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Are the Fama-French Factors Proxying Default Risk?

by

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Abstract:

In this paper we investigate the contention that the Fama-French (1993) model's ability to explain cross-sectional variation in equity returns occurs because the Fama-French factors, SMB and HML, are proxying for default risk. To assess the default risk hypothesis, we augment the CAPM and the Fama-French model with a default factor and run system regressions of the default enhanced models using the GMM approach. Our key findings are that: 1) default risk is not priced in equity returns; and, 2) the Fama-French factors are not proxying for default risk. Although our findings suggest that SMB and HML are not proxying for default risk, our analysis indicates that the Fama-French factors are capturing some form of priced risk. However, what type of risk the Fama-French factors are capturing remains an open question.

Keywords:

FAMA-FRENCH MODEL; DEFAULT RISK; ASSET PRICING.

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1. Introduction

In the Fama-French (1993) model, the two mimicking portfolios of SMB and HML are created to capture respectively, the return premium that small firms receive over large firms, and the return premium that high book-to-market firms receive over low book-to-market firms. One of the unresolved issues with the Fama-French model is what type of risk, if any, are SMB and HML capturing. Fama and French (1996) contend that the model's ability to explain equity returns is because it is capturing priced default risk.[1] The primary goal of the current paper is to investigate this contention, using data drawn from the Australian equities market.

Vassalou and Xing (2004) is the first study that examines default risk in the context of the Fama-French model. They find that default risk is priced in the cross-section of equity returns and they conclude that default risk is systematic. They also find that SMB and HML contain default related information, but they conclude that this is not the main reason why SMB and HML are significant explanators of equity returns. To the best of our knowledge, Vassalou and Xing's (2004) analysis of default risk in the context of the Fama-French model has only been performed in the US. Therefore, in the spirit of Lo and MacKinlay (1990), the main aim of this paper is to assess the external validity of the default risk hypothesis by testing whether default risk is priced in the cross-section of equity returns and whether SMB and HML are proxying for default risk in a market outside the US.

To test whether the Fama-French factors are proxying for default risk, we construct a mimicking portfolio, DEF, that measures the difference in returns between high default risk firms and low default risk firms. The proxy we use for default risk is the default probability obtained from option-based models.[2] The time-series regression slopes on DEF can be interpreted as loadings on priced factors that measure a firm/portfolio's sensitivity to default risk. Following Vassalou and Xing (2004), we augment the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965) with our default factor, DEF, to test whether default risk is priced in equity returns. If default risk is priced, we expect to observe a significantly positive factor premium on DEF in our system-based regressions. Furthermore, if SMB and HML are proxying for default risk, and their ability to explain returns is because they are capturing priced default risk, then SMB and HML should lose their ability to explain returns when regressed with DEF. Specifically, in a system regression framework, the factor premiums on SMB and HML should be insignificant and the factor premium on DEF should be significantly positive. Therefore, inferences will be drawn on whether default risk

1. For example, with regard to SMB one justification is that, generally, smaller firms have more volatile cashflows and less ability to raise external finance, hence, the likelihood of smaller firms defaulting is greater than that of larger firms. This implies that there could be a state variable risk premium in the expected returns of smaller stocks that is the result of priced default risk and therefore, that default risk is inducing the significance of SMB.
2. Vassalou and Xing (2004) and Hillegeist, Keating, Cram and Lundstedt (2004) advocate the use of the Merton (1974) model to estimate default probabilities. Brockman and Turtle (2003) contend that equity should be modelled as a barrier option, specifically, a down-and-out call option, and they derive default probabilities from the barrier model.

is priced and whether SMB and HML are proxying for default risk from the factor premiums estimated in the system regressions.

Fama and French (1996) point out that, as yet, the state variable(s) of special hedging concern to investors inducing the significance of the Fama-French factors has not been identified. If the state variable(s) could be identified, then a theoretical justification for the Fama-French model could be developed in terms of Merton's (1973) Intertemporal CAPM (ICAPM) or Ross' (1976) Arbitrage Pricing Theory (APT). Therefore, this study will seek to provide evidence on whether default risk is the state variable of special hedging concern to investors that is inducing the significance of the Fama-French factors.

The second aim of this paper is to identify whether an augmented version of the Fama-French model provides a better explanation of equity returns than the 'vanilla' version of the model. Specifically, we investigate whether augmenting the Fama-French model with additional default-risk related factor(s) improves the model's ability to explain expected returns. Hence, in addition to attempting to identify whether the Fama-French factors are capturing priced default risk, we also attempt to identify whether the Fama-French model 'works'. To identify whether the Fama-French model works, we first examine whether the Fama-French model explains the returns on our test portfolios and second, we examine whether an augmented model does a better job of explaining the returns on these portfolios. This will hopefully lead to a conclusion on which is the preferred model for asset pricing tests in the Australian equities market.

This paper proceeds as follows. Section 2 presents a brief literature review. Section 3 outlines the empirical framework. Section 4 discusses the data, the construction of the factors and the construction of the dependent variable portfolios. Section 5 presents the results and section 6 summarises and concludes.

2. Default Risk and Asset Pricing Research

2.1 The US Research

Dichev (1998) represents the first study on the 'default-risk/returns' relationship. He used Altman's (1968) Z-Score and Ohlson's (1980) O-Score as proxies for default risk. In a cross-sectional Fama-MacBeth (1973) regression framework, he finds that there is a negative relationship between default risk and returns after controlling for size and book-to-market. The negative relationship observed is inconsistent with a risk-based explanation for default. Similar to Dichev (1998), Vassalou and Xing's (2004) examination of the systematic nature of default risk analysed the interrelationship between size, book-to-market and default risk and their subsequent relationship with returns. Their results suggest that size and book-to-market are default effects since: a) both exist only in segments of the market with high default risk; and, b) the default effect only exists in small and high book-to-market firms. If default risk is systematic, then a positive relationship between default risk and returns should be observed for the entire spectrum of firms. However, Vassalou and Xing observe a positive relationship only in small or high book-to-market stocks.

At a general level, Vassalou and Xing (2004) apply two main techniques, Fama-MacBeth regressions and augmented Fama-French models to formally assess the 'default risk hypothesis'. Interestingly, in two of the Fama-MacBeth regressions that they report, the coefficient on their default measure is negative and significant and in the third regression, it is insignificant. These findings are inconsistent with a risk-based explanation for default. However, Vassalou and Xing (2004) conclude that default risk is systematic, which in our view is at least a little misleading. They seem to totally discount their poor Fama-MacBeth results and instead give full weighting to the positive and significant factor premium observed on the default factor in their systems analysis of default-augmented pricing models. Thus, a balanced reading of their findings leads to conflicting conclusions.

Griffin and Lemon (2002) investigated the relationship between default risk, book-to-marke and returns. They used Ohlson's O-score as their proxy for default risk. Similar to Vassalou and Xing, they find that the book-to-market effect is concentrated in high default risk stocks. Further, they find that the book-to-market effect in high default risk stocks is driven by the poor returns of low book-to-market stocks rather than the superior returns of high book-to-market stocks. By examining cumulative abnormal returns around earnings announcements, Griffin and Lemon establish mispricing to be a driver of these returns which suggests that low book-to-market stocks are overpriced.

2.2 The Australian Research

The literature on measuring default risk in Australia is sparse. Castagna and Matolscy (1981), Izan (1984), Lincoln (1984), and Pacey and Pham (1990) used accounting ratios to derive default prediction models with Australian data. The main limitation of these studies is that they all used a very small number of firms to construct and test their models. Most recently, Gharghori, Chan and Faff (2006b) pitted accounting-based and option-based models against each other. In that analysis, option-based models (namely, the Merton and barrier models) were shown to dominate their accounting competitors.

According to Merton (1974), equity can be modelled as a European call option on the firm's assets. Thus, the market value of equity (V_E) is given by the Black-Scholes (1973) equation for a call option shown below.

$$V_E = V_A N(d_1) - Xe^{-rT}N(d_1 - \sigma_A\sqrt{T}) \tag{1}$$

where $d_1 = \dfrac{\ln(V_A/X) + (r + \frac{1}{2}\sigma_A^2)T}{\sigma_A\sqrt{T}}$

and V_A is the market value of assets, X is the book value of liabilities maturing at time T, r is the risk-free rate, σ_A is the standard deviation of V_A, and N is the cumulative density function of the standard normal distribution.

The observable inputs into the Black-Scholes equation are V_E, X and r, and T is set to one year. To solve for V_A and σ_A, Gharghori, Chan and Faff (2006b) employed the same iterative procedure used by Vassalou and Xing (2004). Since V_A is log-normally distributed, the probability that $V_A(T) < X$, which is a firm's default probability (DP), is given by:

$$DP = 1 - N\left(\frac{\ln(V_A/X) + (\mu - \frac{1}{2}\sigma_A^2)T}{\sigma_A\sqrt{T}}\right) \tag{2}$$

where μ is the estimated growth rate in the market value of assets.

Gharghori, Chan and Faff (2006b) used equation (2) to calculate monthly DPs for all the firms in their sample, as well as the barrier version of the option pricing model (Brockman & Turtle 2003).[3] Through a series of tests, including calculating the Accuracy Ratio proposed by Moody's and running logistic regressions, Gharghori, Chan and Faff (2006b) show that their default measure is very successful in capturing default risk.[4]

Similar to Vassalou and Xing (2004), Gharghori, Chan and Faff (2006a) examined whether default risk was priced in equity returns using a cross-sectional Fama-MacBeth framework. In addition to their formal regression analysis, they also performed the same returns analysis that Vassalou and Xing performed. The findings of their returns analysis were broadly consistent with those of Vassalou and Xing. Specifically, Gharghori, Chan and Faff (2006a) showed that the size effect is concentrated in high default risk firms and that the default effect is observed in small firms only. They also found that the magnitude of the book-to-market effect was conditional on default risk. The only notable difference between the findings of their returns analysis and that of Vassalou and Xing is that they did not find that the default effect was conditional on book-to-market.

In their Fama-MacBeth regression analysis, Gharghori, Chan and Faff (2006a) observed a negative coefficient on DP both before and after controlling for size and book-to-market. Thus, they concluded that default risk was not systematic. Moreover, they also concluded that size and book-to-market's ability to explain cross-sectional variation in equity returns is not a result of these variables capturing priced default risk. Thus, the findings of Gharghori, Chan and Faff's (2006a) cross-sectional analysis and the asset pricing tests in the current paper are consistent (as will become apparent later). Both papers reach the same conclusion, that default risk is not systematic. This is in stark contrast to Vassalou and Xing whose analysis leads to conflicting conclusions: Vassalou and Xing's returns analysis and Fama-Macbeth regressions indicate that default risk is not systematic whereas their asset pricing tests suggest that it is.

3. Empirical Framework

3.1 General Plan

Our analysis begins with individual CAPM and Fama-French regressions on 27 size, book-to-market and DP sorted portfolios. The purpose of the individual regressions is to ascertain the significance of the market factor and the Fama-French factors on individual portfolios and to evaluate the explanatory power of the CAPM and the Fama-French model by comparing the adjusted R^2s for both

3. Details on this have been suppressed to conserve space—interested readers are referred to Gharghori, Chan and Faff (2006b).
4. See Gharghori, Chan and Faff (2006b) for a detailed discussion on the ability of DP to capture default risk.

models. We also examine the (statistical significance of the) regression intercepts to determine to what extent the models are explaining the returns on the test portfolios created.

Next, we run individual regressions on augmented Fama-French models. The first factor with which we augment the model is the default factor, DEF. To test the robustness of the model to other factors, we also augment the model with a leverage factor, a momentum factor and a liquidity factor. The motivation for augmenting the model with a leverage factor is Ferguson and Shockley (2003). Ferguson and Shockley construct an alternate multi-factor model that comprises the market factor, a default factor and a leverage factor. They find that their default and leverage factors add explanatory power to the Fama-French model but that SMB and HML do not add any explanatory power to their multi-factor model. The momentum factor we create follows Carhart (1997). The motivation for augmenting the Fama-French model with a momentum factor is Fama and French (1996) who find that the Fama-French model does not explain the returns on portfolios formed by sorts on past returns. Finally, the motivation for augmenting the Fama-French model with a liquidity factor is Chan and Faff (2005) who find that the system regressions they perform support the overall favourability of a liquidity augmented Fama-French model.

The next stage of the analysis is the system regressions on the various asset pricing models constructed in this paper. For the system regressions, the tests are modified to allow direct estimation of the premia on the risk factors. The advantage of our experimental design is that it allows us test the hypothesis that each expected premium is zero. If the premia are significantly positive, we can conclude that the associated factors are priced in the cross-section of equity returns and therefore, that the factors are systematic.[5] The systems analysis is performed on the CAPM, the default augmented CAPM, the Fama-French model and the default augmented Fama-French model. The results of these system regressions allow us to draw conclusions on the main aim of the study, which is to identify whether default risk is priced and whether the Fama-French factors are proxying for default risk.

The systems analysis is also performed on augmented Fama-French models where the Fama-French model is augmented with the leverage factor, the momentum factor and the liquidity factor, in turn. The purpose of these system regressions is to draw conclusions on the second aim of the study, which is to identify the ‘best’ asset pricing model. Finally, the systems analysis is performed on five-factor models where the default enhanced Fama-French model is further augmented with the leverage factor, the momentum factor and the liquidity factor, in turn. The purpose of these system regressions is to establish the robustness of the default factor in the context of an augmented Fama-French model.

3.2 Modelling Specifics

The empirical modelling applied in this paper is premised on a default enhanced Fama and French (1993) model.[6]

5. The systems analysis is outlined in detail in the next sub-section.
6. The experimental design for the one-factor CAPM, the three-factor Fama-French model and the five-factor models is similar. The only difference is the number of factors is not the same. To conserve space, we present the experimental design for the four-factor model only.

$$E(R_i) - R_f = b_i [E(R_m) - R_f] + s_i E(SMB) + h_i E(HML) + d_i E(DEF) \quad (3)$$

where R_i is the return on asset i; R_f is the return on the risk-free asset; R_m is the return on the market portfolio; SMB is the return on the mimicking portfolio for the size factor; HML is the return on the mimicking portfolio for the book-to-market factor; and DEF is the return on the mimicking portfolio for the default factor.

The empirical counterpart for this model is:

$$R_{it} - R_{ft} = \alpha_i + b_i (R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + d_i DEF_t + \varepsilon_{it} \quad (4)$$

After applying expectations to equation (4), a comparison with the default enhanced Fama-French model of equation (3) reveals the standard zero intercept restriction. As such, in the context of a system-based estimation our null hypothesis becomes: H_0: $\alpha_i = 0$; i = 1, 2, ... N. The restricted version of equation (4) is given by:

$$r_{it} = b_i r_{mt} + s_i SMB_t + h_i HML_t + d_i DEF_t + \varepsilon_{it} \quad (5)$$

where $r_{it} = R_{it} - R_{ft}$; and $r_{mt} = (R_{mt} - R_{ft})$. 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 risk factors:

$$r_{it} = b_i r_{mt} + s_i SMB_t + h_i HML_t + d_i DEF_t + \varepsilon_{it} \quad (5)$$

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

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

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

$$DEF_t = \lambda_{DEF} + \varepsilon_{dt} \quad (9)$$

where i = 1, 2, …, N. In essence, equations (6), (7), (8), and (9) impose a mean adjusted transformation to the independent variables of equation (5). Upon rearrangement, it can be seen that the null hypothesis is effectively a test of the intercept term α^* being equal to a non-linear restriction:

$$H_0: \alpha^* = b_i \lambda_m + s_i \lambda_{SMB} + h_i \lambda_{HML} + d_i \lambda_{DEF}$$

Following Faff (2001), the system-based method chosen to perform the asset pricing tests is the generalised method of moments (GMM) approach. In the system of equations specified above, there are 5N + 4 sample moment equations with 4N +

4 unknown parameters (i.e. $\phi = b_1, b_2, ..., b_N, s_1, s_2, ..., s_N, h_1, h_2, ..., h_N, d_1, d_2, ..., d_N, \lambda_m, \lambda_{SMB}, \lambda_{HML}, \lambda_{DEF}$). That is, there are 5 sample moment conditions for each of N test equations as follows: (a) the mean regression error term is zero; and the regression error term is orthogonal to each regressor; namely, to (b) r_{mt}; (c) SMB_t; (d) HML_t; and (e) DEF_t. In addition, there is one sample moment condition that defines each factor premium—relating to each of equations (6) to (9). Accordingly, the GMM statistic involves N over-identifying restrictions (distributed χ_N^2): [7]

$$GMM = (T - N - 1)^* g_T(\hat{\phi})' \cdot S_T^{-1} \cdot g_T(\hat{\phi}) \tag{10}$$

where $g_T(\hat{\phi}) = \frac{1}{T}\sum_{t=1}^{T} f_t(\hat{\phi})$,

is the empirical moment condition vector; and GMM is (asymptotically) distributed as a chi-square statistic with N degrees of freedom.

The current setting offers the advantage that individual tests of the significance of specific premia can be performed: H_0: $\lambda_m = 0$; H_0: $\lambda_{SMB} = 0$; H_0: $\lambda_{HML} = 0$; and H_0: $\lambda_{DEF} = 0$. This will provide a more powerful test of the four-factor model proposed in this paper.

4. Data Issues

4.1 General

Monthly share price data, market capitalisations, the value-weighted market index and the risk-free return data are obtained from the AGSM file. Accounting data are obtained from Aspect Financial. The accounting data we require are Net Tangible Assets. Daily share price data and market capitalisations, which are used to calculate the DPs, are obtained from SIRCA.[8] The asset pricing tests are conducted over the period January 1996 to December 2004. As we require six-months of prior data to calculate past six-month returns, the AGSM dataset spans July 1995 to December 2004. As one-year of prior data is required to calculate the DPs, the SIRCA dataset spans January 1995 to December 2003.

4.2 Creation of the Independent Variables

The market factor, r_{mt}, is the monthly return on the market portfolio, R_{mt}, less the monthly return on the risk-free asset, R_{ft}. Our proxy for the market portfolio is the value-weighted market index from the AGSM file. Our proxy for the risk-free asset is the monthly return on the 13-week Treasury note, also obtained from the AGSM file.

The creation of SMB and HML follows Fama and French (1993). Specifically, firms are sorted into two size groups (Small and Big) and three book-to-market groups (High, Medium and Low) using a 30–40–30 split.[9] Size rankings are based on market capitalisation and book-to-market rankings are based on the

7. A small-sample adjustment is applied following MacKinlay and Richardson (1991).
8. For a more detailed description of the data required to calculate the DPs, see the data section of Gharghori, Chan and Faff (2006b).
9. Following Fama-French (1993), negative book-to-market firms are removed from the sample.

ratio of book equity to market equity. [10] Firms are ranked in December of year t – 1 and are placed into six portfolios (based on these rankings) from January to December of year t.[11] Six portfolios are formed from the intersection of the two size and three book-to-market groups; S/L, S/M, S/H, B/L, B/M and B/H. SMB (Small minus Big) is the difference, each month, between the simple average of the value-weighted returns on the three small-firm portfolios (S/L, S/M, S/H) and the simple average of the value-weighted returns on the three big-firm portfolios (B/L, B/M, B/H). HML (High minus Low) is the difference, each month, between the simple average of the value-weighted returns on the two high book-to-market portfolios (S/H, B/H) and the simple average of the value-weighted returns on the two low book-to-market portfolios (S/L, B/L).

Based on Gharghori, Chan and Faff's (2006b) findings that DPs estimated from both the Merton and barrier models were reliable proxies for default risk, and that the performance of both models was similar, we take the simple average of the DPs from both models and use this as our proxy for default risk.

The default factor (DEF), the leverage factor (LEV), and the liquidity factor (LIQ) are all created in a similar fashion described below. The difference between these factors and the Fama-French factors is that these factors are created from separate rankings on the variable in question, whereas the Fama-French factors are created by dual sorting on both size and book-to-market. For all three factors, DEF, LEV and LIQ, firms are ranked in December of year t – 1 and are sorted into three groups using a 30–40–30 split. Based on their rankings on the relevant variable, firms are then placed into one of three portfolios and they remain in those notional portfolios from January to December of year t. DEF is the difference, each month, between the value-weighted returns on the high DP portfolio and the value-weighted returns on the low DP portfolio. Similarly, LEV is the difference, each month, between the value-weighted returns on the high leverage portfolio and the value-weighted returns on the low leverage portfolio. Finally, LIQ is the difference, each month, between the value-weighted returns on the low liquidity portfolio and the value-weighted returns on the high liquidity portfolio.[12]

The creation of the momentum factor (MOM) follows Carhart (1997). Each month, firms are ranked on their cumulative return over the prior five months with a one month lag. In the following month, firms are placed into three portfolios based on these rankings using a 30–40–30 split. MOM is the difference, each month, between the equally-weighted returns on the high past returns portfolio and the equally-weighted returns on the low past returns portfolio.[13]

10. We use market capitalisation for market equity and Net Tangible Assets for book equity.

11. 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.

12. DEF and LEV are created from rankings on a firm's DP and leverage in December. LIQ, on the other hand, is created from rankings on a firm's average monthly share turnover in the prior three months—October, November and December. Share turnover is defined as monthly trading volume divided by the number of shares on issue and is our proxy for liquidity. The reason we use average share turnover over three months is to remove any potential seasonalities in share turnover.

13. Unlike the portfolios formed to create the other factors, which are all value-weighted, the portfolios formed to create the momentum factor are equally-weighted, consistent with Carhart (1997).

4.3 Creation of the Dependent Variables

Recall that our main aim is to identify whether SMB and HML are proxying for default risk. This implies that size, book-to-market and DP are the three variables against which the dependent variable portfolios have to exhibit maximum dispersion. Hence, following Vassalou and Xing (2004), we use excess returns on portfolios formed from rankings on all three variables. Initially, all firms in our sample are independently ranked on size, book-to-market and DP in December of year t – 1. Firms are then allocated into three groups according to a 33%:33%:33% partition and 27 portfolios are formed from the intersection of the three size, three book-to-market, and three DP groups; the firms remain in these portfolios from January to December of year t. The excess returns on the 27 portfolios are the value-weighted returns on each portfolio less the return on the risk-free asset.

5. Results[14]

5.1 Preliminaries

Panel A of table 1 reports basic descriptive statistics for the independent variables used in this analysis. The time-series mean of the market premium (0.47% pm), SMB (1.43%), HML (0.87%), LEV (0.71%) and MOM (2.16%) are all positive, significantly so for SMB, HML and MOM. The mean of LIQ is also positive, 0.13%, but it is clearly insignificant (t-statistic is 0.33). Conversely, the mean of DEF is negative, –0.36% pm, with a t-statistic of –0.97. The descriptive statistics suggest that SMB, HML and MOM, and to a lesser extent r_{mt} and LEV, are the factors that are most likely to be priced in equity returns. On the other hand, the descriptive statistics suggest that it is unlikely that DEF and LIQ will be significant. Moreover, the insignificance of DEF (and the negative mean of DEF) suggests that it is unlikely that default risk is priced in equity returns.

Panel B of table 1 reports correlations for the independent variables used in this analysis. One of the most striking features of this panel is the high negative correlation between SMB and HML (–0.548). The construction of the Fama-French factors, with independent sorts on size and book-to-market, is designed to isolate the size effect from the book-to-market effect, and vice versa. Clearly, this has not occurred. The high (albeit negative) correlation between SMB and HML indicates that SMB and HML are closely related and that the component of equity returns that each factor explains may be similar. The high correlation between SMB and HML is one of the reasons why we create the other factors with sorts on the variable in question only. By doing this, we accept that some of the factors are going to be relatively highly correlated with the other factors. However, we believe that creating factors by sorting on multiple variables will not result in a set of factors which have lower correlations with each other.[15]

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14. The results of the regression analysis in this section are for dependent variable portfolios formed from a 3x3x3 sort on size, book-to-market and DP. The regression analysis has also been performed on dependent variable portfolios created from a 5x5 sort on size and book-to-market. The results are qualitatively similar, hence, only the output for the 3x3x3 sort is presented. The results for the regression analysis on the 5x5 size and book-to-market sorted portfolios suggest considerable robustness. Details are suppressed to conserve space.

15. To further emphasise the point, the correlation matrix shows that only SMB and LEV (–0.684) have a larger correlation (in magnitude) than SMB and HML (–0.548).

Table 1

Basic Descriptive Statistics and Correlations for the Independent Variable Factor Portfolios

Panel A of this table reports basic descriptive statistics for the excess market return (r_m) and for the mimicking portfolio factor returns of size (SMB), book-to-market (HML), default (DEF), leverage (LEV), momentum (MOM), and liquidity (LIQ). Panel B reports correlations between the excess market returns and the SMB, HML, DEF, LEV, MOM and LIQ factor returns. Data are monthly covering the period from January 1996 to December 2004.

	r_m	SMB	HML	DEF	LEV	MOM	LIQ
Panel A: Basic Descriptive Statistics							
Mean	0.0047	0.0143	0.0087	–0.0036	0.0071	0.0216	0.0013
Mean std error	0.0029	0.0066	0.0036	0.0037	0.0044	0.0063	0.0039
t-statistic	1.6057	2.1569	2.4192	–0.9675	1.6173	3.3953	0.3372
Median	0.0111	0.0090	0.0091	–0.0012	0.0086	0.0186	–0.0037
Maximum	0.0644	0.2682	0.1417	0.1060	0.2662	0.1616	0.1878
Minimum	–0.1059	–0.2709	–0.1519	–0.1261	–0.1191	–0.3768	–0.1210
Std. Dev.	0.0303	0.0690	0.0375	0.0388	0.0455	0.0660	0.0408
Skewness	–0.8138	0.2206	–0.6655	–0.2604	1.4151	–1.9369	0.6655
Kurtosis	4.1490	6.2045	6.8800	3.7979	11.4485	14.1411	6.5408
Panel B: Correlations							
r_m	1	–	–	–	–	–	–
SMB	0.134	1	–	–	–	–	–
HML	–0.145	–0.548	1	–	–	–	–
DEF	0.304	0.129	0.221	1	–	–	–
LEV	–0.168	–0.684	0.500	0.069	1	–	–
MOM	–0.088	0.014	–0.242	–0.351	–0.246	1	–
LIQ	–0.418	–0.240	0.260	0.006	0.336	–0.280	1

Moreover, creating factors by sorting solely on the variable in question enables us to draw stronger conclusions on the aims of this study. Recall that we have two aims in this paper. The first is to identify whether default risk is priced in equity returns and whether SMB and HML are proxying for default risk. The second is to identify whether a four (or five) factor model will improve on the Fama-French model's ability to explain equity returns. Taking the first aim, if default risk is priced, and SMB and HML are proxies for default risk, then the default factor, DEF, will explain the same component of returns as SMB and HML. If so, then in a four-factor regression that includes DEF, SMB and HML will be insignificant. The likelihood of this occurring is greater if DEF is created without a control for size and book-to-market. Taking the second aim, if a four (or five) factor model outperforms the Fama-French model, then any additional factor will explain a component of returns that is unexplained by SMB and HML. Hence, the additional factor should be created without a control for size and book-to-market and conversely, SMB and HML should be created without a control for the additional factor.

Table 2 reports descriptive statistics for the 27 size, book-to-market and DP sorted portfolios. There is evidence of a strong size effect as returns decrease as we move from the small size portfolios (Sz = 1) to the big size portfolios (Sz = 3). Conversely, the book-to-market effect is only observed in the large size portfolios and the effect is weak. Similarly, the default effect is also weak. For large size portfolios, there is some evidence that low DP stocks (DP = 1) outperform high DP stocks (DP = 3) which suggests a negative relationship between DP and returns. This is inconsistent with a risk-based explanation for default but is consistent with the negative factor premium on DEF in table 1 and with the evidence in Gharghori, Chan and Faff (2006a).

Table 2

Descriptive Statistics for the 27 Size, Book-to-Market and DP Sorted Dependent Variable Portfolios

This table reports descriptive statistics for the 27 size (Sz), book-to-market (BM) and default probability (DP) sorted portfolios for the period January 1996 to December 2004. The portfolios are created from the intersection of independent three-way (33%:33%:33%) sorts on the three variables: smallest (1) to largest (3). The columns in the table show: the average monthly return of the portfolio in the year after portfolio formation (Rets); the average market capitalisation of the portfolio at the portfolio formation date (Mkt Cap); the average book-to-market value of the portfolio at formation date (B/M); the average default probability of the portfolio at formation date (DP) and the average of number of companies in the given portfolio (No. of coys).

Sz	BM	DP	Rets	Mkt Cap ($b)	B/M	DP	No. of coys
1	1	1	0.223	8.7	0.235	0.007	16
1	1	2	0.261	7.2	0.217	0.052	24
1	1	3	0.383	6.5	0.210	0.371	29
1	2	1	0.517	8.1	0.637	0.009	16
1	2	2	0.449	7.2	0.647	0.057	31
1	2	3	0.512	6.6	0.652	0.367	41
1	3	1	0.364	6.4	1.338	0.010	16
1	3	2	0.356	6.5	1.569	0.057	38
1	3	3	0.330	5.9	3.967	0.440	77
2	1	1	0.168	41	0.212	0.005	50
2	1	2	0.270	37	0.215	0.055	30
2	1	3	0.217	36	0.193	0.324	20
2	2	1	0.129	39	0.609	0.007	30
2	2	2	0.307	36	0.627	0.058	38
2	2	3	0.139	36	0.642	0.268	28
2	3	1	0.225	38	1.190	0.007	18
2	3	2	0.229	36	1.389	0.060	31
2	3	3	0.221	34	1.799	0.351	43
3	1	1	0.122	1552	0.189	0.004	73
3	1	2	0.138	2190	0.231	0.048	34
3	1	3	–0.012	2346	0.236	0.251	12
3	2	1	0.134	1048	0.650	0.005	47
3	2	2	0.112	2059	0.614	0.054	37
3	2	3	0.101	1684	0.614	0.268	19
3	3	1	0.166	632	1.119	0.006	22
3	3	2	0.175	699	1.219	0.057	24
3	3	3	0.126	707	1.591	0.329	19

Table 2 also shows that there is strong relationship between size and book-to-market. As we move through book-to-market portfolios 1 to 3, the market capitalisation of the portfolio generally decreases. A decrease in the average book-to-market ratio of increasing size portfolios (from Sz = 1 to 3) is also observed, although the effect is not as clear. Further, table 2 shows that the relationship between DP and size is non-linear. For small and medium size portfolios (Sz = 1 and 2), market capitalisation decreases as we move through DP portfolios 1 to 3. However, for large size portfolios (Sz = 3) the opposite tends to be observed. Additionally, for high DP groups (DP = 3), the average DP of the portfolio is higher, the smaller the size grouping. An interesting result is also observed in the high book-to-market portfolios (B/M = 3). For high book-to-market portfolios, as we move from DP portfolio 1 to 3, the average book-to-market ratio of the portfolio increases substantially. Lastly, the final column of table 2 shows that the most populated portfolios are the 1,3,3 and the 3,1,1 portfolios with an average of 77 and 73 companies, respectively. This means that if a company is small it will most likely have a high book-to-market ratio and a high DP whereas if a company is large, it will most likely have a low book-to-market ratio and a low DP. In summary, table 2 shows that size, book-to-market and DP are interrelated which is consistent with prior research such as Gharghori, Chan and Faff (2006a) and Vassalou and Xing (2004).

5.2 Basic CAPM, Fama-French and Four-Factor Regressions

The first regression results reported, in table 3, are individual CAPM regressions on the 27 size, book-to-market and DP sorted portfolios. For all 27 portfolios, market beta (b_i) is significant and positive, while for 12 (out of the 27) portfolios, the regression intercept (α_i) is significant.[16] Furthermore, for each of these 12 portfolios, the intercept is significantly positive. This implies that for the 12 portfolios in question, the CAPM significantly understates the returns on the portfolio.

The portfolios for which the CAPM understates the returns are generally smaller in size and have higher book-to-market. Only one (out of 9) big portfolio and one low book-to-market portfolio have a significant intercept. Conversely, 11 (out of 18) small and medium sized portfolios, and 11 medium and high book-to-market portfolios have significant intercepts. This suggests that although the CAPM adequately explains the returns of large firms and low book-to-market firms, the CAPM significantly understates the returns of smaller firms and firms with higher book-to-market.[17]

16. Recall that if the CAPM is the true specification for expected returns, then the regression intercepts should be zero. This also applies to the Fama-French model and the alternative multi-factor models.
17. There is no trend in the significance of the intercepts for the DP sorted portfolios.

Table 3

Individual CAPM Regressions on 27 Size, Book-to-Market and DP Sorted Portfolios

This table reports the results of individual CAPM regressions on 27 size, book-to-market and DP sorted portfolios for the period January 1996 to December 2004 according to:

$$r_{it} = \alpha_i + b_i r_{mt} + \varepsilon_{it}$$

where r_{it} is the excess return on portfolio i in month t, r_{mt} is the excess return on the market portfolio in month t. The dependent variable portfolios are created from the intersection of independent three-way (33%:33%:33%) sorts on three variables—Size (Sz); book-to-market (BM) and default probability (DP): smallest (1) to largest (3). t-statistics are reported in parentheses below the estimates. Adjusted R^2s (adj R^2) are reported for each regression and the final row of the table reports the average adjusted R^2 across the 27 regressions.

Sz	BM	DP	α_i	b_i	adj R^2
1	1	1	0.0055	1.8739	0.143
			(0.42)	*(3.62)*	
1	1	2	0.0102	1.5667	0.147
			(0.90)	*(4.45)*	
1	1	3	0.0205	1.5281	0.100
			(1.58)	*(3.31)*	
1	2	1	0.0324	1.3737	0.103
			(2.87)	*(2.96)*	
1	2	2	0.0259	1.5436	0.142
			(2.40)	*(3.98)*	
1	2	3	0.0308	1.6182	0.162
			(2.91)	*(5.25)*	
1	3	1	0.0213	1.0320	0.115
			(2.54)	*(4.12)*	
1	3	2	0.0196	1.2293	0.144
			(2.25)	*(5.76)*	
1	3	3	0.0172	1.2795	0.204
			(2.28)	*(5.74)*	
2	1	1	0.0042	1.1684	0.324
			(0.85)	*(8.11)*	
2	1	2	0.0122	1.2912	0.313
			(2.23)	*(6.75)*	
2	1	3	0.0077	1.2993	0.178
			(0.92)	*(5.44)*	
2	2	1	0.0011	1.1550	0.336
			(0.22)	*(7.59)*	
2	2	2	0.0157	1.1938	0.283
			(2.99)	*(7.30)*	
2	2	3	0.0017	1.2024	0.343
			(0.36)	*(8.23)*	
2	3	1	0.0104	0.8579	0.345
			(2.97)	*(7.20)*	
2	3	2	0.0113	0.7479	0.309
			(3.55)	*(7.68)*	

Table 3 Continued

Sz	BM	DP	α_i	b_i	adj R^2
2	3	3	0.0097	0.9503	0.276
			(2.21)	*(7.22)*	
3	1	1	0.0017	0.8954	0.661
			(0.83)	*(9.49)*	
3	1	2	0.0027	0.9614	0.422
			(0.79)	*(9.44)*	
3	1	3	–0.0104	1.0967	0.183
			(–1.58)	*(5.11)*	
3	2	1	0.0030	0.8365	0.481
			(1.11)	*(10.70)*	
3	2	2	0.0002	1.0488	0.528
			(0.07)	*(10.91)*	
3	2	3	–0.0011	1.1146	0.494
			(–0.32)	*(8.40)*	
3	3	1	0.0066	0.6173	0.344
			(2.63)	*(8.14)*	
3	3	2	0.0053	1.0731	0.447
			(1.54)	*(9.29)*	
3	3	3	–0.0007	1.4711	0.388
			(–0.12)	*(8.07)*	
average					0.293

Table 4 presents the results of individual Fama-French regressions on the 27 portfolios. As was the case with the CAPM regressions, market beta is significant and positive for all 27 portfolios. The loadings on SMB (s_i) are significant and positive for each of the 18 portfolios that are either small (1) or medium (2) in size. However, for the large size portfolios (Sz = 3), the loadings on SMB are significant in only 2 out of 9 cases. This indicates that SMB is a significant explanator of returns for small and medium sized firms, but not for large firms. The loadings on HML (h_i) are significant for 14 (out of 27) portfolios. Specifically, the loadings on HML are significant and positive for all 9 high book-to-market portfolios (B/M = 3). Hence, HML is a significant explanator of returns on high book-to-market portfolios, but not as significant for medium and low book-to-market portfolios. Taken as a whole, our results suggest that both Fama-French factors, particularly SMB, are significant explanators of returns. The most notable finding in this table is that only 3 (out of 27) portfolios have significant regression intercepts.[18] This is a considerable improvement on the CAPM where almost half of the portfolios had significant regression intercepts. In addition, the average adjusted R^2 for the 27 portfolios is 58.7% compared with 29.3% for the CAPM. Taken together, these

18. Although most of the regression intercepts are statistically insignificant, some of the insignificant regression intercepts are economically significant. For example, the 1,1,1 portfolio (which corresponds to small size, low book-to-market and low DP firms) has a regression intercept of –1.27% pm which annualises to around –15%. This is an economically important return but the intercept is statistically insignificant (t-statistic is –1.33).

findings suggest that the Fama-French model does a good job of explaining equity returns and that it is vastly superior to the CAPM in this regard.

Table 4

Individual Fama-French Regressions on 27 Size, Book-to-Market and DP Sorted Portfolios

This table reports the results of individual Fama-French regressions on 27 size, book-to-market and DP sorted portfolios for the period January 1996 to December 2004 according to:

$$r_{it} = \alpha_i + b_i r_{mt} + s_i SMB_t + h_i HML_t + \varepsilon_{it}$$

where r_{it} is the excess return on portfolio i in month t, r_{mt} is the excess return on the market portfolio in month t, SMB_t is the return on the size mimicking portfolio in month t, HML_t is the return on the book-to-market mimicking portfolio in month t. The dependent variable portfolios are created from the intersection of independent three-way (33%:33%:33%) sorts on three variables—Size (Sz); book-to-market (BM) and default probability (DP): smallest (1) to largest (3). t-statistics are reported in parentheses below the estimates. Adjusted R^2s (adj R^2) are reported for each regression and the final row of the table reports the average adjusted R^2 across the 27 regressions.

Sz	BM	DP	α_i	b_i	s_i	h_i	adj R^2
1	1	1	–0.0127	1.3661	1.5532	–0.1875	0.710
			(–1.33)	*(4.35)*	*(10.72)*	*(–0.58)*	
1	1	2	–0.0002	1.0886	1.2297	–0.5714	0.797
			(–0.04)	*(6.27)*	*(11.09)*	*(–3.58)*	
1	1	3	0.0083	1.0119	1.3603	–0.5615	0.662
			(0.93)	*(3.60)*	*(10.45)*	*(–1.52)*	
1	2	1	0.0199	1.0656	0.9911	–0.0307	0.396
			(1.81)	*(2.46)*	*(6.45)*	*(–0.10)*	
1	2	2	0.0050	1.1581	1.4224	0.2709	0.726
			(0.71)	*(5.67)*	*(9.96)*	*(0.83)*	
1	2	3	0.0121	1.2270	1.3589	0.1315	0.740
			(2.09)	*(7.55)*	*(14.23)*	*(0.72)*	
1	3	1	0.0008	0.8027	1.1226	0.6307	0.680
			(0.15)	*(4.88)*	*(12.88)*	*(4.50)*	
1	3	2	–0.0019	0.9735	1.2052	0.6233	0.719
			(–0.34)	*(6.73)*	*(17.76)*	*(3.80)*	
1	3	3	–0.0040	1.0501	1.1461	0.6704	0.861
			(–1.23)	*(13.00)*	*(17.63)*	*(6.22)*	
2	1	1	–0.0022	1.0010	0.5265	–0.0373	0.677
			(–0.58)	*(9.39)*	*(8.33)*	*(–0.33)*	
2	1	2	0.0052	1.1038	0.5814	–0.0549	0.658
			(1.20)	*(8.51)*	*(6.86)*	*(–0.31)*	
2	1	3	–0.0038	1.0746	0.8065	0.1195	0.505
			(–0.55)	*(6.57)*	*(7.66)*	*(0.53)*	
2	2	1	–0.0097	1.0564	0.5492	0.3840	0.620
			(–2.74)	*(9.90)*	*(10.14)*	*(2.96)*	
2	2	2	0.0072	1.0191	0.6125	0.0684	0.642
			(1.93)	*(9.53)*	*(7.07)*	*(0.48)*	
2	2	3	–0.0077	1.1460	0.4239	0.4062	0.492
			(–1.39)	*(9.97)*	*(5.48)*	*(2.29)*	

Table 4 Continued

Sz	BM	DP	α_i	b_i	s_i	h_i	adj R^2
2	3	1	0.0034	0.8371	0.2777	0.3559	0.474
			(1.04)	*(7.92)*	*(4.56)*	*(3.51)*	
2	3	2	0.0014	0.7306	0.3722	0.5356	0.608
			(0.55)	*(10.03)*	*(8.14)*	*(7.35)*	
2	3	3	–0.0038	0.9417	0.4790	0.7657	0.569
			(–1.06)	*(10.06)*	*(7.62)*	*(5.76)*	
3	1	1	0.0027	0.8838	–0.0130	–0.0866	0.662
			(1.17)	*(9.59)*	*(–0.39)*	*(–1.54)*	
3	1	2	0.0043	0.9491	–0.0317	–0.1221	0.419
			(1.05)	*(9.26)*	*(–0.42)*	*(–1.06)*	
3	1	3	–0.0069	1.0615	–0.0571	–0.2927	0.182
			(–0.87)	*(5.19)*	*(–0.46)*	*(–1.17)*	
3	2	1	0.0020	0.8750	–0.0376	0.1503	0.513
			(0.75)	*(11.17)*	*(–0.77)*	*(1.78)*	
3	2	2	–0.0022	1.0822	0.0217	0.2223	0.549
			(–0.68)	*(10.52)*	*(0.48)*	*(2.72)*	
3	2	3	–0.0049	1.1694	0.0301	0.3555	0.551
			(–1.37)	*(8.41)*	*(0.74)*	*(3.93)*	
3	3	1	0.0059	0.6559	–0.0462	0.1366	0.386
			(2.23)	*(8.97)*	*(–1.13)*	*(2.33)*	
3	3	2	–0.0020	1.1477	0.1151	0.6107	0.604
			(–0.64)	*(10.96)*	*(2.35)*	*(6.28)*	
3	3	3	–0.0093	1.5286	0.1906	0.6436	0.458
			(–1.66)	*(9.25)*	*(2.26)*	*(4.20)*	
average							0.587

Table 5 reports the output from individual four-factor regressions on the 27 portfolios. The four-factor model in this table is the Fama-French model augmented with the default factor, DEF. With regard to the market betas, the loadings on SMB and the loadings on HML, the results are very similar to those of the Fama-French regressions in table 4. The market factor is significant for all 27 portfolios, SMB is significant for all of the small and medium sized portfolios, and HML is significant for all of the high book-to-market portfolios.[19] DEF, on the other hand, is only significant for 5 (out of 27) portfolios. Additionally, the regression intercepts are significant for 2 (out of 27) portfolios as opposed to 3 portfolios in the Fama-French regressions. Finally, the average adjusted R^2 for the 27 regressions is 59.8%; this is marginally higher than the average adjusted R^2 (58.7%) of the Fama-French regressions. Taken as a whole, our findings indicate that the performance of the four-factor model and the Fama-French model is similar; any improvement in the four-factor model is marginal at best.

If SMB and HML are proxies for default risk, and their explanatory power is a result of the fact that they are capturing priced default risk, then in the presence of

19. In addition, SMB is significant for one large portfolio resulting in 19 (out of 27) portfolios having significant loadings on SMB. HML is significant for 8 of the low and medium book-to-market portfolios resulting in 17 (out of 27) portfolios having significant loadings on HML.

a superior proxy for default risk, DEF, the Fama-French factors should lose their ability to explain equity returns. Hence, if SMB and HML are proxies for default risk, then the loadings on these factors should become insignificant when regressed with DEF. Clearly, this is not the case. Hence, the findings of our individual regressions indicate that it is unlikely that SMB and HML are proxying for default risk.

Table 5

Individual Regressions of a Default Augmented Fama-French Model on 27 Size, Book-to-Market and DP Sorted Portfolios

This table reports the results of individual regressions of a default augmented Fama-French model on 27 size, BM and DP sorted portfolios for the period January 1996 to December 2004 according to:

$$r_{it} = \alpha_i + b_i r_{mt} + s_i SMB_t + h_i HML_t + d_i DEF_t + \varepsilon_{it}$$

where r_{it} is the excess return on portfolio i in month t, r_{mt} is the excess return on the market portfolio in month t, SMB_t is the return on the size mimicking portfolio in month t, HML_t is the return on the book-to-market mimicking portfolio in month t, DEF_t is the return on the default mimicking portfolio in month t. The dependent variable portfolios are created from the intersection of independent three-way (33%:33%:33%) sorts on three variables—Size (Sz); book-to-market (BM) and default probability (DP): smallest (1) to largest (3). t-statistics are reported in parentheses below the estimates. Adjusted R^2s (adj R^2) are reported for each regression and the final row of the table reports the average adjusted R^2 across the 27 regressions.

Sz	BM	DP	α_i	b_i	s_i	h_i	d_i	adj R^2
1	1	1	–0.0081	1.2123	1.4839	–0.3601	0.3701	0.715
			(–0.80)	(3.94)	(10.51)	(–1.02)	(1.84)	
1	1	2	–0.0003	1.0925	1.2315	–0.5670	–0.0095	0.795
			(–0.05)	(5.80)	(11.05)	(–3.24)	(–0.06)	
1	1	3	0.0102	0.9474	1.3312	–0.6339	0.1554	0.660
			(1.00)	(3.33)	(10.16)	(–1.54)	(0.73)	
1	2	1	0.0169	1.1658	1.0362	0.0817	–0.2410	0.394
			(1.47)	(2.69)	(6.38)	(0.24)	(–1.00)	
1	2	2	0.0074	1.0761	1.3855	0.1789	0.1973	0.726
			(0.94)	(5.57)	(9.95)	(0.53)	(1.17)	
1	2	3	0.0150	1.1281	1.3143	0.0205	0.2380	0.743
			(2.44)	(6.62)	(14.31)	(0.10)	(1.48)	
1	3	1	–0.0010	0.8626	1.1496	0.6979	–0.1443	0.680
			(–0.19)	(4.60)	(12.41)	(4.51)	(–0.95)	
1	3	2	–0.0033	1.0214	1.2267	0.6771	–0.1152	0.718
			(–0.52)	(6.59)	(18.36)	(3.41)	(–0.81)	
1	3	3	–0.0028	1.0125	1.1291	0.6281	0.0906	0.861
			(–0.81)	(12.34)	(17.10)	(5.70)	(1.06)	
2	1	1	–0.0041	1.0645	0.5552	0.0339	–0.1528	0.681
			(–1.10)	(9.60)	(8.99)	(0.29)	(–1.95)	
2	1	2	0.0060	1.0779	0.5697	–0.0840	0.0625	0.656
			(1.27)	(7.80)	(6.49)	(–0.43)	(0.61)	
2	1	3	–0.0046	1.1032	0.8194	0.1515	–0.0687	0.501
			(–0.62)	(6.32)	(7.07)	(0.64)	(–0.36)	
2	2	1	–0.0114	1.1148	0.5755	0.4496	–0.1406	0.623
			(–3.09)	(9.69)	(10.06)	(3.21)	(–1.42)	

Table 5 Continued

Sz	BM	DP	α_i	b_i	s_i	h_i	d_i	adj R^2
2	2	2	0.0083	0.9822	0.5959	0.0271	0.0887	0.641
			(1.91)	(8.84)	(6.84)	(0.18)	(0.84)	
2	2	3	–0.0094	1.2059	0.4509	0.4735	–0.1442	0.494
			(–1.63)	(10.55)	(5.65)	(2.55)	(–1.16)	
2	3	1	0.0028	0.8588	0.2875	0.3802	–0.0522	0.471
			(0.81)	(8.02)	(4.86)	(4.09)	(–0.57)	
2	3	2	0.0017	0.7196	0.3672	0.5232	0.0265	0.605
			(0.67)	(10.00)	(7.96)	(6.62)	(0.44)	
2	3	3	–0.0036	0.9359	0.4764	0.7592	0.0139	0.565
			(–0.98)	(10.76)	(8.07)	(5.90)	(0.14)	
3	1	1	–0.0007	0.9967	0.0378	0.0400	–0.2716	0.738
			(–0.34)	(14.42)	(1.27)	(0.74)	(–4.49)	
3	1	2	0.0064	0.8779	–0.0637	–0.2019	0.1712	0.431
			(1.70)	(10.33)	(–1.00)	(–1.94)	(1.49)	
3	1	3	0.0018	0.7689	–0.1889	–0.6210	0.7040	0.276
			(0.23)	(3.65)	(–1.58)	(–2.29)	(2.78)	
3	2	1	–0.0001	0.9476	–0.0049	0.2317	–0.1746	0.535
			(–0.05)	(11.92)	(–0.10)	(2.55)	(–2.25)	
3	2	2	–0.0018	1.0674	0.0150	0.2058	0.0354	0.546
			(–0.49)	(9.80)	(0.29)	(2.01)	(0.36)	
3	2	3	–0.0030	1.1047	0.0010	0.2830	0.1555	0.559
			(–0.75)	(6.49)	(0.02)	(3.14)	(1.46)	
3	3	1	0.0044	0.7086	–0.0225	0.1956	–0.1266	0.399
			(1.61)	(10.23)	(–0.56)	(2.99)	(–1.86)	
3	3	2	–0.0045	1.2305	0.1523	0.7036	–0.1992	0.621
			(–1.34)	(12.94)	(3.20)	(6.92)	(–2.32)	
3	3	3	–0.0026	1.3039	0.0894	0.3915	0.5407	0.522
			(–0.52)	(10.02)	(1.01)	(2.98)	(3.20)	
average								0.598

We also explored a range of other individual four-factor regressions on the 27 portfolios, where the additional variable is the leverage factor (LEV), the momentum factor (MOM) and the liquidity factor (LIQ). These extended results are very similar to the results of the default augmented Fama-French model in table 5.[20] Hence, similar to the default augmented Fama-French model, our findings indicate that augmenting the Fama-French model with LEV, MOM or LIQ, does not considerably improve the model's ability to explain equity returns. Therefore, our individual regressions indicate that the Fama-French model is the preferred model for explaining equity returns as augmenting the Fama-French model with an additional factor results in, at best, a marginal improvement in the model's explanatory power.

20. Details are suppressed to conserve space.

5.3 System Regressions

Table 6 presents the output from restricted systems based GMM estimation and tests of the non-linear cross equation restrictions implied by the CAPM, the default augmented CAPM, the Fama-French model and a range of augmented Fama-French models.[21] The system based estimation is infeasible for all 27 portfolios, hence, an arbitrary two-way split is performed based on odd-numbered and even-numbered portfolios. Panel A presents the results of the system regressions on the odd-numbered portfolios and panel B presents the results of the system regressions on the even-numbered portfolios.[22]

The first system regression reported is for the CAPM. The GMM statistic is insignificant implying that we cannot reject the null hypothesis. As such, the GMM test supports the overall favourability of the model. In addition, the market premium (λ_m) is positive and significant (t-statistic of 2.64) implying that the market premium is systematic and that it is priced in the cross-section of equity returns. Interestingly, the estimated market premium annualises to a very realistic figure of about 6%.

In fact, the GMM statistic is insignificant for all of the models in this study.[23] Hence, for all of the models in this analysis, we cannot reject the test of the over-identifying restrictions (at the 5% level). However, the results of the GMM tests are inconsistent with the findings of the individual regressions in table 5 which showed that augmenting the Fama-French model with an additional factor does not greatly improve the model's ability to explain equity returns. Therefore, we focus our attention on the factor premium estimates rather than the GMM statistics. If the estimated factor premium is positive and significant, we conclude that the factor is systematic and priced in the cross-section of equity returns. Conversely, if the factor premium is insignificant or negative and significant, we conclude that the factor is not priced and therefore, that the factor is not systematic.

The second system regression reported is for the Fama-French model. As with the CAPM system, the market premium is positive and significant (t-statistic is 2.61). Moreover, the market premium is significant in all of the system regressions run in this analysis. Recall that in the individual regressions, market beta was significant for each of the 27 portfolios, regardless of which model was implemented. Therefore, our findings suggest that the market factor is the dominant explanator of equity returns in the context of a time-series regression. However, this does not imply that the CAPM is the best specification of expected returns. Recall that in the individual regressions, the Fama-French factors, particularly SMB, were found to be significant explanators of returns. The system regressions reinforce this finding. Both SMB and HML have significantly positive factor

21. Heteroskedasticity and autocorrelation consistent covariance matrices (Ferson & Foerster 1994) are applied in all cases.
22. The results of the system regressions in both panels are similar, hence, the exposition in this section will focus on the odd-numbered portfolios; reference to the even-numbered portfolios will be limited to cases where the results differ between panels.
23. However, the GMM statistic is close to significance (at the 10% level) for the five-factor models in panel B.

Table 6

Generalised Method of Moments (GMM) System Tests of the Asset Pricing Models Specified

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

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

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

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

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

$$DEF_t = \lambda_{DEF} + \varepsilon_{dt} \tag{9}$$

where r_{it} is the excess return on portfolio i in month t, r_{mt} is the excess return on the market portfolio in month t, and SMB_t, HML_t and DEF_t are the returns in month t on the size, book-to-market and default mimicking portfolios, respectively. Coefficients b_i, s_i, h_i, and d_i are the loadings on the market, size, book-to-market and default factors, respectively. Coefficients λ_m, λ_{SMB}, λ_{HML}, and λ_{DEF} are the estimated factor premiums on the market, size, book-to-market, and default factors, respectively. The dependent variable portfolios used in equation (5) are created from the intersection of independent three-way (33%:33%:33%) sorts on three variables—size; book-to-market and default probability. The alternative asset pricing models are based on similar systems which we do not specify to conserve space. The generalised method of moments test statistic (GMM), testing that the asset pricing models hold, is distributed as a chi-square with N degrees of freedom. The statistic has had the small sample adjustment applied following MacKinlay and Richardson (1991). The associated p-value is contained in parentheses below the GMM statistic. The associated t-statistic for the factor premiums is contained in parentheses below the coefficient estimate. The sample period is January 1996 to December 2004. Panel A presents the results of the system regressions on the odd-numbered portfolios and Panel B presents the results of the system regressions on the even-numbered portfolios.

	GMM	λ_m	λ_{SMB}	λ_{HML}	λ_{DEF}	λ_{LEV}	λ_{MOM}	λ_{LIQ}
	Panel A: Odd Numbered Portfolios							
CAPM	16.369	0.0056						
	(0.291)	*(2.64)*						
FF	18.011	0.0052	0.0171	0.0096				
	(0.206)	*(2.61)*	*(2.68)*	*(2.86)*				
r_m DEF	18.114	0.0057			–0.0056			
	(0.202)	*(2.69)*			*(–1.81)*			
FF DEF	19.255	0.0059	0.0144	0.0097	–0.0043			
	(0.155)	*(2.88)*	*(2.17)*	*(2.98)*	*(–1.37)*			
FF LEV	19.141	0.0048	0.0143	0.0116		0.0078		
	(0.160)	*(2.23)*	*(2.32)*	*(3.38)*		*(2.58)*		
FF MOM	19.098	0.0051	0.0160	0.0079			0.0235	
	(0.161)	*(2.67)*	*(2.92)*	*(2.56)*			*(4.47)*	
FF LIQ	19.150	0.0052	0.0176	0.0096				0.0016
	(0.159)	*(2.62)*	*(2.77)*	*(2.92)*				*(0.60)*
FF DEF LEV	19.670	0.0051	0.0113	0.0114	–0.0050	0.0074		
	(0.141)	*(2.34)*	*(1.75)*	*(3.43)*	*(–1.48)*	*(2.44)*		
FF DEF MOM	19.607	0.0057	0.0147	0.0080	–0.0043		0.0221	
	(0.143)	*(2.87)*	*(2.54)*	*(2.47)*	*(–1.32)*		*(4.16)*	
FF DEF LIQ	19.741	0.0059	0.0150	0.0099	–0.0043			0.0019
	(0.139)	(2.90)	(2.27)	(3.07)	(–1.39)			(0.72)

Table 6 Continued

	GMM	λ_m	λ_{SMB}	λ_{HML}	λ_{DEF}	λ_{LEV}	λ_{MOM}	λ_{LIQ}
				Panel B: Even Numbered Portfolios				
CAPM	16.626	0.0054						
	(0.217)	*(2.45)*						
FF	18.509	0.0056	0.0139	0.0105				
	(0.139)	*(2.61)*	*(1.91)*	*(3.64)*				
r_m DEF	18.145	0.0046			–0.0061			
	(0.152)	*(2.11)*			*(–1.88)*			
FF DEF	19.475	0.0058	0.0149	0.0089	–0.0060			
	(0.109)	*(2.62)*	*(2.18)*	*(3.00)*	*(–1.74)*			
FF LEV	18.523	0.0050	0.0125	0.0102		0.0077		
	(0.139)	*(2.41)*	*(1.71)*	*(3.10)*		*(2.21)*		
FF MOM	19.304	0.0048	0.0119	0.0108			0.0247	
	(0.114)	*(2.34)*	*(1.64)*	*(3.39)*			*(3.91)*	
FF LIQ	19.206	0.0058	0.0141	0.0107				0.0017
	(0.117)	*(2.68)*	*(1.94)*	*(3.85)*				*(0.62)*
FF DEF LEV	19.487	0.0050	0.0124	0.0086	–0.0064	0.0067		
	(0.109)	*(2.36)*	*(1.77)*	*(2.53)*	*(–1.90)*	*(1.80)*		
FF DEF MOM	19.696	0.0054	0.0141	0.0096	–0.0064		0.0248	
	(0.103)	*(2.46)*	*(2.06)*	*(2.97)*	*(–1.93)*		*(3.95)*	
FF DEF LIQ	19.887	0.0061	0.0151	0.0094	–0.0051			0.0016
	(0.098)	(2.74)	(2.22)	(3.31)	(–1.49)			(0.59)

premiums (t-statistic of 2.68 for λ_{SMB} and 2.86 for λ_{HML}).[24] Furthermore, the estimated size premium annualises to around 20% and the estimated book-to-market premium annualises to about 12%.[25] Hence, the systems analysis indicates that the Fama-French factors are capturing priced risk that is systematic and that is not explained by the market factor.[26,27] Taken together, the results of the system regressions and the individual regressions indicate that although the market factor is the dominant explanator of returns, the Fama-French model is vastly superior to the CAPM in explaining cross-sectional variation in returns.

To test whether default risk is priced in equity returns, we augment the CAPM with the default factor, DEF. The reason we do not run a univariate regression on

24. For the even-numbered portfolios, the size premium has a p-value of 0.06.
25. Although the estimated size premium (20% pa) appears high, it compares favourably with the actual size premium in Table 1 of 17% pa. Furthermore, the estimated size premium for the even-numbered portfolios in Panel B is 17%, which is very close to the actual premium. Hence, our systems analysis confirms the existence of a very strong size effect in the Australian equity market. Additionally, the estimated book-to-market premium of 12% pa also compares favourably with the actual book-to-market premium, which is approximately 10.5% pa.
26. This is the strongest evidence presented in favour of the Fama-French model by any researcher using Australian data.
27. Further, the significantly positive factor premium on HML indicates that there is a risk-based explanation for the book-to-market effect. This is inconsistent with the mispricing hypothesis proposed by Griffin and Lemon (2002).

DEF is that it is unlikely that default risk, if priced, is the only risk factor that affects equity returns. The justification for a default-augmented model according to Vassalou and Xing (2004, p. 860) is that 'such a model can be understood in the context of an Intertemporal Capital Asset Pricing Model (ICAPM) as in Merton (1973). One can postulate a version of ICAPM where default risk affects the investment opportunity set, and therefore, investors want to hedge against this source of risk.'

The results of the system regression on the default augmented CAPM show that the default premium is not significant. Moreover, the default premium is negative and although it is statistically insignificant, it still annualises to about –7%.[28] The insignificant (and negative) default factor we observe suggests that default risk is not priced in equity returns and therefore, that default risk is not systematic. This finding is in direct to contrast to Vassalou and Xing (2004) who find that the default premium is significantly positive.[29]

To test whether SMB and HML are proxying for default risk, we augment the Fama-French model with the default factor, DEF. If SMB and HML are proxying for default risk, then they will lose their ability to explain cross-sectional variation in returns in the presence of a factor that is a superior proxy for default risk, DEF. Specifically, if SMB and HML are proxying for default risk, the factor premiums on SMB and HML will be insignificant and the default premium will be significantly positive. The results of the system regression on the default augmented Fama-French model show that the factor premiums on SMB and HML are significantly positive and that the default premium is insignificant (and negative). Hence, our findings suggest that SMB and HML are not proxying for default risk. This reinforces the findings of the individual regressions on the default augmented Fama-French model where the loadings on SMB and HML remained significant and only a handful of portfolios (5 out of 27) had significant loadings on DEF.

The next three system regressions reported are for augmented Fama-French models where the additional factor in each model is LEV, MOM and LIQ, respectively. The purpose of these regressions is to establish the robustness of the Fama-French model to additional factors. The regression output shows that the factor premiums on LEV and MOM are positive and significant and that the factor premium on LIQ is insignificant. Furthermore, the estimated leverage premium is about 9% pa and the estimated momentum premium is around 28% pa.[30] Despite the significance of LEV and MOM, the factor premiums on the Fama-French factors remain significant when the model is augmented with either LEV, MOM or LIQ.[31]

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28. A negative default premium is inconsistent with a positive risk-return relation as it suggests that low default risk firms are earning a return premium over high default risk firms.
29. The significantly positive default premium that Vassalou and Xing (2004) observe is the basis for their conclusion that default risk is systematic. It should be noted that the default factor we have created, which employs the mimicking portfolio approach, differs from the default factor that Vassalou and Xing (2004) created, which is a measure of the change in the aggregate default risk of the market.
30. Although the estimated momentum premium (28%) is quite high, it compares favourably with the actual momentum premium of around 26% pa. It is worth noting that short-selling constraints and transaction costs would make it difficult to earn such a high premium in practice.
31. For the even-numbered portfolios, the factor premium on SMB is significant at the 10% level when the Fama-French model is augmented with LEV or MOM.

The insignificance of the liquidity premium indicates that LIQ is not priced in the cross-section of equity returns. This is in direct contrast to the findings of Chan and Faff (2005) who find that the liquidity premium is significant. Conversely, the significance of the factor premiums on LEV and MOM indicate that LEV and MOM are priced in the cross-section of equity returns. This is a surprising finding as it is in conflict with the individual regressions which show that when the Fama-French model is augmented with LEV or MOM, there are only a handful of significant loadings on LEV (5 out of 27) and MOM (7). The most notable finding of the system regressions on the augmented Fama-French models is that the Fama-French factors are robust to the inclusion of additional factors. However, the evidence in favour of the model needs to be down-weighted given that the factor premiums on LEV and MOM are significant.

The final three system regressions reported are for five-factor models where the Fama-French model is augmented with DEF and one of LEV, MOM and LIQ, in turn. The purpose of these system regressions is to identify whether default risk is priced in equity returns when we control for leverage, past returns and liquidity. As shown in Gharghori, Chan and Faff (2006b), the default risk proxy we employ in this paper, the DP from the option-based models, is a function of leverage, past returns and volatility. Hence, the default factor may be significant when we control for leverage (LEV) or past returns (MOM).[32] For completeness, we also run a five-factor system regression using LIQ. The results of these system regressions show that the default premium remains insignificant. Moreover, the factor premium on DEF is negative in all cases. Hence, the five-factor system regressions reinforce our original conclusion that default risk is not priced in equity returns.

6. Summary and Conclusions

Prior empirical tests of the Fama-French model in Australia have focused on the Fama and French (1993) methodology.[33] As yet, no Australian research has analysed the risk-based nature of the model. This study seeks to address this void in the literature. The main aim of this paper is to test whether the Fama-French factors' ability to explain equity returns is because they are capturing priced default risk. First, we test whether default risk is priced in equity returns.

Our findings suggest that default risk is not priced in equity returns and therefore, that default risk is not systematic. We also find that the estimated factor premiums on the Fama-French factors are significantly positive thus supporting a risk-based interpretation of the Fama-French model. However, we find that the Fama-French factors are not proxying for default risk. Therefore, our results do not support the contention of Fama and French (1996) that the Fama-French factors'

32. A mimicking portfolio for volatility has not been created as it is deemed inappropriate in the context of a time-series regression. The reason for this is that interpreting the loading on a volatility factor would be problematic, as the loading would represent a measure of both systematic market risk and idiosyncratic risk. The difficulty in interpreting the loading would be compounded by the fact that we already have a measure of systematic market risk, market beta.
33. See Halliwell, Heaney and Sawicki (1999), Faff (2001, 2004), and Gaunt (2004). Chan and Faff (2005) test a liquidity augmented Fama-French model. Durack, Durand and Maller (2004) compare the conditional CAPM of Jagannathan and Wang (1996) to the Fama-French model.

(particularly HML's) ability to explain equity returns is because they are capturing priced default risk.

The second aim of this paper is to identify whether an augmented version of the Fama-French model, primarily focusing on factors related to default risk, provides a better explanation of equity returns than the 'vanilla' version of the model. Our findings suggest that the Fama-French model is vastly superior to the CAPM in explaining returns. In addition, we find that augmenting the Fama-French model with an additional factor(s) results in, at best, a marginal improvement in the model's explanatory power. Specifically, the insignificant factor premiums on the default factor and the liquidity factor suggest that default risk and liquidity risk are not priced in equity returns. In contrast, the significantly positive factor premiums on the leverage and momentum factors suggest that these factors are priced in equity returns. However, the results of the individual regressions suggest that augmenting the Fama-French model with either a leverage or a momentum factor produces only a marginal improvement in the model's explanatory power. Therefore, for reasons of parsimony, we conclude that the Fama-French model is the preferred model for explaining equity returns.

Collectively, our evidence combined with that of Gharghori, Chan and Faff (2006a, 2006b), provide a forceful rejection of the 'default risk hypothesis' of Vassalou and Xing (2004). Notably, the findings of this group of Australian studies do suggest that the Fama-French factors are capturing priced risk. However, what type of risk the Fama-French factors are capturing remains an open question. One possibility is that the Fama-French factors are capturing risk that is associated with macroeconomic factors. Vassalou (2003) suggests that it may be news related to future GDP growth. Investigating whether a factor that measures GDP growth is priced in equity returns and whether the Fama-French factors are proxying for news about GDP growth is beyond the scope of this paper. We leave this to future research.

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