Tangibility and Investment Irreversibility in Asset Pricing

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Abstract

Zhang (2005) and Cooper (2006) provide a theoretical risk-based explanation for the value premium by suggesting a nexus between firms' book-to-market ratio and investment irreversibility. They argue that unproductive physical capacity is costly in contracting conditions, but provides growth opportunities during economic expansions, resulting in covariant risk between firms' investment in tangible assets and market-wide returns.

This paper uses the Australian accounting environment to empirically test this theory – a test that is not possible using US data. Consistent with the theoretical argument, tangibility is priced in equity returns, and augmenting the Fama and French three-factor model with a tangibility factor increases model explanatory power.

1. Introduction

Fama and French (1993) developed the three-factor asset pricing model in response to numerous studies identifying anomalies that are not priced by the Capital Asset Pricing Model (CAPM). While the Fama and French (1993) model has strong explanatory power, it is criticised in the literature for being empirically driven. Debate remains regarding the source of the size and value premia, with various studies arguing that they are a function of data snooping (Kothari, Shanken and Sloan, 1995), market inefficiency (Lakonishok, Shleifer and Vishny, 1994) and risk (Fama and French, 1996).

Zhang (2005) and Cooper (2006) provide a risk-based explanation for the value premium. Both argue that the proportion of a firm's tangible assets or assets-in-place represents a measure of market-wide risk. During an economic downturn, firms with a high proportion of tangible assets have excess unproductive capacity – capacity that is largely irreversible (Cooper (2006)). Conversely, in an upturn, firms with a high proportion of tangible assets have the installed physical capacity to take advantage of positive shocks. Firms without tangible assets-in-place incur a lag in acquiring assets to take advantage of positive aggregate shocks.

As detailed by Zhang (2005) and Cooper (2006), this relationship between assets-in-place and the business cycle results in covariance risk between tangible assets and market-wide returns. This relationship is consistent with the value premium being in part explainable by a tangibility factor, and consistent with a tangibility factor having explanatory power in addition to that of the three-factor model.

Australian accounting regulations provide an environment to test the Zhang (2005) and Cooper (2006) theory that is not available in markets such as the United States. Prior to the adoption of International Accounting Standards in 2005, the liberal stance of fair value accounting that has traditionally characterised Australian regulation provided firms with wide scope to capitalise intangible assets[1]. Specifically, certain internally generated intangible assets, such as brands, mastheads and customer lists, could be capitalised under Australian Generally Accepted Accounting Principles (GAAP) but not under United States GAAP. Therefore, the balance sheet of Australian companies provides a more complete disclosure of the proportion of tangible and intangible assets than do their United States counterparts.

Consistent with the Cooper and Zhang theory, tangibility is found to be priced in Australian equity returns. Also consistent with their theory, adding a tangibility factor to the Fama and French three-factor model results in increased explanatory power and a reduction in explanatory power of the book-to-market factor.

Over a 32-year sample period, this paper shows that a positive and statistically significant return is generated on a zero investment portfolio that comprises a long position in firms with a high proportion of tangible assets and a short position in firms with a low proportion of tangible assets. These results are maintained after controlling for both the size and value premia. The magnitude and significance of the book-to-market factor decreases after controlling for tangibility, while the magnitude and significance of the small firm premium does not change. These results are consistent with the hypothesis proposed by Zhang (2005) and Cooper (2006), as they empirically demonstrate that the value premium may be partly explained by the risk of investment irreversibility. The four-factor model constructed with this additional factor representing tangibility is also shown to have increased explanatory

[1] Clinch and Barth (1998) observed that Australian accounting standards allow for the capitalisation of a wider range of intangible assets compared with those able to be recognised in the United States. They found a positive relationship between revalued intangible assets and share prices, although they did not control for the size and book-to-market premia.

power (as measured by adjusted R^2) when compared with the Fama-French three-factor model.

The paper proceeds as follows. Section 2 examines Australian and international asset pricing literature. Section 3 discusses the data and the research design. Section 4 presents the results of time series tests of the Fama and French (1993) three-factor model and the tangibility-augmented asset pricing model in Australia. Section 5 provides a summary.

2. Literature Review

Fama and French (1993) examined a long time series of equity returns and found that a statistically significant, positive return could be earned by investing in a zero investment portfolio that takes a long position in firms with small market capitalisation and a short position in large firms (SMB premium). Similarly, a zero investment portfolio consisting of a long position in firms with a high book-to-market ratio and a short position in firms with a low book-to-market ratio also produced a significant, positive return (HML premium). Upon augmenting the CAPM with these two additional variables, Fama and French (1993) demonstrated that this three-factor model explained a significantly greater amount of the variability in equity returns.

The most comprehensive study of the validity of the Fama and French (1993) three-factor model in Australia was undertaken by O'Brien, Brailsford and Gaunt (2008).[2] In both time-series and cross-sectional tests, both the size and book-to-market premia were found to be

[2] Further examinations of the applicability of the three-factor model in Australia have been performed by Fama and French (1998), Halliwell, Heaney and Sawicki (1999), Faff (2001) and Gaunt (2004). While these studies were unable to replicate Fama and French (1993) using Australian data, they were all limited by including only a small number of firms and examining only short sample periods.

positive and significantly different from zero. The Fama-French (1993) three-factor model was also found to have a superior ability to explain Australian equity returns compared with the CAPM.

While debate as to the source of the size and value premia remains unresolved, one common hypothesis is that these premia are due to an increased amount of syematic risk being borne by investors who hold small-firm and value securities. Fama and French (1996) argue that the source of excess returns on these securities is increased default risk. In particular, it is argued that the cash flows for small firms are more volatile, hence they are more likely to default than larger firms. Firms with a high book-to-market ratio are likely to have a distressed share price, similarly indicating an increased probability of default. However, this default risk argument has been bought into question, with Vassalou and Xing (2004) reporting that while default risk is priced in equity returns, it does not explain the size and value premia. In an Australian study, Gharghori, Chan and Faff (2007) found no evidence of default risk being priced, and therefore concluded that it was not a systematic risk factor and that it could not explain the premiums on the Fama-French factors. Over a longer time-series[3], Chan, Faff and Kofman (2009) found that while the default risk premium was positive and significantly different from zero, it did not explain the size or book-to-market premia.

An alternative hypothesis used to explain the value premium is based on the irreversibility of capital investment. Zhang (2005) argues that due to costly reversibility, assets-in-place are riskier than growth options in times of economic contraction. Assets-in-place and growth

[3] Gharghori, Chan and Faff (2007) only had a 9-year sample period (1996-2004), while Chan, Faff and Kofman (2009) had a 30-year sample period (1975-2004).

options were shown to be equally risky in periods of expansion. He therefore argues that value firms have counter-cyclical betas while growth stocks have pro-cyclical betas.

These findings are supported by Petkova and Zhang (2005), who constructed an *ex ante* model of the market risk premium as a proxy measure of the business cycle. A positive correlation was found to exist between conditional betas of value firms and this measure of the business cycle, while the conditional betas of growth firms were negatively correlated to the business cycle. Therefore, value firms are riskier than growth in economic contractions, but growth firms are more risky during aggregate expansion, with the book-to-market premium being a covariant risk factor that can be explained by the countercyclical pricing of risk.

Cooper (2006) derived a real options model in order to explain the value premium. He argued that where a company has a large amount of idle physical capacity, the book value of a firm in distress remains constant but its market value decreases, thus increasing its book-to-market ratio. This is because costly irreversibly means that capital investment remains relatively constant across time. Those firms with physical assets-in-place are more sensitive to aggregate market conditions, given that idle capacity can be employed in boom periods to increase output without the need for costly investment. Cooper (2006) argues that firms with a high book-to-market ratio are those that have invested in a larger proportion of installed capital capacity and are therefore more sensitive to aggregate conditions and have high systematic risk.

The Cooper theory can be directly tested by determining whether tangibility is priced in equity returns as a covariant risk factor. As investment in assets-in-place is largely irreversible, tangible assets are more costly during an economic contraction. Investment in tangible assets also provides capacity that enables firms to take advantage of positive aggregate shocks without the need for further investment. Furthermore, if the value premium is in part capturing the risk of investment irreversibility, the HML factor will have reduced ability to explain returns when regressed along with a measure of investment irreversibility, namely tangibility.

3. Data and Research Design

3.1. Data

This study examines a 32-year period from 1975 to 2006, which is the longest time series examined in an asset pricing setting in Australia. A long time-series of data is required to perform asset pricing tests that allow for the examination of the relationship between equity returns and the tangibility of assets across multiple business cycles.

Monthly price relative and market capitalisation data were obtained for each firm from the Australian Graduate School of Management (AGSM) database. The value-weighted market index and monthly 13-week Treasury note yield were also obtained from the AGSM file, with the latter used as a proxy for the risk-free return. The balance sheet data (book-value and net intangible assets) were obtained from Aspect Financial for the period 1992 to 2006. Prior to 1992, accounting data was collected from the Australian Stock Research Service Summarised Balance Sheet and Profit and Loss Statements.[4]

Fama and French (1993) argue that only firms with ordinary common equity should be included in the study of their three-factor model. Therefore, all listed trusts and financial firms were deleted from the sample. When constructing the independent variables, firms with a negative book value are removed from the study, as are those firms with extremely high book-to-market values.[5] To avoid look-ahead bias, only firms with a balance date greater than or equal to six months prior to portfolio formation were included. The book-to-market ratio was calculated as the book-value of ordinary equity divided by the market capitalisation of equity.

A characteristic of the Australian equities market is that trading is concentrated within a small number of firms with large market capitalisations. Therefore illiquidity presents methodological problems as some firms do not trade across the period that returns are calculated. Where a company does not trade in a particular month, three possible assumptions may be made regarding the allocation of returns to that firm in the period that it does not trade and in the subsequent month. These firms could be assigned the return on the market portfolio, or the risk-free rate of return, or the return of all traded firms within the portfolio in which the illiquid firm is allocated. All three assumptions were tested and the results reported in this paper assume the market return.

[4] Book Value is defined as Net Assets.

[5] All companies with a book-to-market ratio greater than ten are removed. However, robustness tests were performed and the significance of the results was not altered when this filter rule was changed to only eliminate companies with a book-to-market ratio greater than 20.

Across the sample period examined in this paper, the average value-weighted market risk premium is 0.67% per month. Therefore, assuming a risk-free rate of return would result in negative abnormal returns being attributable to firms that do not trade.[6]

The negative relationship between illiquidity and firm size results means that using the return of all traded firms within the portfolio in which the illiquid firm is allocated provides biased estimates of the small firm premium. As past literature has found a positive size premium[7], applying the return on other firms in the portfolio would result in illiquid stocks being deemed to earn positive abnormal returns in the periods across which they do not trade. Assuming illiquid firms earn the return of other firms in their portfolio results in an SMB premium of 3.9% per month, which is implausibly high. The return on the market portfolio is a more conservative estimate of the returns generated by firms that do not trade.

3.2 Independent Variables

Portfolio Construction

Fama and French (1993) constructed their three-factor asset pricing model by forming six portfolios, sorted by market capitalisation and the book-to-market ratio. The current paper replicates these six portfolios to form the SMB and HML independent variables, which are designed to mimick the underlying risk factors in returns related to firm size and the book-to-market ratio. An additional two-way split is carried out based on the ratio of intangible assets to net assets (intangibility ratio). The tangibility (TMI) portfolio is constructed to mimic the

[6] The significance of the size, book-to-market and tangibility premia is the same whether the market return or risk-free rate is attributed to illiquid firms. In both cases, the tangibility-augmented model is shown to have increased explanatory power compared with the Fama-French three-factor model. Therefore, the results are robust to changes in this assumption.

[7] See O'Brien et al. (2008).

underlying risk factor in returns that is related to investment irreversibility. Twelve portfolios are constructed from the intersection of the size, book-to-market and tangibility groups. These portfolios are then used to construct the independent variables in the tangibility-augmented model. Summary statistics for each of the independent variables are reported in Table 1. As shown in the fifth column, the number of firms for which intangible assets were more than 5% of total assets varies considerably across the sample period. This number increased from 9% of the total sample in 1975 to 34% in 2006. The median intangibility ratio of firms with a material amount of intangible assets has also increased through time, ranging from 17% in 1975 to 25% in 2006.

[Table 1 about here]

Each December from 1974 to 2005, firms are ranked on their book-to-market ratio each December and the sample is split into three groups; low (bottom 30%), medium (middle 40%) and high (top 30%)[8]. Independently, firms are ranked using market capitalisation. The median is then used to split firms into two portfolios, namely small and big. Firms are also ranked each December according to their ratio of intangible assets to net assets. All firms with zero intangible assets or a ratio of less than 5% are placed in the tangible portfolio, while the remaining firms are classified as the intangible group.[9] The 5% cut-off is used as any proportion of intangible assets less than 5% of the net total assets is deemed to be

[8] As most firms in Australia have a June financial year end, we rank firms in December so that for most firms, there is a six-month lag between their book value and market value. This is analogous to the Fama-French (1993) methodology except that the majority of US firms have a December financial year-end.

[9] Robustness tests were performed by forming the intangible portfolio with firms that had an intangibility ratio greater than 10% and 20% respectively. While the returns generated on both alternative tests were economically the same as the results in this paper, the sample size of the intangibility portfolio was too small in both instances to provide statistically reliable results.

immaterial.[10] All firms are held within these portfolios from January to December of the year after formation.

Consistent with Fama and French (1993), the SMB mimicking portfolio is calculated as the returns on the zero investment portfolio formed by taking a long position in small firm portfolios and a short position in large firm portfolios. The simple average of returns on the six large-firm portfolios[11] is subtracted from the simple average of returns on the six small-firm portfolios.[12] The HML mimicking portfolio is the difference between the simple average returns on the four high book-to-market portfolios[13] less the average returns on the four low book-to-market portfolios[14]. Similarly, the TMI factor is calculated as the difference between the simple average of returns for the six tangible-firm portfolios[15] and the six intangible-firm portfolios.[16]

[10] This assumption is consistent with Australian Accounting Standards. In devising qualitative thresholds for guidance in determining the materiality of an amount, AASB 1031 states that amounts less than 5% of an appropriate base may be assumed to be immaterial.

[11] The six big-firm portfolios are Big/Low/Tangible, Big/Low/Intangible, Big/Medium/Tangible, Big/Medium/Intangible, Big/High/Tangible, Big /High/Intangible.

[12] The six small-firm portfolios are Small/Low/Tangible, Small/Low/Intangible, Small/Medium/Tangible, Small/Medium/Intangible, Small/High/Tangible, Small/High/Intangible.

[13] The four portfolios on high book-to-market firms are Small/High/Tangible, Small/High/Intangible, Big/High/Tangible and Big/High/Intangible.

[14] The four portfolios on low book-to-market firms are Small/Low/Tangible, Small/Low/Intangible, Big/Low/Tangible and Big/Low/Intangible.

[15] The six tangible-firm portfolios are Small/Low/Tangible, Small/Medium/Tangible, Small/High/Tangible, Big/Low/Tangible, Big/Medium/Tangible and Big/High/Tangible.

[16] The six intangible-firm portfolios are Small/Low/Intangible, Small/Medium/Intangible, Small/High/Intangible Big/Low/Intangible, Big/Medium/Intangible and Big/High/Intangible.

Mimicking Portfolio Returns

Table 2 provides the average monthly returns on the zero investment portfolios used as independent variables in each of the regressions undertaken in this study. Panel A reports the returns on the SMB and HML factors that are formed using a replication of the Fama-French (1993) methodology. The premia on the size (0.514% per month) and book-to-market (0.557% per month) portfolios are both positive and significantly different from zero at the 5% confidence level. This is consistent with previous Australian literature (see O'Brien et al, 2008). Panel B reports the return statistics for the independent variables used in the tangibility-augmented model. Following the addition of a factor to represent the risk of investment irreversibility, a positive average monthly return is found to exist for the SMB 2x3x2 (0.512%), HML 2x3x2 (0.387%) and TMI 2x3x2 (0.279%) factors. The SMB factor remains significantly different from zero at the 5% level after controlling for TMI, while the HML factor becomes insignificant.

[Table 2 about here]

Characteristics of Firms with Tangible Assets

Given that this is the first investigation of tangibility of assets as a factor in asset pricing, it is important to consider the different characteristics of firms that invest in tangible and intangible assets. It is shown that firms with a material proportion of intangible assets are, on average, larger than firms whose assets are predominantly tangible. Firms in the tangible portfolio have an average market capitalisation of $299 million, compared with those in the intangible portfolio that have, on average, a market capitalisation of $1017.81 million.

The method of constructing independent variables employed by Fama and French (1993) and replicated in this study is designed to control for the other regressors in the asset pricing model. The effectiveness of this methodology is evident in the low correlation between the SMB and TMI factors (-0.02). There is a small positive correlation between the TMI and HML factors (0.20), however this is smaller in magnitude than the correlation between the two Fama and French factors (-0.34). This provides evidence that the regressors in the tangibility-augmented asset pricing model are largely independent of each other.

3.3. Dependent Variables

The dependent variables used to analyse both the Fama and French (1993) three-factor model and the tangibility-augmented asset pricing model are the returns on eight portfolios formed at the intersection of a 2x2x2 split based on size, book-to-market ratio and tangibility. In December of each year all firms are sorted by size and split at the median. Independently, the sample is sorted by the book-to-market ratio and similarly divided into high (top 50%) and low (bottom 50%) book-to-market portfolios. An independent two-way split is carried out based on tangibility. Firms with no intangible assets and an intangibility ratio less than 5% are placed in one category, while those with an intangibility ratio greater than 5% are placed in another.[17] A traditional split at the median, such as the one performed by Fama and French

[17] The dependent variables were also constructed using a 2x3x2 split based on size, book-to-market and tangibility, as well as using the 5x5 split based on size and book-to-market adopted by Fama and French (1993). The results were found to be robust to changes in the construction of the dependent variable. Regardless of the manner in which the dependent variables were formed, the average adjusted R^2 of the tangibility-augmented model was always higher, and there were also less significant constant terms compared with the Fama-French three-factor model.

(1993), is not possible for tangibility given that more than half of all firms do not capitalise any intangible assets across the sample period.

The number of portfolios that can be constructed as dependent variables is limited due to sample size problems created by the smaller number of firms in the intangible portfolios. Therefore, eight portfolios are constructed from the intersections of the size, book-to-market and tangibility break points. The value-weighted monthly returns are calculated for each of these portfolios from January to December and portfolios are reformed annually. The composition of each portfolio is recalculated on an annual basis. The monthly excess returns on these eight portfolios for January 1975 to December 2006 are the dependent variables used in the time-series regressions to test both the basic Fama and French model and the tangibility-augmented model.

Table 3 provides descriptive statistics for the eight portfolios used in the analysis of both the basic three-factor asset pricing model and the tangibility-augmented model. Column 4 reports the average number of firms within each of these portfolios. After creating portfolios with a 2x2x2 split there are a statistically reliable number of firms in each portfolio, with the smallest number being in the Small/Low/Intangible portfolio, which contained, on average, 35.3 firms each year. A relationship is evident between the market capitalisation and book-to-market ratio of firms. A figure of 61.6%[18] of firms above the median market capitalisation are also below the median book-to-market ratio. As firm size decreases, the number of firms in the value portfolio becomes larger, with 57.9%[19] of small firms possessing a book-to-market ratio above the median. This common characteristic of small firms belonging to the value

[18] The percentage quoted in the text is derived as: (214.7+77.9)/(214.7+77.9+137.2+67.0).

[19] The percentage quoted in the text is derived as: (202.6+90.4)/(169.9+35.3+202.6+90.4).

portfolio is consistent with US (Fama and French, 1993) and Australian (Halliwell, Heaney, and Sawicki, 1999 and O'Brien et al, 2008) evidence. The tangible firm portfolios have a greater number of firms than each of the intangible firm portfolios due to less than half of firms across the sample period capitalising a material percentage of intangible assets.

Column 7 reports the value-weighted monthly returns for the eight portfolios formed on size, book-to-market ratio and tangibility. These results are suggestive that a firm's size, book-to-market ratio and tangibility of assets are all priced in the cross-section of equity returns. All four small firm portfolios achieve higher value-weighted average returns compared with the equivalent large firm portfolios. Three of the four portfolios consisting of small firms earned returns that were statistically different from zero at the 1% level, while only two of the four large firm portfolios earned returns that were significantly different from zero. There is also evidence that the returns earned by firms with a high book-to-market ratio are greater than those generated by companies allocated to the low book-to-market portfolios. All four portfolios comprised of value stocks earned returns that were significantly different from zero at the 5% level (three were significant at the 1% level), while the returns on only one of the four growth stock portfolios were significantly different from zero. The return premiums earned on portfolios consisting of small firms and value stocks are consistent with other asset pricing evidence (Fama and French, 1993; O'Brien et al., 2008).

Small firm portfolios comprised of firms with a higher proportion of tangible assets outperform those with intangible assets. This effect is stronger for small firms. The average returns earned on the tangible portfolios were statistically significantly different from zero at the 1% level in three of the four portfolios, while only two of the four portfolios of firms that report material intangible assets earned returns that were significantly different from zero.

[Table 3 about here]

3.4. Time Series Modelling

Fama and French (1993) propose a three-factor asset pricing model that is expressed as follows:

$$E(R_i) – R_f = b_i[E(R_m) – R_f] + s_i\, E(SMB) + h_i\, E(HML) \tag{1}$$

where R_i is the return on asset i, R_f is the risk free rate of interest, R_m is the return on the value-weighted market portfolio, SMB is the return on the mimicking portfolios for size and HML is the return on the mimicking portfolio for the book-to-market factor.

The empirical counterpart for this model takes the form:

$$R_{it} – R_{ft} = a_i + b_i[R_{mt} – R_{ft}] + s_i\, SMB_t + h_i\, HML_t + \varepsilon_i \tag{2}$$

The Fama and French (1993) model augmented with a tangibility factor may be expressed as follows:

$$E(R_i) – R_f = b_i[E(R_m) – R_f] + s_i\, E(SMB) + h_i\, E(HML) + g_i\, E(TMI) \tag{3}$$

where TMI is the return on the mimicking portfolio for the tangibility factor.

The empirical counterpart for this model is:

$$R_{it} – R_{ft} = a_i + b_i[R_{mt} – R_{ft}] + s_i\, SMB_t + h_i\, HML_t + g_i\, TMI_t + \varepsilon_i \tag{4}$$

The first stage of analysis involves individual regressions of Equations 2 and 4 above. Following from methodology adopted by Chan et al. (2009), systems-based estimations are performed. The null hypothesis in this instance is: H_0: ai = 0; i = 1, 2, …, N, and the restricted version of Equation 4 is given by:

$$r_{it} = b_i\, r_{mt} + s_i\, SMB_t + h_i\, HML_t + g_i\, TMI_t + \varepsilon_i \quad (5)$$

These tests allow for a direct estimation of the mean premia for the four risk factors:

$$r_{mt} = \lambda_m + \varepsilon_{mt} \quad (6)$$

$$SMB_t = \lambda_{SMB} + \varepsilon_{st} \quad (7)$$

$$HML_t = \lambda_{HML} + \varepsilon_{ht} \quad (8)$$

$$TMI_t = \lambda_{TMI} + \varepsilon_{gt} \quad (9)$$

The three-factor model augmented with a tangibility factor is tested using the generalised method of moments (GMM) approach, as employed by Faff (2001). Through a systems-based application of the GMM methodology, non-linear cross-equation restrictions are tested. Accordingly, testing the empirical system of Equations 6, 7, 8 and 9 involves 5N + 4 sample moment equations with 4N + 4 unknown parameters.

The advantage of using the GMM method is that it relaxes the assumption that returns are independent and identically distributed normal. It also allows for the simultaneous estimation of all asset parameters.

4. Results of Time-Series Regressions

4.1. Individual Regressions

Tables 4 and 5 provide the results for the eight regressions used to estimate Equations 2 and 4, respectively. The market risk premium is shown to be an important determinant of Australian equity returns, with the beta coefficient significant at all conventional statistical significance levels for all eight portfolios for both models. Only two of the eight alpha terms are significantly different from zero at the 5% level for the tangibility-augmented model compared with four of the eight coefficients that are statistically different from zero in the basic Fama-French three-factor model.

The size and the book-to-market factors are both important in explaining returns when either Equations 2 or 4 are estimated. Table 4 shows that both SMB and HML are significant for the Fama-French model in the majority of regressions. The estimated loadings on the SMB variable is significantly different from zero at the 5% level in five of the eight portfolios, while the estimated loadings on the HML factor is significantly different from zero at the 1% level in six of eight portfolios. This is consistent with previous Australian studies (O'Brien et al, 2008). Similarly, the results in Table 5 show that both the SMB and HML mimicking portfolios also have power in explaining returns in the tangibility-augmented model. The estimated coefficient on the SMB factor has the expected sign and is significantly different from zero at the 5% level in six of the eight portfolios, while the HML factor is significantly different from zero at the 1% level in seven of the eight regressions.

The estimated coefficients on the TMI factor are significantly different from zero at the 1% level for seven of eight regressions. Therefore, the TMI mimicking portfolio explains variation in equity returns that is not captured by the Fama-French three-factor model. Of note, the estimated coefficients for the TMI variable are significant across as many portfolios as the coefficients on the HML factor and more than the coefficients on the SMB factor. This result provides suggestive empirical support for Cooper's (2006) theory that investment irreversibility is a covariance-based risk factor. As all four factors in the tangibility-augmented model are significant in a majority of portfolios, this model appears to explain additional variance in equity returns that is not captured by the Fama-French (1993) model.

Table 4 also shows that for the Fama-French three-factor model, the average adjusted R^2 across the eight portfolios is 74.4% and ranges from 48.2% to 90.5%. As reported in Table 5, the average adjusted R^2 for the tangibility-augmented asset pricing model across the eight portfolios is 78.1% and ranges from 68.9% to 90.6%. Therefore, the tangibility-augmented model has increased explanatory power compared with the Fama-French three-factor model. This result is suggestive that (a) tangibility of assets plays an important role in explaining Australian equity returns and (b) Cooper's (2006) argument that investment irreversibility is priced in equity returns.

[Tables 4 & 5 about here]

4.2 Systems Regressions

Table 6 presents the results from the systems-estimation of Equation 5. With respect to the GMM test, all three models are rejected at the 1% level. While this result is consistent with the GMM test results reported by Chan et al (2009), it is at odds with the results from the individual regressions, results that showed that both the Fama-French model and the tangibility-augmented model had strong explanatory power, and that both models had greater power in explaining equity returns than the CAPM. Therefore attention is focused on the coefficients of each of the factor premiums. Where a coefficient is positive and significantly different from zero, it can be said to be priced in equity returns.

An examination of the coefficients for the CAPM and Fama-French model demonstrates that, as expected, all factors are priced in returns. The market premium is positive and significantly different from zero for all asset pricing models, as is the SMB premia. The magnitude of the estimated SMB coefficient appears large (0.93% per month), however it is more realistic than that reported in previous Australian studies[20]. The estimated coefficient attaching to the HML factor is also positive and significantly different from zero, with a value of 0.61% per month.

The estimated factor premia on both the excess market return and SMB are positive and significantly different from zero for the tangibility-augmented model. The estimated TMI coefficient is also positive and significant (*t*-statistic 2.12), providing evidence that tangibility is priced in Australian equity returns. The estimated TMI premium is 0.32% per month. Of note, the estimated coefficient on the HML factor becomes insignificant once tangibility is included in the asset pricing model. Both of these results are consistent with the Cooper and Zhang theory that the value premium is derived from the risk of investing in physical assets-in-place.

[Table 6 about here]

5. Summary

Cooper (2006) proposes that the value premium is due to those firms having a common characteristic of irreversible investments, which are riskier in economic contractions. It is argued that tangible assets are largely irreversible and costly in economic downturns.

[20] Chan et al. (2009) and Gharghori et al. (2007) report a SMB premia of 4.7% and 1.7% per month respectively

Following a prolonged downturn, firms with tangible assets have unused capacity and can take advantage of an expansion in the business cycle. Using tangibility as a measure of investment irreversibility, this paper provides empirical evidence in support of the Zhang (2005) and Cooper (2006) theory.

Firms with a high proportion of tangible assets are shown to earn returns of 0.28% per month greater than those with intangible assets after controlling for size and book-to-market. The magnitude and significance of the value premium is reduced after controlling for tangibility, indicating that investment irreversibility is a driving force behind the value premium. When the three-factor model is augmented with a variable representing this tangibility factor, the explanatory power of the model is increased. The average adjusted R^2 of the tangibility-augmented model is 78% (compared with 74% for the basic model), while the *t*-statistic s for the constant terms (mispricing measures) are also lower for the four-factor model. Only two of eight regressions have a constant term that is significant at the 1% level.

Using a systems-estimation, tangibility is found to be priced in the cross-section of equity returns. The HML factor becomes insignificant after controlling for tangibility, providing evidence that this factor may have a role in explaining the value premium. This paper therefore provides evidence that is consistent with the Zhang (2005) and Cooper (2006) hypothesis that investment irreversibility is priced in equity returns and the risk of irreversibility is a key factor in the value premium. A tangibility-augmented asset pricing model is shown to have greater explanatory power than the basic Fama and French (1993) model.

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Table 1: Annual Sample Size and Characteristics

Year (t)	Final Sample	Median Market Capitalisation ($ millions)	Median Book-to-market ratio	Proportion of Firms With Intangibility Ratio >5%	Median Intangibility Ratio Of Firms With Intangibility Ratio >5%
1975	747	14.38	2.08	0.09	0.17
1976	785	19.48	1.95	0.09	0.17
1977	802	20.35	1.93	0.08	0.16
1978	811	22.49	1.76	0.07	0.19
1979	790	27.33	1.50	0.08	0.19
1980	771	41.20	1.28	0.06	0.18
1981	772	62.89	1.03	0.06	0.18
1982	770	54.47	1.24	0.07	0.17
1983	743	51.32	1.61	0.07	0.18
1984	721	75.98	1.29	0.07	0.20
1985	748	70.21	1.20	0.08	0.21
1986	802	94.29	1.12	0.13	0.21
1987	931	139.04	0.96	0.20	0.21
1988	1119	127.89	1.56	0.25	0.20
1989	1103	143.83	1.85	0.28	0.20
1990	981	197.72	1.82	0.26	0.20
1991	852	183.99	2.18	0.23	0.20
1992	780	275.65	1.69	0.23	0.23
1993	855	288.58	1.46	0.20	0.22
1994	871	482.91	0.85	0.21	0.23
1995	1011	377.88	0.99	0.22	0.21
1996	1051	433.38	1.12	0.23	0.22
1997	1055	486.43	0.90	0.23	0.22
1998	1096	844.51	1.15	0.24	0.22
1999	1098	869.99	1.27	0.23	0.23
2000	1148	966.02	0.97	0.27	0.23
2001	1284	508.81	1.23	0.37	0.22
2002	1286	931.58	1.32	0.37	0.23
2003	1250	902.02	1.26	0.36	0.24
2004	1265	962.72	0.89	0.35	0.25
2005	1388	1020.92	0.81	0.33	0.25
2006	1518	750.10	0.82	0.34	0.25

This table outlines the number and characteristics of firms that are used to create portfolios in December of year *t-1*. The final sample is the number of firms studied after excluding property trusts and financial firms, and firms with negative book values or with book-to-market ratios greater than ten. The intangibility ratio is measured as intangible assets divided by total net assets.

Table 2: Returns and Standard Deviation on the Mimicking Portfolios

This table examines the monthly returns on zero investment portfolios, used as independent variables in the subsequent generalised method of moments (GMM) regressions. It also provides the standard deviation and *t*-statistic of these returns. Panel A reports the returns on the six portfolios formed on size and book-to-market ratio. The size (SMB 2x3) and book-to-market premia (HML 2x3) are calculated using the Fama and French (1993) methodology. Panel B reports the returns on the twelve portfolios formed on size, book-to-market ratio and tangibility of assets used as independent variables in the tangibility-augmented model. The average returns for the size (SMB 2x3x2), book-to-market (HML 2x3x2) and tangibility premia (TMI 2x3x2) are also shown in Panel B.

Panel A: Mimicking Portfolios for the Fama-French (1993) Model

Size	Book-to-Market ratio	Number of Companies	Average Returns (%)	Standard Deviation (%)
Small	Low	131.5	1.011	9.005
Small	Medium	182.1	1.333	6.253
Small	High	201.0	1.441	5.601
Big	Low	183.5	0.387	5.195
Big	Medium	202.0	0.786	4.497
Big	High	94.8	1.071	5.925

	Mean (%)	Standard Deviation (%)	*t*-statistic
SMB 2x3	0.514	4.847	2.012*
HML 2x3	0.557	4.276	2.471*

Panel B: Mimicking Portfolios for the Tangibility-Augmented Model

Size	Book-to-Market ratio	Tangibility	Number of Companies	Average Returns (%)	Standard Deviation (%)
Small	Low	Tangible	107.2	0.992	8.589
Small	Low	Intangible	17.2	0.732	11.683
Small	Medium	Tangible	135.2	1.219	5.821
Small	Medium	Intangible	40.6	0.682	6.454
Small	High	Tangible	130.1	1.463	5.080
Small	High	Intangible	67.9	0.869	6.138
Big	Low	Tangible	143.8	0.240	5.027
Big	Low	Intangible	43	0.219	7.543
Big	Medium	Tangible	146.5	0.364	3.512
Big	Medium	Intangible	63.2	0.662	5.338
Big	High	Tangible	61.7	0.980	4.684
Big	High	Intangible	38.6	0.418	7.763

	Mean (%)	Standard Deviation (%)	*t*-statistic
SMB 2x3x2	0.512	4.498	2.162*
HML 2x3x2	0.387	4.347	1.689
TMI 2x3x2	0.279	2.839	1.926

*Denotes significance at the 5% level. **Denotes significance at the 1% level.

Table 3: Descriptive Statistics for the 8 Dependent Variable Portfolios

This table provides descriptive statistics for each of the 8 portfolios formed at the intersection of the size, book-to-market and tangibility splits. The results that are reported are: average number of companies (no. coys), median market capitalisation (median mkt cap), median book-to-market ratio (median B/M), the average monthly returns for each portfolio (average rtns), standard deviation of returns (st dev) and the *t*-statistic of average returns (t-stat).

Size	Book-to-Market	Tangibility	Number of Companies	Median Market Capitalisation	Median Book-to-Market	Average Returns	Standard Deviation	t statistic
Small	Low	Tangible	169.90	6.39	0.58	0.011	0.08	2.72**
Small	Low	Intangible	35.30	7.41	0.63	0.008	0.08	1.87
Small	High	Tangible	202.60	5.30	2.16	0.014	0.05	5.09**
Small	High	Intangible	90.40	5.76	2.53	0.009	0.05	3.19**
Big	Low	Tangible	214.70	569.25	0.58	0.003	0.05	1.25
Big	Low	Intangible	77.90	1722.74	0.61	0.003	0.05	0.94
Big	High	Tangible	137.20	301.74	1.68	0.006	0.04	3.20**
Big	High	Intangible	67.00	558.85	1.98	0.007	0.06	2.05*

*Denotes significance at the 5% level. **Denotes significance at the 1% level.

Table 4: Three-Factor Model Individual Regressions

This table presents the results from regressing the 384 monthly returns of each of the 8 portfolios formed at the intersection of splits on size, book-to-market and tangibility. The following regression is estimated using the GMM technique: Rp-Rf = a + b(Rm-Rf) + sSMB + hHML + e
The 8 portfolios are formed by independent splits on three variables – market capitalisation (size), book-to-market ratio (BM) and tangibility of assets (tang). The *t*-statistics are reported in parentheses below their associated coefficients. The right hand column reports the adjusted R^2 for each of the individual regressions and the average adjusted R^2 is shown in the final row.

Size	BM	Tang	α	Rm-Rf	SMB	HML	Adj R^2
Small	Low	Tangible	-0.0008	1.1004	1.0596	-0.1386	0.905
			(-0.65)	(42.39**)	(34.56**)	(-2.77**)	
Small	Low	Intangible	-0.0011	0.8416	0.7768	-0.1026	0.482
			(-0.26)	(15.84**)	(11.64**)	(-0.61)	
Small	High	Tangible	0.0018	0.8305	0.8416	0.4138	0.893
			(1.98*)	(35.18**)	(32.89**)	(12.43**)	
Small	High	Intangible	-0.0036	0.8854	0.7313	0.5338	0.747
			(-2.41*)	(22.91**)	(15.96**)	(13.22**)	
Big	Low	Tangible	-0.0015	0.8486	-0.0294	-0.1713	0.902
			(-2.11*)	(47.26**)	(-1.78)	(-6.96**)	
Big	Low	Intangible	-0.002	0.8505	-0.0731	-0.1191	0.631
			(-1.18)	(22.11**)	(-2.00*)	(-1.59)	
Big	High	Tangible	0.0003	0.6794	0.0508	0.1739	0.696
			(0.26)	(16.12**)	(1.85)	(3.76**)	
Big	High	Intangible	-0.0041	1.1428	0.0147	0.5258	0.698
			(-1.97*)	(20.44**)	(0.33)	(8.54**)	
						Average	0.744

*Denotes significance at the 5% level. **Denotes significance at the 1% level.

Table 5: Tangibility-Augmented Model Individual Regressions

This table presents the results from regressing the 384 monthly returns of the 8 portfolios formed by size, book-to-market and tangibility. The following regression is estimated using the GMM technique:
Rp-Rf = a + b(Rm-Rf) + sSMB + hHML + gTMI + e
The 8 portfolios are formed by independent splits on three variables – market capitalisation (size), book-to-market ratio (BM) and tangibility of assets (tang). The *t*-statistics are reported in parentheses below their associated coefficients. The right hand column reports the adjusted R^2 for each of the individual regressions and the average adjusted R^2 is shown in the final row.

Size	BM	Tang	α	Rm-Rf	SMB	HML	TMI	Adj R^2
Small	Low	Tangible	-0.0030	1.1811	0.9907	-0.1048	0.5804	0.836
			(-1.60)	(25.59**)	(15.26**)	(-1.34)	(5.60**)	
Small	Low	Intangible	0.0012	0.7424	1.0505	-0.2812	-0.8882	0.791
			(0.47)	(15.27**)	(20.63**)	(-2.60**)	(-5.52**)	
Small	High	Tangible	0.0024	0.8177	0.7731	0.3020	0.3249	0.800
			(1.98*)	(22.17**)	(15.31**)	(4.92**)	(5.55**)	
Small	High	Intangible	-0.0020	0.8550	0.7975	0.5591	-0.3148	0.784
			(-1.49)	(27.83**)	(14.29**)	(9.87**)	(-5.76**)	
Big	Low	Tangible	-0.0028	0.8850	-0.0159	-0.1299	0.1878	0.906
			(-4.11**)	(52.86**)	(-0.93)	(-6.93**)	(5.15**)	
Big	Low	Intangible	0.0006	0.7769	-0.2600	-0.2886	-0.2396	0.709
			(0.40)	(19.27**)	(-3.83**)	(-3.23**)	(-2.86**)	
Big	High	Tangible	0.0007	0.6665	0.0635	0.1491	0.0119	0.689
			(0.59)	(17.72**)	(2.29*)	(3.84**)	(0.22)	
Big	High	Intangible	-0.0011	1.0641	0.0120	0.5020	-0.5430	0.733
			(-0.55)	(20.93**)	(0.25)	(10.62**)	(-7.59**)	
							Average	0.781

*Denotes significance at the 5% level. **Denotes significance at the 1% level.

Table 6: Generalised Method of Moments (GMM) System Tests of Asset Pricing Models

The test of the tangibility-augmented Fama-French model is based on the system:

$$r_{it} = b_i\, r_{mt} + s_i\, SMB_t + h_i\, HML_t + g_i\, TMI_t + \varepsilon_i \qquad [i = 1, 2, \ldots, N] \tag{5}$$

These tests allow for a direct estimation of the mean premia for the four risk factors:

$$r_{mt} = \lambda_m + \varepsilon_{mt} \tag{6}$$

$$SMB_t = \lambda_{SMB} + \varepsilon_{st} \tag{7}$$

$$HML_t = \lambda_{HML} + \varepsilon_{ht} \tag{8}$$

$$TMI_t = \lambda_{TMI} + \varepsilon_{gt} \tag{9}$$

The generalised method of moments (GMM) test statistic is distributed as a chi-square with N degrees of freedom and the associated p-values are in parentheses below the GMM statistic. Coefficients λ_m, λ_{SMB}, $\lambda_{HML}$and λ_{TMI}, are the estimated factor premia on the market, size, value and tangibility factors respectively. The associated *t*-statistics for these coefficients is reported in parentheses below the factor premium estimates.

	GMM	λ_m	λ_{SMB}	λ_{HML}	λ_{TMI}
CAPM	51.03	0.007918			
	(0.0016**)	(3.88**)			
FF	54.70	0.008715	0.009338	0.006136	
	(0.0005**)	(4.10**)	(3.56**)	(2.71**)	
FF TMI	57.71	0.008588	0.007678	0.003303	0.003188
	(0.0002**)	(4.09**)	(3.23**)	(1.39)	(2.12*)

*Denotes significance at the 5% level. **Denotes significance at the 1% level.