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Akhtaruzzaman, Md; Docherty, Paul; Shamsuddin, Abul (2014). Interest rate, size and book-to-market effects in Australian financial firms. Originally published in Applied Economics Vol. 46, Issue 25, p. 3005-3020

Available from: <http://dx.doi.org/10.1080/00036846.2014.920478>

This is an Accepted Manuscript of an article published by Taylor & Francis in Applied Economics on 28/05/14, available online: <http://dx.doi.org/10.1080/00036846.2014.920478>

Accessed from: <http://hdl.handle.net/1959.13/1051646>

Interest rate, size and book-to-market effects in Australian financial firms

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ABSTRACT

The Fama-French three-factor model (1993) has been extensively used to study the pricing of non-financial stocks. This study provides the first examination of the pricing of Australian financial stocks using the Fama-French framework. The four-factor model (market, size, book-to-market, and momentum) augmented with the level, slope, and curvature of the interest rate term structure is used to examine the pricing of Australian financial stocks. The interest rate factors have not been previously considered for pricing Australian stocks within the Fama-French framework. Consistent with US evidence, we use a system-based estimation to show that the size and book-to-market factors are not priced in the cross-section of the equity returns of Australian financial stocks. Momentum and term spread are priced in the equity returns of both financial and non-financial stocks. These findings are robust to the inclusion of control variables such as default spread, the inflation rate and a dummy variable for the global financial crisis.

Keywords: Fama French model, financial firms, non-financial firms, interest rate risk, term premium

JEL classification: G12, G21, G22, G23

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1. Introduction

Fama and French (1993) find that the market risk, size and value premia are the three common risk factors that explain the returns of US non-financial firm stocks, challenging the empirical validity of the Sharpe-Linter-Mossin single-factor capital asset pricing model. Fama and French (1992, 1993) exclude financial firms from their study because “.....the high leverage that is normal for these firms probably does not have the same meaning as for nonfinancial firms, where high leverage more likely indicates financial distress” (Fama & French, 1992, p. 427). Due to the difficulty in interpreting the high leverage, most subsequent applications of the Fama and French (hereafter FF) model and the subsequent Carhart (1997) four-factor model exclude the equity returns of financial firms. There are two exceptions to this exclusion. Barber and Lyon (1997) are not able to reject the null hypothesis of equivalence between the returns on US financial and non-financial stocks for any size or book-to-market sorted portfolios. The pricing of the size and book-to-market factors is beyond the scope of their study. In a subsequent study, Viale, Kolari, and Fraser (2009) find that firm size and the book-to-market ratio are not priced in the cross-section of returns of US bank stocks, while the term spread is priced. The term spread refers to the difference between 10-year government bond yield and 13-week Treasury note yield, measuring slope of the yield curve. The divergent results in these two papers create the need to re-examine the ability of the FF (1993) model to explain the returns of financial stocks.

This study contributes to the existing literature in a number of ways. We provide the first examination of the robustness of the Fama and French (1993) three factor and Carhart (1997) four-factor models for Australian financial stocks. Such an out-of-sample test is important, given the mixed evidence regarding the explanatory power of this model for stocks in the US financial sector. Moreover, it is the first study to consider whether interest rate term-structure factors—level, slope and curvature—are additional risk factors in the returns of Australian

financial and non-financial stocks in the Fama-French framework. Extant international studies that have considered the pricing of interest rate factors focus on the level and slope of interest rates (Viale et al., 2009). We extend this investigation by considering the curvature of the yield curve, because curvature may contain information on future interest rates (Cochrane & Piazzesi, 2008).

Despite the scarcity of evidence that seeks to explain the returns of financial stocks, understanding the factors that affect returns in this section of the economy has important economic implications. Stock returns of financial firms have a positive and significant relationship with future economic growth (see Cole, Moshirian, & Wu, 2008). Hence, an understanding of risk factors that have the potential to be priced in the equity returns of financial firms will provide a better understanding of the determinants of economic growth. This study fills a void in the existing literature by examining whether the size, book-to-market, and momentum factors are priced in Australian equity returns; a market that is characterised by a high concentration of financial stocks. Financial firms constitute approximately 34% of the market value of all common-equity firms listed on the Australian Securities Exchange as at June 2011 (Australian Securities Exchange, 2011, 2012). In the NYSE, financial firms only comprise around 25% of market value of all listed firms (Viale et al., 2009). Further, the Australian Stock Market is concentrated by institutional and foreign ownership, contributing to 80% of direct share ownership (Black & Kirkwood, 2010). This concentration is relevant in an asset pricing context, as behavioral studies report that experienced traders are less likely to exhibit behavioral biases (Greenwood & Nagel, 2009).

The extant literature reports that the FF model does not perform well in Australia compared to other countries¹ and a significant amount of mispricing of the test portfolios remains after controlling for the market, size, and value factors (see Gharghori, Lee, & Veeraraghavan, 2009). These findings provide scope for a modified asset-pricing model that can better explain returns in the Australian context. For Australian non-financial firms, the FF three-factor model has been augmented by additional risk factors such as liquidity (Chan & Faff, 2003), leverage (Gharghori et al., 2009), momentum (O'Brien, Brailsford, & Gaunt, 2010), human capital (Durack, Durand, & Maller, 2004), and tangibility (Docherty et al., 2010). However, interest-rate factors have not been examined in Australia within the Fama-French-Carhart framework.²

Only a limited number of international studies have considered the pricing of interest-rate factors in equity returns using the FF (1993) framework. Using the Arbitrage Pricing Theory (APT) framework, Sweeney and Warga (1986) and Czaja et al. (2009) provide evidence that the change in the long-term interest rate is priced across financial and non-financial firms for US and German markets, respectively. Using the Consumption-Capital Asset Pricing Model, Lioui and Maio (2014) demonstrate that the interest rate factor is priced in the cross-section of equity returns of US firms. Jareño (2008) undertakes a unique analysis within the FF framework. They investigate whether Spanish stocks are sensitive to changes in the long-term interest rate after controlling for the FF factors. We extend on the work of Jareño (2008) by

¹ For example, see Halliwell, Heaney, and Sawicki (1999), Gaunt (2004), and Docherty, Chan, and Easton (2010).

² In contrast to the asset-pricing framework employed in our study, a number of studies (Faff and Howard, 1999; Faff et al., 2005) use the augmented market model of Stone (1974). These studies provide estimate of empirical duration and, in general, find that the change in the interest rate influences both financial and non-financial firms.

also considering the other two factors of interest rate term structure—slope and curvature—that may explain returns. Unlike Jareño (2008), this study examines the efficacy of interest rate factors across separate samples of financial and non-financial stocks. The change in the interest-rate level factor only captures a parallel shift of the term structure of interest rates. Hence, the slope and curvature are considered as additional factors to account for a possible non-parallel shift of interest-rate term structure and to track return variation over the business cycle. Willner (1996) and Diebold, Ji and Li (2006) show that the three interest rate factors can adequately capture the interest rate risk exposure of a fixed income portfolio than a classical duration model with only the interest rate level-factor. Bliss (1997) reports that the slope and curvature factors have an incremental explanatory power of 28% beyond the level factor in explaining US stock returns. Czaja, Scholz, and Wilkens (2010) find that the level, slope and curvature of the interest rate term structure are all priced in the German financial firm stocks.

There is a voluminous literature documenting that both a default factor (Campbell, 1987; Fama & French, 1989; Fama & Schwert, 1977) and inflation (Fama & Schwert, 1977; Kaul, 1987; Nelson, 1976) can be used to predict future returns. Given this evidence, default spread and change in the inflation rate are also included as control variables to ensure that our results are not afflicted by omitted variables problems.

Our main results are summarised as follows. The size and value premia are not priced in the equity returns of financial firms. In contrast, the value premium is priced for non-financial stocks, but the size premium is not, which is consistent with recent studies that suggest that the size premium has disappeared (Mathijs, 2011). Momentum is a priced factor in the cross-section of equity returns of both financial and non-financial firms. Term spread and curvature are priced across financial and non-financial firms, while change in the interest rates is not priced. Results demonstrate that the pricing of the value, momentum, and term spread factors

is robust to the inclusion of three control variables: default spread, change in the inflation rate and a dummy variable for the global financial crisis.

The paper proceeds as follows: Section 2 discusses the data and empirical approach. Section 3 discusses the empirical results and Section 4 draws some conclusions.

2. Data and Methodology

2.1 Data

Monthly return and market capitalisation data are obtained for each firm from the Australian Graduate School of Management (AGSM) database for the period 1993 to 2010. Monthly 13-week Treasury note yields are obtained from the Reserve Bank of Australia.³ Firms are classified into financial and non-financial portfolios based on the Global Industry Classification Standard (GICS). As in previous Australian studies,⁴ firms with negative book value and a book-to-market ratio greater than ten are removed from the sample. To be consistent with the previous literature and to avoid any look-ahead bias, firms with a balance sheet date greater than or equal to six months prior to portfolio formation are included. For example, book values are calculated for 31 December 1993 using accounting information released prior to and including 30 June 1993. The book-to-market ratio is calculated as the book value of ordinary equity divided by the market capitalisation using the Aspect FinAnalysis database. Descriptive statistics for financial and non-financial firms are provided in Table 1. In general, Table 1 shows that the average market capitalisation and book-to-market ratio of financial firms are higher than those of non-financial firms.

³ Yields on Options Indexed Swaps or 3-Month Bank Accepted Bills are used as a proxy of Treasury note yields, when Treasury notes are not available.

⁴ See Docherty, et al., 2010, Gaunt, 2004 and O'Brien, et al., 2010

<Insert Table 1>

2.2 Independent variables

2.2.1 Portfolio construction

FF (1993) construct the three-factor asset-pricing model by forming six portfolios, sorted by the market capitalisation and the book-to-market ratio. We replicate these six portfolios for both non-financial and financial firms to form the SMB and HML independent variables, designed to mimic the underlying risk factors in returns related to firm size and the book-to-market ratio, respectively.

In December of each year t from 1992 to 2009, non-financial and financial firms are ranked on the market capitalisation. The median market capitalisation is used to split stocks into two groups, Small and Big (S and B). Non-financial and financial firms are ranked on their book-to-market ratio each December, and the sample is split into three groups: low (bottom 30 per cent), medium (middle 40 per cent) and high (top 30 per cent).⁵ Six portfolios (S/L, S/M, S/H, B/L, B/M and B/H) are constructed from the intersection of size and book-to-market ratio. The SMB (small minus big) portfolio is the difference between the simple average of the monthly returns on the three small-stock portfolios (S/L, S/M and S/H) and the simple average of the monthly returns on the three big-stock portfolios (B/L, B/M and B/H). This portfolio is constructed to mimic the risk factor in returns related to the size.⁶ Similarly, the HML (high minus low) portfolio is the difference between the simple average of the monthly

⁵ As most firms in Australia have a June financial year end, we rank firms in December so that for most firms, there is a 6-month lag between their book value and market value. This is analogous to the FF (1993) methodology except that the majority of US firms have a December financial year-end.

⁶ Given the small firm portfolio is populated with microcaps, it is likely that a liquidity premium partially contributes to the observed small firm premium (SMB).

returns of the two high book-to-market portfolios (S/H and B/H) and the simple average of the monthly returns of the two low book-to-market portfolios (S/L and B/L). This portfolio is formed to mimic the risk factor in returns related to the book-to-market ratio. Both SMB and HML mimicking portfolios are value-weighted. The use of value-weighted returns results in mimicking portfolios that capture the differing return behaviour of small and big stocks, or high and low book-to-market ratio stocks in a way that corresponds to realistic investment opportunities.

The momentum factors (Mom) are constructed using the methodology employed by Carhart (1997) for both financial and non-financial firms. Each December, firms are ranked on their returns from January to November and the sample is split into three groups: winners (top 30% based on past performance), medium (middle 40%) and losers (bottom 30%). The conservative one month lag between the formation period and the implementation of the momentum strategy is consistent with prior literature (Jegadeesh & Titman, 1993). Six portfolios (2x3) are formed at the breakpoints of the independent sorts on size and momentum. The Mom portfolio is calculated as the average of the two portfolios of winners from the previous year less the average of the two portfolios of losers from the previous year.

2.2.2 Mimicking portfolio returns

The Panel A of Table 2 provides the average monthly returns of three mimicking portfolios, SMB, HML, and Mom for non-financial and financial firms. The average SMB return for non-financial firms is 0.3% per month, which is not significantly different from zero. Brailsford et al. (2012) also find a positive but insignificant size premium for Australian non-financial firms for the period of 1982-2006. The HML factor produces an average premium of 0.8% per month, which is significantly different from zero at the 1 percent level. This

result is consistent with the previous Australian literature (Brailsford et al., 2012; Docherty et al., 2010). The results also indicate that the HML factor is more stable than the SMB factor, which is confirmed by the lower standard deviation of the HML factor. The SMB and HML factors produce an average premium of 0.07% and 0.06% per month, respectively. Both the SMB and HML returns are quite small and insignificant for financial firms in Australia. There is no previous Australian literature pertaining to this information. However, the insignificance of SMB and HML premiums for financial firms may stem from the anomaly that size and value effects are much weaker in large firms (Fama & French, 2008). In Australia, the average size of financial firms are larger than that of non-financial firms (see Table 1). Our results are consistent with Viale et al. (2009) who find that SMB and HML returns are statistically insignificant for US banks. The average momentum return is 0.7% per month and 0.8% per month for non-financial and financial firms, respectively. These returns are significantly different from zero for both financial and non-financial firms.

<Insert Table 2>

2.2.3 Interest rate factors

Over the sample period, the mean for the interest rate level factor is 6.33%. On average, the yield curve has a positive slope and negative curvature, which imply an ascending and concave yield curve. The positive slope of the average zero yield curve implies that the term premium is positive on average, which fits well with a typical financial institution's practice of lending for long terms and borrowing for short terms. The correlation matrix as shown in Table 2 shows that correlations among interest rate factors are less than 50%. We also find that the highest variance inflation factor (VIF) for interest rate factors used in our models is

3.40, which is well below the critical value of 10, implying that multicollinearity is not a major problem.

2.3 Dependent variables

Dependent variables used in the asset-pricing models are nine portfolios formed at the intersection of a 3x3 split based on size and book-to-market ratio.⁷ Fama and French (2008) also emphasise the importance of examining the pervasiveness of an anomaly across different size groups. Without size partitions, the results can be unduly influenced by micro-cap stocks. Micro-cap stocks are numerous, although accounting for only a small fraction of the total market capitalization. Further, micro cap stocks tend to be illiquid, subject to high trading costs and market-microstructure problems, thereby casting doubt over the realisation of trading returns involving such stocks. It has been identified that micro-cap stocks are particularly illiquid in non-US markets such as Australia (Gray & Johnson, 2011). Accordingly, all analysis in this study is conducted for big, small, and micro size groupings. Big stocks are those that comprise the top 90% of the total market capitalisation of the sample. Small stocks are those that constitute the next 7% of the total market capitalisation and micro stocks represent the remaining 3%. (Docherty, Chan, & Easton, 2011) identify that the 90/7/3 cutoffs generate size groupings that closely resemble Fama and French (2008).⁸

⁷ Due to the small number of firms in the Australian sample (particularly for financial stocks), the traditional 5x5 split would be impractical.

⁸ Fama and French (2008) determine market capitalisation cut-offs using NYSE stocks, and then apply them to the population of NYSE, AMEX and NASDAQ stocks. In their study, Big, Small, and Micro groups represent 90.48%, 6.45% and 3.07%, respectively of total market capitalisation. In terms of the number of sample stocks under each classification, Fama and French (2008) report that 60%, 20% and 20% of stocks are classified as Micro, Small, and Big, respectively. In our study, Micro, Small, and Big represents 70.51% (77.95%), 15.15% (13.62%) and 14.34% (8.43%), respectively for the sample of financial (non-financial) firms.

Firms are ranked on their book-to-market ratio and the sample is split into three groups; low (bottom 30%), medium (middle 40%) and high (top 30%). Nine portfolios are then constructed from the intersection of the size and book-to-market breakpoints. The value-weighted monthly returns are calculated for each of these portfolios from January to December and portfolios are reformed annually. Table 3 provides descriptive statistics for the nine portfolios used in the analysis. All three value-stock portfolios of non-financial firms earned higher average returns compared to equivalent growth-stock portfolios. However, in the case of financial firms, the value-stock portfolio achieves a higher average return than the growth-stock portfolio in micro-stock only (see Table 3). Variation in portfolio returns due to the size difference does not yield a definite pattern for both non-financial and financial firms. It is also evident from Table 3 that mean monthly return differs between financial and non-financial firms. Empirical results fail to reject the null hypothesis of return equivalence for micro, big, and growth portfolios.⁹

<Insert Table 3>

2.4 Time-series modelling

FF (1993) propose a three-factor model that can be expressed as follows:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \varepsilon_{p,t} \quad (1)$$

⁹ To check the robustness of the results for these portfolios, the sample has also been split into three portfolios, that are based on size and book-to-market ratio, respectively through an one-way independent sorting. Empirical results from the two-way and one-way sorted portfolios are quite similar in relation to size and value premium.

Where $R_{p,t}$ is the return on asset p, $R_{f,t}$ is the risk-free rate of return, $R_{m,t}$ is the return on the value-weighted market portfolio, SMB_t is the return on the mimicking portfolio for size and HML_t is the return on the mimicking portfolio for the book-to-market factor at time t.

We expand the FF three-factor model by adding the Carhart (1997) momentum (Mom) factor to Equation (1):

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \varepsilon_{p,t} \quad (2)$$

The Fama-French-Carhart model augmented with interest-rate factors—level, slope, and curvature—may be expressed as follows:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \beta_{p,l}\Delta I_t + \beta_{p,t}Term_t + \beta_{p,c}C_t + \varepsilon_{p,t} \quad (3)$$

Where ΔI_t is the change in 10-year government bond yield and $Term_t$ denotes the term spread, which is the difference between 10-year government bond yield and 13-week Treasury note yield. C_t is the curvature factor. Following Diebold and Li (2006) C_t is defined as the difference between twice the two-year yield minus the sum of the ten-year and three-month yields. ΔI_t is used to measure the sensitivity of the market value of the firm's equity due to change in interest-rate level factor. To account for the non-linearity in the shape of interest-rate term structure, slope and curvature of the yield curve are added to the model.

In general, the sensitivity of firms' stock returns to the level, slope, and curvature factors of the yield curve is directly associated with the sensitivity of their portfolios to the long-, short-, and medium-term rates. The direction of interest rate effects on financial and non-financial firms is a priori indeterminate. However, financial firms—in particular banks—typically lend for long terms and borrow for short terms, resulting in a positive duration gap. With a

positive duration gap¹⁰ financial firms are expected to have a negative relationship with the change in interest rate. The term spread and curvature of the yield curve primarily capture movements in short- and medium-term rates, respectively (see Diebold & Li, 2006). Thus, the effect of the term spread on stock returns of financial firms largely depends on their holdings of short-term interest-sensitive assets and liabilities, while the effect of the curvature factor substantially depends on their holdings of medium-term interest-sensitive assets and liabilities.

Non-financial firms hold interest-sensitive financial instruments but by a smaller proportion than their financial counterparts. Hence, non-financial firms are expected to be less exposed to interest rate factors compared to financial firms. However, the direction of the interest effect is a priori indeterminate for them. Previous international studies on non-financial firms provide mixed results. Bae (1990) and Booth and Officer (1985) find no significant relation between the change in the interest rate level and US non-financial stock returns. Czaja et al. (2009) report a negative relation between the change in the interest rate level and German non-financial stock returns, while Oertmann, Rendu, and Zimmermann (2000) obtain a positive relationship between them in the European context.

To check the robustness of the extended four-factor model with interest rate factors, default spread (DEF_t) and change in the inflation rate (ΔInf_t) are used as control variables in Equation 3. Default spread (DEF_t) is the difference in returns between the UBS Australia corporate bond index (all maturities) and the UBS Australia Treasury bond index (all

¹⁰ $\Delta E = -(D_A - kD_L) * A * \frac{\Delta R}{1+R}$, where ΔE is the change in equity, $(D_A - kD_L)$ is the leverage adjusted duration gap, A is the asset size, k =liabilities/assets (a measure of leverage) and ΔR is the change in interest rate.

maturities).¹¹ Monthly inflation rate is computed from the difference in yields between the commonwealth 10-year treasury bond and treasury indexed bond, since inflation rate computed from consumer price index is only available at quarterly intervals in Australia.

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \beta_{p,I}\Delta I_t + \beta_{p,t}Term_t + \beta_{p,c}C_t + \beta_{p,def}Def_t + \beta_{p,inf}\Delta Inf_t + \varepsilon_{p,t} \quad (4)$$

The first stage of analysis involves individual regressions of Equations 2 to 4 and the second stage performs system regressions to determine whether factors in the augmented FF model are priced in the cross-section of equity returns. In the context of a system-based estimation and under the null hypothesis, restrictions of zero intercepts are imposed: $H_0 : \alpha_p = 0; p = 1, 2, \dots, N$. The restricted version of Equation 4 is as follows:

$$r_{p,t} = \beta_{p,MRP}r_{m,t} + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \beta_{p,I}\Delta I_t + \beta_{p,t}Term_t + \beta_{p,c}C_t + \beta_{p,def}Def_t + \beta_{p,inf}\Delta Inf_t + \varepsilon_{p,t} \quad (5)$$

where $r_{p,t} = R_{p,t} - R_{f,t}$; and $r_{m,t} = R_{m,t} - R_{f,t}$. A variation of this standard asset-pricing test is to re-configure in a way that allows direct estimation of the premia for the four Fama-French-Carhart risk factors along with the three interest rate factors and two control variables: default spread (DEF_t) and change in inflation (ΔInf_t).

$$r_{m,t} = \lambda_m + \varepsilon_{m,t} \quad (6)$$

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

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

$$Mom_t = \lambda_{Mom} + \varepsilon_{Mom} \quad (9)$$

¹¹Corporate bond yields are only available from September 1996. Hence, we use the return difference as a proxy of the yield difference. Nguyen, Faff, and Gharghori (2009) also used this measure to compute default spread.

$$\Delta I_t = \lambda_{\Delta I} + \varepsilon_{\Delta I} \quad (10)$$

$$Term_t = \lambda_{Term} + \varepsilon_{Term} \quad (11)$$

$$C_t = \lambda_C + \varepsilon_C \quad (12)$$

$$Def_t = \lambda_{Def} + \varepsilon_{Def} \quad (13)$$

$$\Delta Inf_t = \lambda_{\Delta Inf} + \varepsilon_{\Delta Inf} \quad (14)$$

Where λ_i and ε_i are risk premium and error term for a risk factor i (i refers to market risk, SMB, HML, Mom, change in interest rate, term spread, curvature, default spread, and inflation rate, respectively).

We adopt the generalized method of moments (GMM) system approach proposed by MacKinlay and Richardson (1991) and employed for asset-pricing tests (for example, see Chan, Faff, & Kofman, 2011; Docherty et al., 2010). In our test, there are $9N+4$ sample moment equations with $8N+4$ unknown parameters¹², leading to a GMM statistic based on N -overidentifying restrictions (distributed χ_N^2) :

$$GMM = (T - N - 1) \times g_T(\hat{\phi})' \cdot S_T^{-1} g_T(\hat{\phi}) \quad (15)$$

where $g_T(\hat{\phi}) = \frac{1}{T} \sum_{t=1}^T f_1(\hat{\phi})$ is the empirical moment condition vector and S_T^{-1} is the weighting matrix that weights each sample moment condition. Several variations of the GMM test are available and we run different GMM tests for robustness. However, we select the GMM test, which is based on a Bartlett kernel with first-order Vector Autoregressive pre-whitening and variable Newey-West bandwidth. In the chosen GMM test, the weighting matrix is updated once and then co-efficient estimates are iterated to convergence (see Ferson

¹² There are ten sample moment conditions for each of N test equations: (a) the mean regression error term is zero; and the regression error term is orthogonal to each regressor; namely to (b) $r_{m,t}$; (c) SMB_t ; (d) HML_t ; (e) Mom_t ; (f) ΔI_t ; (g) $Term_t$; (h) C_t ; (i) DEF_t ; and (j) ΔInf_t . In addition, there is one sample moment condition that defines each factor premium relating to each of Equations 6 to 14.

& Foerster, 1994). Unreported robustness checks made by running other alternative GMM tests suggest that our empirical tests are negligibly affected by the chosen GMM test.

The GMM test is advantageous, because it relaxes the assumption that returns are independent and identically distributed (iid), and that returns are normally distributed. It also allows for the simultaneous estimation of all asset parameters to enable us to determine whether or not a particular model can satisfactorily explain a sample of stocks.

3. Empirical results

3.1 Individual regressions

Tables 4 and 5 provide the results of individual regressions used to explain time-series variation in stock returns. We examine the four-factor model and the four-factor model augmented with interest-rate factors for samples of financial and non-financial stocks after controlling the effects of default spread and change in inflation on stock returns.

The market risk premium is an important determinant of Australian equity returns. For both non-financial and financial firms, the market risk premium is significant at the 1% level across all the estimates of individual regressions used in the study. Additionally, both SMB and HML are significant in the majority of portfolios. In general, size and book-to-market factors are found to be important in explaining Australian equity returns for both financial and non-financial firms. As expected, the SMB loading steadily increases as we move from large portfolios to micro portfolios for both financial and non-financial firms. The micro portfolios actually demonstrate a large positive and significant loading on SMB, while the large portfolios have a slight negative and significant loading on SMB in most cases. This monotonic relationship between the size and SMB factor is consistent with previous studies

(Docherty et al., 2010). The influence of the HML factor on portfolio returns also demonstrates a regular pattern related to change in book-to-market ratios. Growth portfolios have negative loadings on the HML factor in both non-financial and financial firms. In most cases, the loading on the HML factor increases as the average book-to-market ratio increases. These results are consistent with Australian and international studies (Davis, Fama, & French, 2000; Docherty et al., 2010).

It is evident from Tables 4 and 5 that while winners do outperform losers in both financial and non-financial stocks, there is only limited evidence to suggest that the time-series of equity returns are correlated with the momentum factor. In Panels B (Panel C) of Table 4, the momentum factors are statistically significant in three (six) of the portfolios after including the interest rate factors and control variables. However, in Table 5, the coefficient on the momentum factor is not statistically significant in any of the panels where the sample consists of financial stocks.

The estimated coefficients on the change in interest rate (ΔI_t) are significant and negative for financial firm portfolios in most cases, but insignificant for non-financial firms (see Tables 4 and 5). The finding of negative sensitivity of financial firm returns to the change in interest rate is consistent with the presence of a positive duration gap as discussed earlier. The finding of negative sensitivity of financial firm returns to the change in interest rate is reported by other studies (Elyasiani & Mansur, 1998; Faff, Hodgson, & Kremmer, 2005; Faff & Howard, 1999) that use the augmented market model of Stone (1974). The magnitude of the interest-rate loading of financial firms is much larger than that of non-financial firms. The results are compatible with the fact that non-financial firms hold less interest-sensitive financial instruments than their financial counterparts do.

Three low book-to-market portfolios and the micro-medium portfolio of non-financial firms exhibit a negative sensitivity to the term spread, implying that growth stocks of non-financial firms are sensitive to the term spread (see Panels B and C of Table 4). Four portfolios of financial firms demonstrate a positive sensitivity to the term spread (see Panels B and C of Table 5). Interest rate risk exposures of financial and non-financial firms originating from the term spread are quite different, perhaps reflecting their differential balance sheet characteristics and risk management strategies (Lepetit, Nys, Rous, & Tarazi, 2008). The positive sensitivity of financial firms to the term spread implies that financial firms gain from rising short-term interest rates as the term spread is primarily influenced by the short-term rates. When short-term interest rates rise, losses of the value of the short-term assets are overcompensated by the decrease in value of the corresponding liabilities, resulting in positive effects on financial firms. Viale et al. (2009) report a positive relationship between the returns of large US banks and the term spread. Czaja et al. (2009) also report a positive relationship between the returns of German insurance companies and the term spread. On the contrary, the negative sensitivity of non-financial firms implies that non-financial firms lose from rising short-term rates. FF (1993) and Jaehoon and Hangyong (2006) find a negative relationship between the returns of the US non-financial firms and the term spread, while Czaja et al. (2009) report similar results for German non-financial firm stocks.

Curvature is not found to be a significant factor in explaining the returns of financial and non-financial stocks except micro-medium portfolios of financial and non-financial firms. The empirical literature also demonstrates that Australian financial and non-financial firms are not exposed to the curvature factor of interest rate term structure (see Akhtaruzzaman, 2013, p. 76).

The augmented four-factor model with interest-rate factors marginally improves the explanatory power as compared with the four-factor model. Since the size and book-to-market factors do not become insignificant with the addition of interest-rate factors, interest-rate factors are not proxying FF factors. The Wald test results demonstrate that the interest-rate factors play an important role in explaining the returns of financial firms and non-financial firms.

<Insert Tables 4-7>

3.2 System regressions

Table 6 presents the results from the GMM system estimation of Equation 5. The GMM test demonstrates that FF (1993) model holds for Australian financial firms. However, the four-factor model augmented by interest-rate factors appears to be adequate for pricing both financial and non-financial firm stocks in Australia.

Next, we turn our attention to the pricing of individual factor premium. When the estimated factor premium is positive and significant, it can be said that the factor is systematic and priced in the cross-section of equity returns. The first system regression reported in Table 6 is for the FF (1993) model. The market premium is positive and significant for both financial and non-financial firms, implying that it is a systematic risk factor and priced in the cross-section of equity returns. The estimated market premium annualises to a realistic figure of 6.8% and 6.0% for non-financial and financial firms, respectively.¹³ The results from the system estimation in relation to size and value premiums can be interpreted in the context of the corresponding results from the individual regressions. Individual regressions demonstrate

¹³ Gharghori, Chan, and Faff (2007) also find the market risk premium of 6% for non-financial firms.

that the factor loadings on SMB and HML are significant for both non-financial and financial firms. However, the GMM system estimation shows that the HML factor is priced for the equity returns of non-financial firms, while it is not priced for the equity returns of financial firms. GMM system regressions reinforce the results of mimicking portfolios reported in the Panel A of Table 2, where HML portfolio return is significant only for non-financial firms. The GMM system regressions also demonstrate that the size premium is not priced in the cross-section of equity returns of both financial and non-financial firms (See Table 6). The insignificance of the size premium in this study and Faff (2004)'s finding of the negative size premium raise doubt on the existence of the size premium in the Australian market.

The second system regression is for the four-factor model. As with the three-factor FF model, only the HML factor is priced for non-financial firms. Consistent with the results of the three-factor FF system regression, neither HML nor SMB, is priced in the cross-section of equity returns of financial firms. The momentum factor is priced in the equity returns of financial and non-financial firms.

The third system regression is for the Fama-French-Carhart four-factor model augmented with three interest rate factors: change in interest rate, term spread, and curvature. A notable finding from the augmented four-factor model is that the pricing of the HML factor for non-financial firms is robust to the inclusion of interest-rate factors. The term spread is priced in the cross-section of equity returns of both financial and non-financial firms. This result reinforces the findings of individual regressions on the term spread, where the term spread is statistically significant in explaining the returns of both firm types. Change in long-term interest rates is not priced in the cross-section of equity returns of financial and non-financial firms, though the results of individual regressions show that the former group has a

significant and negative exposure to the change in the long-term interest rate. Curvature is priced in the cross-section of equity returns of financial and non-financial firms. The results of the fourth system regression show that the pricing of HML, momentum, term spread, and curvature is robust to the inclusion of two control variables: default spread and change in the inflation rate.

<Insert Table 6>

3.3 Robustness analyses

We have employed a number of robustness checks to examine the robustness of the results of the augmented four-factor model. First, we have introduced two control variables—default spread and change in the inflation rate in the augmented four-factor model. Results are found to be robust after the inclusion of control variables (see Panel C of Tables 4 and 5 and Table 6). Second, we have introduced a dummy variable for the global financial crisis (GFC) from October 2008 to December 2010 to examine whether the GFC influences the returns of Australian financial and non-financial firms. We also interact a dummy variable for the GFC with the level, term spread, and curvature factors in order to assess whether the co-efficients of change in interest rate (level), term spread, and curvature factors are moderated by the GFC. Results as shown in Appendix A demonstrate that the co-efficients of the GFC dummy variables are not significant, implying that the returns of financial and non-financial firms are not significantly influenced by the GFC. Thus, our results are robust to the introduction of the financial crisis dummy variable. This result is supported by the fact that the Australian government provided a guarantee on deposits in Australian financial institutions, which essentially insulated financial firms from international systemic risk during the GFC (see Reserve Bank of Australia, 2009). Also, Australia had a distinct interest rate regime, which is characterised by a relatively higher interest rate structure as compared to the US and

European countries during the GFC. The Australian government also provided stimulus packages to support the economy during the GFC. Third, to check the robustness of the results, we have examined the effects of size, book-to-market, momentum, and interest rate factors on the returns of financial firms, when the size, book-to-market, and momentum premiums are built on non-financial firms. We find that the results are robust to this analysis.¹⁴

4. Conclusion

Previous asset-pricing literature in Australia on the FF model has focused on non-financial firms. As of yet, no Australian study has analysed the applicability of the FF model to financial firms. This study fills a void in the literature. This issue is worth investigating, given (1) the mixed evidence in the two studies that have examined pricing of US financial stocks and (2) Australian equity market is dominated by financial firms. This paper also augments the FF (1993) asset-pricing model with the momentum factor and three interest-rate factors: change in long-term interest rates, term spread, and curvature. We examine whether these interest-rate factors improve the explanatory power of the FF (1993) model in describing the cross-section of equity returns for both financial and non-financial stocks.

Factor loadings on SMB and HML are statistically significant in most portfolios of financial and non-financial stocks. However, the GMM system regression results suggest that the size and book-to-market factors are not priced in the equity returns of Australian financial firms, which is in line with Viale et al. (2009)'s finding for US bank stocks. This result suggests that the FF (1993) model is not an adequate asset-pricing model for Australian financial firms. The book-to-market factor is priced in the cross-section of equity returns of non-financial

¹⁴ The results are not tabulated in the paper to conserve space and available from authors upon request.

firms, while the size factor is not priced across non-financial firms. The insignificance of the size premium is consistent with the recent evidence that suggests that the size premium is disappearing after the 1980s. Momentum factor is found to be priced in the cross-section of equity returns of both financial and non-financial firms.

In individual time series regressions, financial stock returns are negatively related to the change in the long-term rate, while non-financial stocks are immune to this factor. Financial firms exhibit a positive sensitivity to the term spread, while non-financial firms demonstrate a negative sensitivity to this factor. Term spread and curvature are priced across financial and non-financial firms, while the change in the interest rate is not priced. The term spread is known to contain information on future inflation and the business cycle, and exposure to these macroeconomic factors is priced across financial and non-financial firms.

For non-financial firms, the most important source of this incremental explanatory power is the term spread exposure of growth stocks. In general, both change in long-term interest rates and term spread are more important in explaining the returns of financial firms than those of non-financial firms. The different results for financial firms may be attributed to their special role as intermediaries and asset transformers, and a strict prudential regulatory framework under which they operate. Overall, the augmented four-factor model is found to be better than the FF three-factor model to price equities even after introducing the control variables of default spread and change in the inflation rate.

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Table 1

Annual sample size and characteristics: January 1993 to December 2010. This table outlines the number and characteristics of financial and non-financial firms used to create portfolios in December of year t-1. The final sample is the number of firms studied after excluding firms with negative book values or book-to-market ratios greater than ten.

Year	Non-Financial Firms			Financial Firms		
	Number of firms	Average Market Capitalisation (AUD in Million)	Average book-to-market	Number of firms	Average Market Capitalisation (AUD in Million)	Average book-to-market
1993	437	534.14	1.48	27	865.03	2.09
1994	530	639.13	0.70	104	581.39	1.40
1995	767	418.09	0.75	147	387.25	1.08
1996	846	419.99	0.90	175	448.06	1.24
1997	842	484.79	0.80	181	569.14	1.07
1998	834	921.43	1.06	182	767.74	0.99
1999	856	901.38	1.29	189	935.77	1.15
2000	860	997.88	0.91	185	1,051.59	0.95
2001	971	467.72	1.01	206	1,201.67	1.16
2002	1040	882.09	1.43	204	1,355.19	1.51
2003	1032	843.29	1.41	180	1,413.49	1.15
2004	1029	885.46	0.85	181	1,582.44	0.86
2005	1025	1,013.49	0.65	178	1,900.54	0.75
2006	1280	546.58	0.71	211	2,077.04	0.75
2007	1356	968.84	0.58	229	2,374.82	0.76
2008	1487	1,020.85	0.60	236	2,389.70	0.82
2009	1297	430.43	1.30	186	1,698.76	1.93
2010	1334	614.87	0.71	184	2,539.29	1.26

Table 2

Descriptive statistics and correlation matrix for factors: January 1993 to December 2010. Panel A presents the descriptive statistics of factors. Panel B presents the correlation matrix for factors for non-financial and financial firms, respectively.

Panel A: Descriptive statistics of factors

	Non-financial firms			Financial firms								
	SMB	HML	MOM	SMB	HML	MOM	ΔI	Term	C	Def	ΔInf	ΔI
Mean	0.003	0.008	0.007	0.001	0.001	0.008	0.005	0.0001	0.009	-0.004	0.647	0.001
Standard deviation	0.057	0.027	0.059	0.045	0.050	0.049	0.032	0.003	0.012	0.007	0.823	0.002
t-statistics for mean	0.89	4.26***	1.80*	0.20	0.22	2.30**	2.25**	-0.63	10.77***	8.47***	11.54***	-0.44

Panel B: Correlation matrix for the factors used for non-financial firms

	Market risk premium		SMB	HML	MOM	ΔI	Term	C	Def	ΔInf					
Market risk premium			0.23***	-	0.11	0.05	0.19***	0.17	0.04	-	0.18***	0.05			
SMB	-	0.02		-	0.35***	0.14**	0.11	0.15**	0.07	-	0.12*	0.12*			
HML		0.14**	-	0.32***		-	0.32***	0.07	0.16**	0.12*	-	0.17**	-	0.03	
MOM	-	0.09	-	0.11	-	0.001		-	0.01	-	0.10	-	0.02		
Change in Interest rate		0.19***		0.17***		0.16**		0.31***	0.13**		0.02		0.26***		
Slope		0.17***		0.10		0.15**		0.31***	0.45***	-	0.28***		0.22***		
Curvature		0.04		0.01		0.11		0.13**	0.45***	-	0.40***		0.31***		
Default spread	-	0.18***	-	0.03		0.10	-	0.03	0.02	-	0.28***	-	0.40***	-	0.06
Change in inflation rate		0.05		0.17***		0.10		0.08	0.26**		0.22***		0.31***	-	0.06

Note: Figures in bold reflect the correlation between factors used for non-financial firms.

*/**/*** significant at the 10%, 5% and 1% level, respectively

Table 3

Descriptive statistics for stock portfolios formed on size and book-to-market ratio: January 1993 to December 2010. Panel A reports the descriptive statistics of nine portfolios for non-financial and financial firms. Panels B and C report descriptive statistics for three stock portfolios each formed on size and book-to-market, respectively. Panel D reports SMB and HML factors, constructed by using one-way sorting.

Panel A: 9 stock portfolios formed on size and book-to-market ratio

Size	Book-to-market ratio	Non-financial firms				Financial firms				t-statistics for difference in means
		Average number of firms	Average returns (%)	Standard Deviation of returns (%)	t-statistics for means	Average number of firms	Average returns (%)	Standard Deviation of returns (%)	t-statistics for means	
Micro	Low	203.27	0.16	6.19	0.38	32.65	0.70	5.21	1.98**	-1.75*
Micro	Medium	279.51	0.64	4.95	1.89*	43.10	1.23	4.19	4.32***	-2.33**
Micro	High	254.34	1.01	4.94	2.99***	47.14	1.48	5.96	3.64***	-1.30
Small	Low	52.60	0.37	5.52	0.99	14.05	0.73	4.78	2.25**	-1.07
Small	Medium	58.41	0.76	4.39	2.55**	9.16	1.02	5.42	2.75***	-0.93
Small	High	21.28	1.32	5.27	3.69***	3.33	0.76	8.52	1.30	0.93
Big	Low	29.80	0.73	3.02	3.58***	11.21	1.51	4.78	4.65***	-2.93***
Big	Medium	42.06	0.90	4.10	3.22***	11.83	1.04	4.81	3.18***	-0.45
Big	High	8.94	0.82	5.38	2.23**	1.61	0.03	8.58	0.06	1.31

*/**/** significant at the 10%, 5% and 1% level, respectively

Table 4

Regressions of excess stock returns for non-financial firms on the excess market return, mimicking returns for the size (SMB), book-to-market equity (HML), and Momentum (Mom): January 1993 to December 2010. The following regression is estimated using the Ordinary Least Squares (OLS) method:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \varepsilon_{p,t} \quad (2)$$

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \beta_{p,I}\Delta I_t + \beta_{p,t}Term_t + \beta_{p,c}C_t + \varepsilon_{p,t} \quad (3)$$

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \beta_{p,I}\Delta I_t + \beta_{p,t}Term_t + \beta_{p,c}C_t + \beta_{p,def}Def_t + \beta_{p,inf}\Delta Inf_t + \varepsilon_{p,t} \quad (4)$$

Panel A: Effects of size, value, and momentum factors

Size	Book to Market	α_p	$R_m - R_f$	SMB	HML	Mom	$Adj R^2$
Micro	Low	-0.0040	1.0307***	0.5932***	-0.2521***	0.0060	0.7600
Micro	Medium	-0.0011	0.8415***	0.5242***	0.1288***	0.0733	0.7560
Micro	High	0.0006	0.7630***	0.5699***	0.4263***	0.0607	0.7284
Small	Low	-0.0018	1.1292***	0.3020***	-0.1829**	0.0515	0.6407
Small	Medium	0.0007	0.9521***	0.1821***	0.1333*	0.0835	0.5757
Small	High	0.0038	0.9657***	0.2284***	0.4797***	0.0320	0.4419
Big	Low	0.0055***	0.7225***	-0.0339	-0.2256***	0.0172	0.6170
Big	Medium	0.0046**	0.9931***	-0.0622*	-0.0514	0.0133	0.5702
Big	High	-0.0020	0.8517***	0.0953*	0.7887***	-0.0529	0.3625

Panel B: Effects of size, value, momentum, and interest rate factors

Size	Book to Market	α_p	$R_m - R_f$	SMB	HML	Mom	ΔI	Term	C	Adj R ²	Wald test ($\beta_{p,I} = \beta_{p,s}$ $= \beta_{p,c} = 0$)
Micro	Low	-0.0005	1.0410***	0.6117***	-0.2367***	-0.0343	-0.0343	-0.3406*	-0.0245	0.7621	5.46
Micro	Medium	0.0015	0.8511***	0.5400***	0.1270*	-0.0664	-0.1909	-0.2569	-0.1454	0.7597	7.52**
Micro	High	0.0029	0.7677***	0.5807***	0.4040***	-0.0789*	0.0306	-0.1855	-0.1139	0.7321	4.44
Small	Low	-0.0036	1.1451***	0.3205***	-0.1332**	-0.00059	0.5322	-0.5648***	0.1187	0.6449	10.01**
Small	Medium	0.0032	0.9707***	0.1942***	0.1115	-0.1047**	-0.9812	-0.1734	-0.0657	0.5868	6.59*
Small	High	0.0076**	0.9771***	0.2400***	0.4432***	-0.1114**	0.5104	-0.3284	-0.0585	0.4529	3.50
Big	Low	0.0075***	0.7421***	-0.0169	-0.2030***	-0.0324	-0.1948	-0.3068**	-0.1640	0.6348	13.90***
Big	Medium	0.0070***	0.9984***	-0.0514	-0.0631	-0.0403	0.2434	-0.2071	-0.0020	0.5706	2.22
Big	High	-0.0044	0.8539***	0.1064*	0.7426***	-0.0619	0.0321	0.0981	-0.5044	0.3576	1.41

Panel C: Effects of size, value, momentum, interest rate, and macroeconomic factors

Size	Book to Market	α_p	$R_m - R_f$	SMB	HML	Mom	ΔI	Term	C	Def	ΔInf	Adj R ²
Micro	Low	-0.0029	1.0190***	0.6007***	-0.2708***	-0.0452	0.0944	-0.3858*	-0.2850	-0.0055*	0.7912	0.7642
Micro	Medium	0.0070**	0.8162***	0.5244***	0.0701	-0.0842***	0.1405	-0.3232*	-0.4944*	-0.0084***	0.5037	0.7726
Micro	High	0.0091***	0.7287***	0.5665***	0.3358***	-0.0998***	0.5932	-0.2495	-0.3879	-0.0090***	-0.7657	0.7479
Small	Low	0.0066	1.1250***	0.3094***	-0.1631*	-0.0156	0.5985	-0.6095***	-0.1570	-0.0052	1.1491	0.6472
Small	Medium	0.0106***	0.9230***	0.1743***	0.0318	-0.1295***	-0.4398	-0.2591	-0.4875	-0.0113***	0.0689	0.6172
Small	High	0.0140***	0.9366***	0.2253***	0.3722***	-0.1331***	1.1032	-0.3944	-0.3385	-0.0093**	-0.8512	0.4651
Big	Low	0.0111***	0.7197***	-0.0234	-0.2444**	-0.0448**	0.2258	-0.3385***	-0.2627	-0.0049***	-1.1125	0.6504
Big	Medium	0.0123***	0.9645***	-0.0652*	-0.1203	-0.0579*	0.6466	-0.2671	-0.2909	-0.0080***	-0.0776	0.5864
Big	High	-0.0016	0.8357***	0.0967*	0.7153***	-0.0708	0.1116	0.0588	-0.7413	-0.0046	0.9005	0.3560

*/**/*** significant at the 10%, 5% and 1% level, respectively

Table 5

Regressions of excess stock returns for financial firms on the excess market return, mimicking returns for the size (SMB), book-to-market equity (HML) and Momentum (Mom): January 1993 to December 2010. The following regression is estimated using the OLS method:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \varepsilon_{p,t} \quad (2)$$

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \beta_{p,I}\Delta I_t + \beta_{p,t}Term_t + \beta_{p,c}C_t + \varepsilon_{p,t} \quad (3)$$

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \beta_{p,I}\Delta I_t + \beta_{p,t}Term_t + \beta_{p,c}C_t + \beta_{p,def}Def_t + \beta_{p,inf}\Delta Inf_t + \varepsilon_{p,t} \quad (4)$$

Panel A: Effects of size, value, and momentum factors

Size	Book to Market	α_p	$R_m - R_f$	SMB	HML	Mom	Adj R^2
Micro	Low	0.0010	1.1416***	0.2986***	-0.0338	0.0412	0.5329
Micro	Medium	0.0072***	1.0169***	0.1039***	0.1184**	-0.0019	0.6426
Micro	High	0.0087***	1.0634***	0.4090***	0.5320***	0.0235	0.5858
Small	Low	0.0025	1.0451***	-0.0785	0.1071*	-0.0336	0.5311
Small	Medium	0.0037	1.2308***	-0.0546	0.0970	0.0572	0.5461
Small	High	0.0017	1.2456***	-.02810***	0.4851***	-0.0479	0.3799
Big	Low	0.0106***	1.0183***	-0.4110***	-0.2556	0.0035	0.5712
Big	Medium	0.0062***	0.9501***	-0.3852***	-0.0438	-0.0180	0.5147
Big	High	-0.0039	0.8097***	-0.4300***	0.7028***	-0.0009	0.3959

Panel B: Effects of size, value, momentum, and interest rate factors

Size	Book to Market	α_p	$R_m - R_f$	SMB	HML	Mom	ΔI	Term	C	Adj R ²	Wald test ($\beta_{p,I} = \beta_{p,S}$ = $\beta_{p,C} = 0$)
Micro	Low	-0.0023	1.1197***	0.27784***	-0.0432	0.0311	1.2025	0.1378	-0.5588	0.5347	3.85
Micro	Medium	0.0023	1.0185***	0.1115**	0.1249**	0.0089	-1.2758*	0.3604**	-0.3797	0.6488	5.44
Micro	High	-0.0003	1.0480***	0.4082***	0.5283***	0.0369	-1.5265	0.7551***	-0.6089	0.5994	10.39**
Small	Low	0.0001	1.0549***	-0.0632	0.1120*	-0.0207	-2.1414**	0.3646	0.2558	0.5432	5.58
Small	Medium	0.0028	1.2568***	-0.0264	0.1163	0.0764	-1.9710*	0.0619	0.0424	0.5474	3.44
Small	High	0.0041	1.2709***	-0.2576**	0.4972***	-0.0370	-1.7931	-0.0448	0.6043	0.3758	1.42
Big	Low	0.0048	1.0309***	-0.3904***	-0.2398***	0.0243	-2.1084**	0.4000*	-0.4611	0.5816	7.35*
Big	Medium	0.0013	0.9568***	-0.03686***	-0.0357	0.0012	-1.9322**	0.4299*	-0.2474	0.5238	6.94*
Big	High	0.0015	0.8493***	-0.3971***	0.7246***	0.0118	-1.5727	-0.3642	0.6690	0.3933	1.41

Panel C: Effects of size, value, momentum , interest rate, and macroeconomic factors

Size	Book to Market	α_p	$R_m - R_f$	SMB	HML	Mom	ΔI	Term	C	Def	ΔInf	Adj R ²
Micro	Low	-0.0016	1.1131***	0.2760***	-0.0406	0.0297	1.2202	0.1231	-0.6331	-0.0014	0.2886	0.5306
Micro	Medium	0.0060*	0.9922***	0.1245***	0.1459***	0.0092	-0.8732	0.3019*	-0.4932*	-0.0055**	-1.4733	0.6596
Micro	High	-0.0029	1.0720***	0.4176***	0.5203***	0.0429	-1.5510	0.8092***	-0.3145	0.0049	-1.3752	0.6007
Small	Low	0.41	1.0253***	-0.0529	0.1335***	-0.0216	-1.7570*	0.2986	0.0897	-0.0062**	1.1131	0.5502
Small	Medium	0.0080*	1.2161***	-0.02250	0.1404**	0.0721	-1.6075	-0.0294	-0.2790	0.0085**	0.2153	0.5563
Small	High	-0.0010	1.3048***	-0.2851**	0.4643***	-0.0406	-2.4896	0.0303	0.6518	0.0072	3.3077	0.3791
Big	Low	0.0045	1.0344***	-0.3855***	-0.2392***	0.0263	-2.056**	0.4080*	-0.3867	0.0007	-0.6461	0.5782
Big	Medium	0.0057	0.9307***	-0.3342***	-0.0034	0.0079	-1.1822	0.3726*	-0.1641	-0.0057*	-4.2465***	0.5546
Big	High	0.0136	0.7488***	-0.4059***	0.7742***	-0.0043	0.9755	-0.5900	-0.2911	-0.0207***	1.8470	0.4197

*/**/** significant at the 10%, 5% and 1% level, respectively

Table 6

Generalised method of moments (GMM) system tests of asset-pricing models. In the context of a system-based estimation and under the null hypothesis, zero intercepts are imposed: $H_0 : \alpha_p = 0; p = 1, 2, \dots, N$ and the restricted version of Equation 2 is as follows:

$$r_{p,t} = \beta_{p,MRP}r_{m,t} + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \beta_{p,\Delta I}\Delta I_t + \beta_{p,t}Term_t + \beta_{p,c}C_t + \beta_{p,def}Def_t + \beta_{p,inf}\Delta Inf_t + \varepsilon_{p,t} \quad (5)$$

where $r_{p,t} = R_{p,t} - R_{f,t}$; and $r_{m,t} = R_{m,t} - R_{f,t}$. A variation of this standard asset-pricing test is to re-configure in a way that allows direct estimation of the premia for the six risk factors along with two control variables: default spread (DEF_t) and change in inflation (ΔInf_t).

$$r_{m,t} = \lambda_m + \varepsilon_{m,t} \quad (6)$$

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

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

$$Mom_t = \lambda_{Mom} + \varepsilon_{Mom} \quad (9)$$

$$\Delta I_t = \lambda_{\Delta I} + \varepsilon_{\Delta I} \quad (10)$$

$$Term_t = \lambda_{Term} + \varepsilon_{Term} \quad (11)$$

$$C_t = \lambda_C + \varepsilon_C \quad (12)$$

$$Def_t = \lambda_{Def} + \varepsilon_{Def} \quad (13)$$

$$\Delta Inf_t = \lambda_{\Delta Inf} + \varepsilon_{\Delta Inf} \quad (14)$$

Where λ_i and ε_i are risk premium and error term for a risk factor i (i refers to market risk, SMB, HML, Mom, change in interest rate, term spread, curvature, default spread, and inflation rate, respectively).

The GMM test statistic is used to test the null hypothesis that the over-identifying restrictions imposed on cross-section equations are satisfied to imply that the asset-pricing models hold. The GMM test statistic is distributed as a chi-square with 9 degrees of freedom.

	GMM	λ_m	λ_{SMB}	λ_{HML}	λ_{Mom}	$\lambda_{\Delta I}$	λ_{Term}	$\lambda_{Curvature}$	$\lambda_{default}$	$\lambda_{\Delta Inflation}$
Panel A: Non-financial firms										
FF	9.90	0.0057**	0.0014	0.0066***						
FF_Mom	8.68	0.0061***	0.0037	0.0070***	0.0079**					
FF-Mom-Interest rate factors	5.22	0.0522**	0.0039	0.0074***	0.0074**	0.0001	0.0088***	-0.0045**		
FF-Mom-Interest rate plus macroeconomic factors	7.83	0.0063***	0.0039	0.0075***	0.0082**	0.0001	0.0089**	-0.0045***	0.6221***	-0.0001
Panel B: Financial firms										
FF	21.70***	0.0050***	0.0021	-0.0015						
FF_Mom	9.32	0.0064***	0.0005	0.0001	0.0079***					
FF-Mom-Interest rate factors	3.33	0.0061***	0.0009	0.0006	0.0083***	-0.0001	0.0084***	-0.0042***		
FF-Mom-Interest rate plus macroeconomic factors	3.08	0.0061***	0.0004	0.0010	0.0087***	-0.0001	0.0084***	-0.0041***	0.5859***	-0.0001

Note: FF refers to the Fama French (1993) three-factor model; FF Mom model is the four-factor model; Augmented four-factor model stands for the FF-Mom model with three interest-rate factors: change in interest rate, slope, and curvature; and FF-Mom-Interest rate plus macroeconomic factors is the Augmented four-factor model with two control variables: default spread and change in the inflation rate.

*/**/** significant at the 10%, 5% and 1% level, respectively

Appendix A

Effects of the global financial crisis on the sensitivity of stock returns to factors. The following regression is estimated using the OLS method to examine the effects of the global financial crisis on the sensitivity of stock returns to factors:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,MRP}(R_{m,t} - R_{f,t}) + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,Mom}Mom_t + \beta_{p,\Delta I}\Delta I_t + \beta_{p,t}Term_t + \beta_{p,c}C_t + \beta_{p,def}Def_t + \beta_{p,inf}\Delta Inf_t + \beta_{gfc}D_{gfc} + \beta_{gfc,\Delta I}D_{gfc} * \Delta I_t + \beta_{gfc,t}D_{gfc} * Term_t + \beta_{gfc,c}D_{gfc} * C_t + \varepsilon_{p,t} \quad (A1)$$

Where D_{gfc} takes a value of 1 for the GFC (October 2008-December 2010)) and 0 otherwise and $\beta_{gfc,\Delta I}$, $\beta_{gfc,t}$ and $\beta_{gfc,c}$ represent the effect of the GFC on the sensitivity of stock returns to the change in the interest rate, term spread, and curvature, respectively. All other parameters are described in sub-section 2.4.

Panel A: Non-financial firms

Size	Book to Market	α_p	$R_m - R_f$	SMB	HML	Mom	ΔI	Term	C	Def	ΔInf	D_{gfc}	D_{gfc}^* Change in interest rate	D_{gfc}^* Slope	D_{gfc}^* Curvature
Micro	Low	0.01	1.06***	0.60***	-0.27***	-0.04	0.42	-0.59*	0.01	-0.01	1.19	-0.01	-2.05	0.31	-1.59
Micro	Medium	0.01**	0.82***	0.52***	0.07	-0.08**	0.34	-0.60**	-0.25	-0.02**	0.64	0.01	0.39	0.48	-1.25
Micro	High	0.01**	0.73***	0.57***	0.34***	-0.10***	0.76	-0.39*	-0.30	-0.01**	-0.69	0.01	-0.56	0.30	-0.49
Small	Low	0.01	1.17***	0.31***	-0.16*	-0.01	0.67	-0.57*	-0.03	-0.01	1.42	-0.01	-1.60	-0.11	-0.75
Small	Medium	0.01**	0.92***	0.17***	0.03	-0.13***	-0.50	-0.27	-0.50	-0.01*	0.04	0.01	1.41	-0.38	-0.28
Small	High	0.01	0.97***	0.22***	0.37***	-0.13**	0.91	-0.20	-0.36	-0.01	-0.71	0.01	0.68	-0.96	0.28
Big	Low	0.01**	0.80***	-0.03	-0.25***	-0.05**	0.21	-0.15	-0.15	-0.01	-0.64	0.01	-1.12	-1.26	-0.30
Big	Medium	0.01	1.02***	-0.07**	-0.12	-0.05	0.56	-0.01	-0.29	-0.01	0.20	-0.01	-2.16	-0.58	-0.17
Big	High	-0.01	0.91***	0.09	0.71***	-0.08	-0.13	0.39	-0.76	0.01	1.27	0.01	0.67	-1.98	0.59

Panel A: Financial firms

Size	Book to Market	α_p	$R_m - R_f$	SMB	HML	Mom	ΔI	Term	C	Def	ΔInf	D_{gfc}	D_{gfc}^* Change in interest rate	D_{gfc}^* Slope	D_{gfc}^* Curvature
Micro	Low	0.01	1.02***	0.27***	-0.05	0.01	1.48	-0.21	-0.70*	-0.01	-0.13	0.02	2.33	0.89	0.72
Micro	Medium	0.01*	0.93***	0.13***	0.14***	-0.01	-0.77	0.21	-0.67**	-0.01*	-1.82*	0.02	1.20	0.32	1.23
Micro	High	0.01	0.98***	0.41***	0.51***	0.02	-1.38	0.47	-0.34	-0.01	-1.83	0.01	2.61	1.26	0.14
Small	Low	0.01	0.90***	-0.05	0.11*	-0.05	-1.45	0.01	-0.15	-0.01	-1.80*	0.01	0.53	1.70	1.31
Small	Medium	0.02***	1.09***	-0.02	0.13*	0.03	-1.02	-0.54*	-0.37	-0.02***	-0.74	0.02	0.26	1.80	0.80
Small	High	0.01	1.12***	-0.27**	0.44***	-0.08	-1.77	-0.32	0.22	0.001	2.32	-0.01	-4.74	3.42	1.96
Big	Low	0.01	1.05***	-0.39***	-0.24***	0.03	-2.31**	0.56**	-0.46	0.004	-0.66	0.01	2.07	-0.84	0.53
Big	Medium	0.01	0.88***	-0.32***	0.001	-0.01	-0.67	0.31	-0.40	-0.01	-4.47***	0.001	-5.58	1.21	1.30
Big	High	0.02	0.65***	-0.39***	0.77***	-0.03	-0.11	-0.93*	-0.43	-0.03	1.45	-0.02	-8.10	3.09	0.27