000 through 31 December 2017.

Table 1 Summary statistics for size and book-to-market value sorted portfolios

Portfolios	Mean	Standard Deviation	Risk/Return Ratio	Skewness	Kurtosis	Jarque-Bera
	Panel 1: Portfolios by Size: Small, Medium and Large					
SOrds	1.25%	2.33%	1.86	0.55*	4.98*	25.91*
MOrds	1.11%	2.72%	2.46	0.01	3.21	0.22
LOrds	0.98%	3.26%	3.31	0.24	2.98	1.16
	Panel 2: Portfolios by BV/MV Ratio					
VOrds	1.35%	2.78%	2.05	-0.71	2.63	0.79
GOrds	0.90%	2.84%	3.17	0.39*	3.39	3.85
	Panel 3: Portfolios by Size and BV/MV Ratio					
SVOrds	1.69%	3.29%	1.95	0.35*	3.97*	7.23*
MVOrds	1.31%	3.06%	2.33	-0.28	3.17	1.70
LVOrds	1.39%	3.43%	2.46	-0.28	2.71	2.02
SGOrds	0.40%	2.61%	6.53	0.21	3.48	1.98
MGOrds	0.92%	2.72%	2.95	0.35*	3.43	3.48
LGOrds	0.89%	3.32%	3.72	0.42*	3.24	3.74
	Panel 4: Stock and Bond Portfolios					
All Ords	0.93%	3.76%	4.05	-0.31	2.93	1.97
Bond	0.65%	1.53%	2.35	-0.43	4.39*	13.35*

* denote significance at the 5% levels

The small growth stocks, SGOrds, had the lowest mean return and highest risk, and the large growth stocks, LGOrds, outperformed SGOrds. Whereas small value stocks, SVOrds, outperformed large value stocks, LVOrds (Panel 3, Table 1). Two important issues are worth noting about these findings. First, the lower returns on small growth stocks compared to large growth stocks suggest a size effect for growth stocks. Second, they suggest that it is the value premium in the small stocks that increases their returns over large stocks. [15] also finds a reversed size effect on growth stocks. Most previous studies also find a higher value premium than a size premium, which is an indication of what has specifically been stated in this study, that it is the value premium in small stocks for their higher performance than large stocks. The specifics of this finding merit further research.

SOrds, GOrds, SVOrds, MGOrds, and LGOrds portfolios display excessive levels of skewness relative to a normal distribution. SOrds, SVOrds and bond portfolios display excessive levels of kurtosis as well. The combined effect of skewness and kurtosis is measured through the Jarque-Bera statistic. Based on the Jarque-Bera test, the null hypothesis that the return distributions are normal is not rejected, except for SOrds, SVOrds and bond portfolios. SOrds and SVOrds are the only two portfolios with excessive levels of both skewness and kurtosis, and this combined effect leads to abnormal distributions (Table 1). The skewed finding in the distribution of returns is an indication of biased higher returns than the normal distribution, which further confirms higher returns to small and low book value (value) stocks. This finding complements the earlier coefficient of variation result. The return characteristics of neutral (medium) growth and medium value portfolios are shown to be within the middle range. This is consistent as per their neutral position towards size and value tilt. The ALL ordinaries and large ordinaries, with a combination of large growth portfolios, are shown to have performed the poorest. This is due to the lower performance of large growth stocks, which dominates these portfolios.

4.2. CAPM Analysis

The ex-post model of the CAPM can be expressed as follows:

$$R_I - R_F = \beta_I (R_M - R_F) + \varepsilon_I \qquad (3)$$

$Where: \mathrm{R_I} = return$ on the index, $\mathrm{R_F}$ = risk free rate, performance, $\beta_\mathrm{I} = beta$ of the index, $\mathrm{R_M}$ = return on the market index, ε = ramdom error term

The time series regression takes the form of equation 4.

The alpha and random error terms are assumed to be insignificant in the CAPM equation (3). However, in the regression analyses, the alpha is usually estimated to test the reliability of the beta as the sole risk estimator. The null hypothesis is alpha = 0. The CAPM results are shown in Table 2.

$$R_I - R_F = \alpha + \beta_I (R_M - R_F) + \varepsilon_I \qquad (4)$$

The LHS assets are the monthly risk premiums of eleven portfolios sorted on size and BV/MV factors. The RHS variables are the single factor CAPM market betas. The study period spans from 1st January 2000 to 31st December 2017. The All Ordinaries index is used as the market index. 2-tailed test statistics are employed to determine the importance of the coefficients. Hence, the significant coefficients are marked by asterisks.

Table 2 The realized annual mean returns and excess returns, the CAPM estimated annual mean returns, excess returns left out by the CAPM, and the beta coefficients with t-stats

Nos	Indices	Beta	t-stats	Actual Annual Mean Return	Annual Mean Risk Premium	CAPM Annual Risk Premium	Excess of CAPM
1	SOrds	0.38	(3.13)*	13.30%	9.80%	2.09%	7.71%
2	MOrds	0.76	(6.00)*	11.32%	7.82%	4.25%	3.57%
3	LOrds	0.90	(5.85)*	9.81%	6.31%	4.99%	1.32%
4	VOrds	0.75	(6.78)*	14.52%	11.02%	4.17%	6.86%
5	GOrds	0.86	(5.60)*	8.62%	5.12%	4.78%	0.34%
6	SVOrds	0.32	(1.84)	20.38%	16.88%	1.78%	15.10%
7	MVOrds	0.83	(5.73)*	14.00%	10.50%	4.60%	5.90%
8	LVOrds	0.81	(6.04)*	15.04%	11.54%	4.53%	7.01%
9	SGOrds	0.34	(2.36)	7.07%	3.57%	1.87%	1.70%
10	MGOrds	0.73	(5.71)*	8.94%	5.44%	4.09%	1.35%
11	LGOrds	0.97	(5.09)*	8.56%	5.06%	5.39%	-0.33%
12	Bond	0.20	(2.50)*	5.62%	2.12%	1.09%	1.04%
13	Market Index	1.00		9.07%	5.57%	5.57%	0.00%
	Risk Free	0.00		3.50%			

* denote significance at the 5% levels

Table 2 highlights the actual annual mean returns, the actual annual excess mean returns, the annual returns as per CAPM prediction, and beta coefficients for the portfolios sorted on firm size and BV/MV factors. The All Ordinaries index is used as the market index. The coefficients and the CAPM returns are evaluated by regressing monthly excess returns of every individual portfolio against the market index's excess monthly returns. The beta coefficients compare the risk premiums' co-variability on the portfolios sorted by size and BV/MV factors against the risk premiums on the market index. The results show that risk premiums on all portfolios are positive. As expected, this suggests that investors usually are risk-averse and only prepared to take just an extra risk for extra return. The testable implication of the CAPM shows the null the (R_M-R_F) > 0 is not rejected. The beta coefficients for all portfolios except for small value and small growth portfolios are significant at a 5% significance level. This indicates that the market factor is significant in explaining risk premiums on the portfolios. The null hypothesis of beta = 0 is not rejected. Although in this case, an alternative hypothesis (alpha is = 0) cannot be rejected at the 5%

level for SVOrds and SGOrds. This indicates that betas do not fully elucidate the risk premiums on small value and growth stocks.

The betas for small and value portfolios are generally low and lower for value portfolios than growth portfolios (Table 3). From our finding of higher returns on small and value portfolios over large and growing, the opposite is needed for the CAPM to explain size and value premiums in stock returns. The CAPM failure to explain size and value premiums in stock returns supports the original findings by [22], which led them to develop the three-factor model. It is also consistent with the similar findings of several previous studies, including the Australian studies by [17], [19], [21]. [15] also finds similar results for several international stock markets. Due to the lower market betas for small and value portfolios, the CPAM estimated risk premiums are significantly lower than the realized risk premiums on these portfolios. For example, the CAPM leaves out as much as 7.71%, 6.86%, 15.10%, 5.90%, and 7.01% of the covariation in returns unexplained per annum on SOrds, VOrds, SVOrds, MVOrds, and LVOrds, respectively. See table two numbers 1, 4, 6, 7, and 8. CAPM's misspecification is the largest for the small value portfolio, which has the lowest market beta. The alpha or idiosyncratic risk, not shown here, are significant for these portfolios. The positioning of the portfolios in relation to the CAPM security market line is depicted in Fig. 2. The dotted lines alongside the security market line demonstrate the importance of alpha values at the 5% level. The alphas of the portfolios outside the dotted lines are contemplated to be positive and significantly away from zero in the rejection region of the alphas. Alphas for SOrds (1), VOrds (4), SVOrds (6), MVOrds (7), and LVOrds (8), respectively, clearly are outside the alpha ≠ zero region. These are mostly value portfolios across the three size groups, with SVOrds portfolio labeled as number 6 is the most significant outlier. This is a minimal and value portfolio. The betas for these portfolios are lowest with the alphas or idiosyncratic risk significant (Fig. 2). This figure depicts the size and BV/MV sorted portfolios' position in relation to the CAPM market Line. A plus /minus 5% significance band is provided around the CAPM market line to capture the variable in error on the regression model. The alphas outside this region are considered significantly away from zero with an interpretation that the null hypothesis, alpha ≠ zero, rejected. The market line is extended from the risk-free (RF) rate of 3.5% through the beta of 1 for the market index. The All Ordinaries index is used as the market index. The study period is from 1st January 2000 through 31st December 2017.

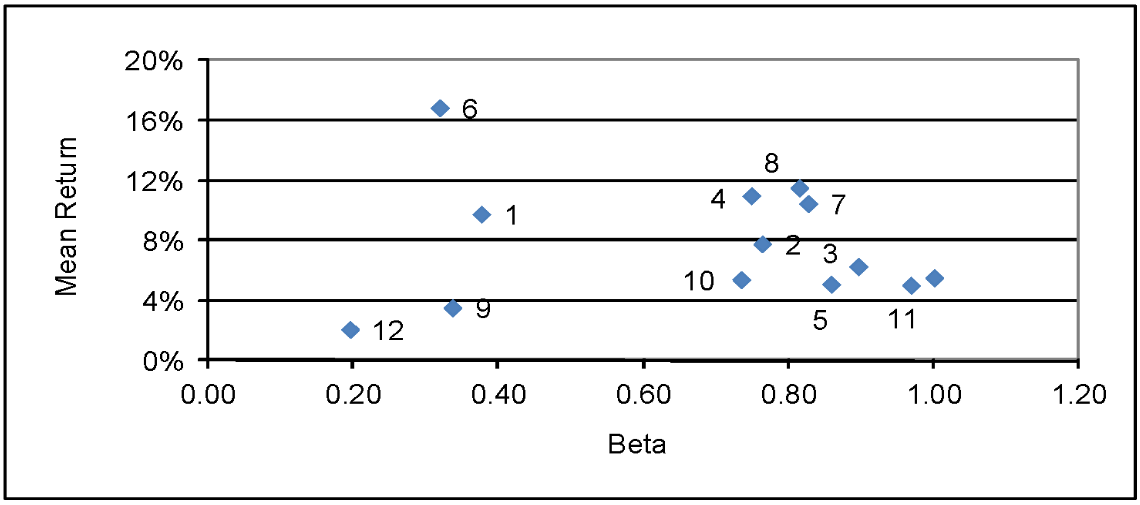

Fig. 2 Position of BV/MV

From these results, it could be concluded that the single index market model is an inappropriate model for capturing the returns on minimal and value stocks. This finding corresponds with the earlier findings. Further confirmation of the present higher risk in stock returns beyond that could be fully explained by the stocks' market betas' systematic risk. The left out risk beyond market beta is described as idiosyncratic risk or residual risk. How the extended three-factor model captures this additional risk is analyzed next.

5. The Fama-French Three-Factor Model

The Fama French Three-factor model is an extension of the CAPM, including two additional variables, SMB and HML. The ex-ante form of the model can be expressed as follows:

$$E(R_I)t - RF(t) = \beta_I[(E(RM)t - RF(t)] + s_I E(SML)t + h_I E(HML)t + \varepsilon(t)_i \quad (5)$$

$$Where:\ E(R_M)-R_F,\ \beta_I, E(SML),\ E(HML),\varepsilon_1\ are\ expected\ returns\ on\ the\ market,\ size\ factor\ in\ stocks\ and\ BV/MV\ factor\ in\ stocks;\ \beta_I, s_I, h_I\ are\ the\ slopes\ in\ the\ time\ series\ regression\ for\ each\ factor\ loading\ respectively.$$

The time series regression takes this form,

$$R_I(t) - RF(t) = \alpha + \beta_I[RM(t) - RF(t)] + s_I(SML)(t) + h_I(HML)(t) + \varepsilon_I(t) \qquad (6)$$

where: *Ri(t)* is the return on the asset *I* for month *t*, *RF(t)* is the risk-free rate, *RM(t)* is the market return, *SML(t)* is the difference between returns on diversified portfolios of small stocks and big stocks, and *HML(t)* is the difference between returns on diversified portfolios of high book-to-market (value) stocks and low book-to-market (growth) stocks.

As shown in Table 2 and Fig. 2, CAPM leaves the significant variation in stock returns unexplained. Table 3 presents the FF three-factor model, which, in addition to the market factor (beta coefficient), includes slope coefficients on small minus large (SML) and high minus low (HML) factors to capture the residual covariations in the excess returns. The spreads on SML are the difference in returns between small and large indices. The spreads on HML are the difference in returns between stocks with high and low book values. Positive spreads on SML indicate small stocks outperforming large ones, and positive spreads on HML indicate value outperforming growth. The time series regression results in Table 3 show that all alpha values are generally lower than the CAPM alpha values. None are significant at the 5% level. The market betas for SOrds, SVOrds, and SGOrds, which were extremely low (statistically not distinguishable from zero) by the CAPM estimates, improved in the three-factor model (Table 1, Panel 3). The test statistics suggest that most betas are in the range of two to four standard deviations from zero. This finding is in line with the findings of improvements in beta estimates by the FF model for small stocks [6]. Similar findings have also been reported by [17], [18], and [19] for Australian stocks. SOrds, SVOrds, and SGOrds have positive and significant loadings on the SMB slope coefficients, which indicates the presence of small firm premiums in the returns for these portfolios. The SMB coefficients are negative and significant for high value and growth stocks (Table 3, Panels 2–3). The negative slopes, particularly for LOrds, LVOrds, and LGOrds, indicate a lack of a size premium. The slopes on SMB for medium size-based indices should be zero. The insignificant slopes on SMB for MOrds, MVOrds, and MGOrds support this hypothesis. Overall, the regression results for SMB support the size premium hypothesis for Australian stocks and are consistent with the findings reported in the stock market literature [4], [6], [15], [17], [21], [22].

Table 3 shows the regression results of the Fama-French three-factor model. The estimated model is shown in Equation 6, where *Ri(t)* is the return on asset *I* for month *t*, *RF(t)* is the risk-free rate, *RM(t)* is the market return, *SMB(t)* is the difference between returns on diversified portfolios of small and big stocks, and *HML(t)* is the difference between returns on diversified portfolios of high (value) and low (growth) book-to-market stocks. The *t*-statistic for the regression coefficients uses HAC standard errors. The adjusted R^2 is calculated for each equation in the system. The *D*-statistics, which test for spurious relationships in the regression model, are also reported. The All Ordinaries index is used as the market index. The study period is from January 1, 2000 to December 31, 2017, with 216 monthly observations analyzed.

Table 3 The regression results of the Fama-French three-factor model

Dependent Variable	Alpha (t-stat)	Beta (t-stat)	SMB (t-stat)	HML (t-stat)	Adjusted R-Squared	Standard Errors	Durbin Watson
Panel1 - Indices by Size: Small, Medium and Large							
SOrds	0.004	0.833	0.290	0.229	0.820	0.020	1.979
	(1.23)	(4.49)*	(4.55)*	(2.16)*			
MOrds	0.006	0.630	-0.275	-0.053	0.633	0.023	2.130
	(1.98)	(4.94)*	(-3.85)*	(-0.45)			
LOrds	0.004	0.450	-0.710	0.229	0.626	0.020	1.979
	(1.12)	(4.49)*	(-11.13)*	(2.16)*			
Panel 2 - Indices by BV/MV Ratio							
VOrds	0.004	0.732	-0.409	0.553	0.523	0.019	2.080
	(1.88)	(5.45)*	(-6.65)*	(5.42)*			
GOrds	0.005	0.228	-0.508	-0.100	0.521	0.020	2.004
	(1.68)	(4.46)*	(-8.08)*	(-0.96)			
Panel 3 - Indices by Size and BV/MV Ratio							
SVOrds	0.005	0.920	0.327	0.865	0.800	0.025	1.977
	(1.88)	(2.93)*	(4.08)*	(6.49)*			
MVOrds	0.006	0.970	-0.311	0.200	0.750	0.026	2.253
	(1.47)	(4.48)*	(-3.87)*	(1.47)			
LVOrds	0.003	0.623	-0.630	0.811	0.601	0.022	1.962
	(1.60)	(4.65)*	(-9.06)*	(7.03)*			
SGOrds	0.004	0.863	0.236	-0.787	0.431	0.021	1.845
	(1.65)	(4.29)*	(3.48)*	(-7.05)*			
MGOrds	0.006	0.876	-0.174	-0.344	0.580	0.023	2.215
	(1.72)	(5.29)*	(-2.47)*	(-2.89)*			
LGOrds	0.005	0.760	-0.676	0.007	0.555	0.022	2.003
	(1.23)	(3.68)*	(-9.56)*	(0.06)			

VOrds, SVOrds, and LVOrds have significant positive slopes on HML. Significant positive slopes on high BV/MV (value indices) indicate a value premium in the returns of these portfolios. Negative or insignificant slope coefficients indicate a lack of the same premium. This should be the case for growth indices, and the results indeed confirm this hypothesis. Like the findings regarding SMB, the finding for HML is also consistent with the stock market literature and supports the hypothesis that small and value stocks outperform large and growth stocks. The overall regression results from the FF model seem to support the findings of [6] and [24] that the size effect is mostly driven by marginal companies in distress. These are usually small firms with depressed earnings and future growth, and thus the market drives their MVs below their BVs (high BV to low MV; value firms). Therefore, like small firms, value firms tend to have high returns and positive slopes on the SMB and HML factor loadings. The higher returns on small and value firms are supposed to compensate investors for the high risk due to depressed earnings and future growth (i.e., a higher capitalization rate implies a high return due to expected low future growth). Conversely, strong (usually large) and growth firms are shown to have negative slopes on the SMB and HML factor loadings. The market values of these firms are usually higher than their book values in anticipation of high future growth, and the capitalization rates are low, implying higher expected returns from future growth. Therefore, investors accept initially low returns by paying a high price, in anticipation of a low risk and high growth in the future values of these firms. The cumulative monthly spreads on SMB and HML over the 18-year study period are graphically depicted in Fig. 3. The results show that over the 18 years, the value premium depicted by HML increased by 87% [(1,876 − 1,000) / 1,000], that is, by almost 4.8% per year. The small firm premium depicted by SMB, however, was more volatile than the value premium. It was negative between 2001 and 2003, hovering around the 950 level, gradually increasing to 1,600 in April 2016, i.e. by almost 60% [(1600 − 1,000) / 1,000], and then following a decreasing trend similar to HML through to December 2017. The size effect was negative from 2001 to 2003 and then became significantly positive from 2007 to 2017, which is consistent with the negative size effect reported by [19] and the positive size effect reported by [25] respectively. Time-variant volatility in the firm size premium was also found by [26] and [27]. Therefore, the findings of this study confirm the results of Faff [19] for a different extended period including newly constructed SMB and HML variables.

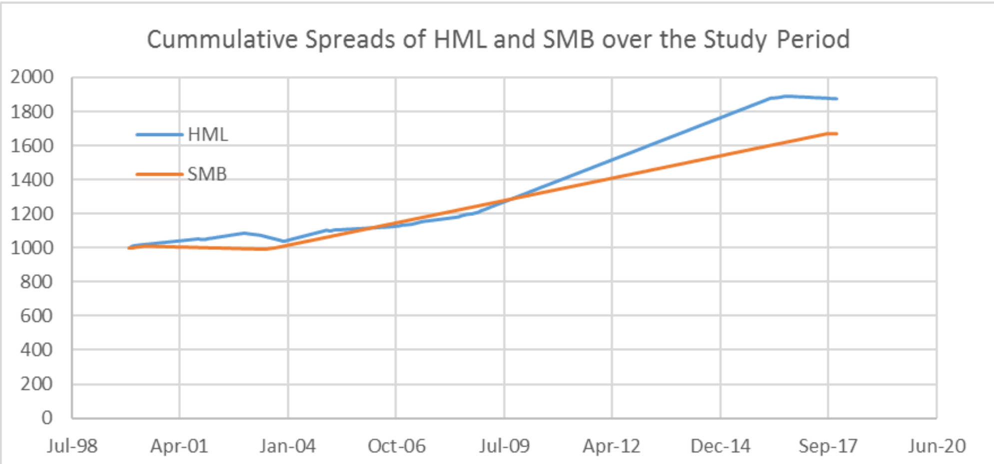

Fig. 3 Cumulative spreads on SMB and HML. The study period was from January 1, 2000, till December 31, 2017, with 216 monthly observations analyzed

The finding of time-variant effect on SMB also added to the debate of [28] and [29]. [28] found evidence to suggest that small-capitalization shares underperformed large-capitalization shares between 1990–1998. [29] provided a contradictory explanation to [28] by showing evidence that the size effect tends to move in cycles. The movement in SMM spread in this study exhibited a cyclical pattern as well. The spread was thinner from 2000 through 2001, became negative from 2001 through 2003, widened over 2004 through 2010 and became thinner again after 2011 through 2017. The general pattern of the value spread was upward (Fig. 3). The existence of strong and persistent value premium shows in the regression results. The increased HML as average book-to-market ratios rose led to a positive and significant factor loading for the value portfolios. This result is robust evidence that HML has significant explanatory power in explaining variations in returns of Australian stocks. These results are consistent with international studies on the three-factor model [15], [17], [21], [22], [30], [31].

6. Conclusion

The findings by [4] and [32] suggested that the CAPM is not specific in estimating risk premiums for small stock. Estimated low betas for small firms is reflected in this current study. Similar earlier studies in Australia by [19], [17], [21] showed promising results. This study highlights that market betas for small firms are normally low compared to the realized risk premium and that CAPM is unable to estimate 5% of the realized annual risk premium. Furthermore, this study also demonstrates that the market betas on small firms normally improve by almost 10% in the FF three-factor model, while the improved betas reduce the unexplained CAPM risk premiums by 2% per annum. Additionally, the SML and HML factors mimicking size premiums and value premiums, respectively, further reduce the unexplained CAPM risk premiums by 3%. Thus, the FF three-factor model is able to capture almost all of the realized risk premiums on small-value Australian stocks. [21] sample set mainly includes stocks in ASX 300, while [21] handpicked stocks come from AGSM data base and extend significantly by including smaller stocks. The studies also claim to have improved the data sorting method. However, the results validated evidence that the value premium is not significantly different. They also showed evidence of the negative side. Interestingly, the findings of this study on both size and value premium are significantly different from previous studies. Therefore, criticisms of recent Australian studies on earlier studies are questionable. Although the later studies expanded sample sizes, extended study periods and improved portfolio construction methods, they mostly provided rigor and robustness to the analysis and reconfirmed most of the earlier findings as opposed to seriously refuting any particular result.

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