Invited Editorial

Do the common risk factors always capture strong variation in stock returns?

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Abstract This paper examines the role of stock market factors in stock returns using the generalised autoregressive conditional heteroskedastic model. We use a time series regression approach where monthly returns on stocks are regressed on the returns to a market portfolio of stocks and mimicking portfolios for size and book-to-market equity. Implications of conditional heteroskedasticity are then documented. We show that accounting for heteroskedasticity increases the evidence that risk-adjusted returns are strongly related to common risk factors.

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Introduction

Many researchers have noted the important role of volatility in the Sharpe (1964)–Lintner (1965) capital asset pricing model (CAPM) or the consumption betas of the intertemporal asset-pricing model of Breeden (1979) (eg Bodurtha and Mark, 1991; Bollerslev *et al.*, 1988; Breeden *et al.*, 1989; Campbell, 2003; Jegannathan and Wang, 1996; Schwert and Seguin, 1990). Typically, the commonly used model for estimating financial volatility is based on various autocorrelation or heteroskedasticity specifications. Based on alternative model specifications, evidence of nonconstant conditional covariance of returns on the stock market was reported by Christie (1982), Porteba and Summers (1987) and

French *et al.* (1987). Jegannathan and Wang (1996) show that, conditionally, heteroskedastic CAPM explains nearly 30 per cent of the cross-sectional variation in stocks, while traditional CAPM has 1 per cent explanatory powers. Giovannini and Jorion (1987) find that time varying conditional second moments could improve the empirical performance of the static CAPM. The role of volatility persistence is unknown for asset pricing model when stock returns are related to various common risk factors. These common stock market risk factors are influential in risk–return relationship and can be based on firm’s financial performance as well as characteristics. The purpose of this paper is to determine whether the important

role of common risk factors is inconsistent with the evidence of conditional heteroskedasticity.

In a series of seminal papers, Fama and French (1992a, b) demonstrated the joint roles of market beta, size, earnings/price, leverage and book-to-market equity (BE/ME) in the cross-section of average stock returns. In another related paper, Fama and French (1993) use a time series approach to identify five common risk factors in the returns to stocks and bonds. In this paper, we investigate a similar relationship between the common stock market risk factors and stock return variability by using the generalised autoregressive conditional heteroskedastic (GARCH) model. Our presentation assumes that there are three stock-market factors: an overall market factor and factors related to firm size and the ratio of book-to-market value of equity. As Durack *et al.* (2004) noted that the Fama–French three-factor model has succeeded the CAPM as the paradigm within which asset prices are analysed. Therefore, it is critical to study whether the support for the three-factor model is sensitive to the model specification. More specifically, we see whether the portfolios constructed to mimic risk factors related to size and BE/ME still capture strong common variation in stock returns when the asset-pricing model is intrinsically conditionally heteroskedastic.

Our main results suggest that there is indeed strong evidence that size and BE/ME proxy for sensitivity to common risk factors in stock returns, even when we take into account the conditional heteroskedasticity. The unique combination of these stock market characteristics and risks has an unambiguous effect on stock returns, which varies inversely with a firm's market value represented by stocks with high book-to-equity ratios. In the following section, we describe the data set and methodology used throughout this paper. In the next section, we present the main empirical results. The last section concludes the paper.

Data and methodology

We use the procedure described in Fama and French (1993) to construct mimicking risk factors and excess returns. The mimicking risk factors in returns relating to size and BE/ME are based on the intersection of two size (market equity) and three BE/ME groups and the excess returns are based on 25 size-BE/ME stock portfolios. The returns on all the portfolios formed on size and BE/ME are obtained from Kenneth French.¹

The results are based on the period from July 1926 to June 2007. We utilise median NYSE size (price times shares) to break all NYSE, Amex and NASDAQ stocks into two groups, small and big. We also divide NYSE, Amex and NASDAQ stocks into three BE/ME groups based on the NYSE stocks-ranked values of BE/ME. Following Fama and French (1992a, 1993), the intersection portfolios of the two size (ME) and three BE/ME groups give us six portfolios. The risk factor in returns mimicking size is the difference, each month, between average returns on the three small-stock portfolios and the average of the three big-stock portfolios. The risk factor in returns mimicking BE/ME is the difference, each month, between the average of the returns on the two high-BE/ME portfolios and two low-BE/ME portfolios.

For excess returns, the 25 portfolios constructed at the end of each June are the intersections of five portfolios formed on size (ME) and five portfolios formed on the ratio of book equity to market equity. The size breakpoints for year t are the NYSE market equity quintiles at the end of June of year t . BE/ME for June of year t is the book equity for the last fiscal year end in $t-1$ divided by ME for December of $t-1$. The BE/ME breakpoints are NYSE quintiles. Small (S) and Big (B) stand for the smallest and biggest size quintiles; Low (L) and High (H) stand for the lowest and highest book-to-market quintiles. Our dependent variable is based on $R(t)$, which denotes the return on each of the 25 portfolios from July 1926 to June

2007. Among other variables used in the regression model, $RM(t)$ is the return of CRSP's value-weighted index on all NYSE, AMEX and NASDAQ stocks, and $RF(t)$ is the one-month T-bill rate obtained from Ibbotson and Associates.

Empirical results

We first present average characteristics for 25 portfolios to summarise our data. The average of annual averages of firm size, annual B/E ratios, annual number of firms and annual E/P ratios (in per cent) for the 25 portfolios are reported in Table 1. The various panels of Table 1 show that portfolios in the largest size quintile have the largest annual averages of firm size (ie fewest stocks but largest fractions of value) and the portfolios in the smallest size quintile have the greatest number of firms on average (ie largest stocks but smallest fractions of value).

The panels also show that, as we move from lower to higher BE/ME portfolios, the proportion of total value accounted for by a portfolio decreases. The information regarding the average E/P ratio for each of our 25 portfolios reveals that the average annual number of firms in a portfolio appears lower in the higher E/P columns, suggesting a correlation between the two variables. As stocks with high B/E ratios imply low market values, an investor should expect high compensation in terms of expected returns for holding these stocks.

Table 2 contains the summary statistics for the monthly dependent and explanatory returns (in per cent) used in the time series regression. The first explanatory variable ($RM-RF$) is the excess return of CRSP's value-weighted index on all NYSE, AMEX and NASDAQ stocks. The second variable small minus big (SMB) is the difference, each month, between the simple average of the

Table 1 Descriptive statistics for 25 stock portfolios formed on size and book-to-market equity: July 1926–June 2007, 972 observations

Size quintile	Book-to-market equity (BE/ME) quintiles				
	Low	2	3	4	High
<i>Average of annual averages of firm size</i>					
Small	29.19	31.27	29.90	26.40	20.55
2	132.37	133.54	135.19	134.06	130.73
3	303.52	308.49	308.56	310.51	315.95
4	777.15	770.71	763.27	766.67	771.94
Big	6651.38	5417.3	4644.9	3815.33	3483.32
<i>Average of annual B/E ratios for portfolio</i>					
Small	0.43	0.74	1.07	1.54	4.89
2	0.40	0.72	0.99	1.43	3.41
3	0.37	0.67	0.97	1.41	3.10
4	0.35	0.67	0.96	1.44	3.06
Big	0.31	0.64	0.94	1.42	1.29
<i>Average of annual number of firms in portfolio</i>					
Small	292.43	191.01	194.91	239.98	375.47
2	94.76	75.89	78.61	74.27	58.04
3	77.95	62.67	61.17	52.26	36.90
4	74.49	60.96	49.75	39.04	26.40
Big	88.22	55.08	40.42	31.59	18.45
<i>Average of annual E/P ratios (in percent) for portfolio</i>					
Small	3.03	5.82	8.89	9.11	10.05
2	4.21	7.91	9.16	12.33	10.32
3	4.53	7.37	10.61	12.65	13.62
4	4.90	8.29	11.33	13.01	13.97
Big	6.12	8.97	11.27	13.82	14.54

Table 2 Summary statistics for the monthly dependent and explanatory returns (in percent) in the regression: July 1926–June 2007, 972 observations

Name	Mean	SD	t	Autocorrelation for lag			Correlations			
				1	2	12				
<i>Explanatory returns</i>										
RM-RF	0.54	5.41	3.73	0.107	−0.017	−0.002	1.00			
SMB	0.15	3.35	1.45	0.150	0.090	0.030	0.31	1.00		
HML	0.51	3.57	4.47	0.162	0.001	0.031	0.20	0.09	1.00	
<i>Dependent variable(R): Excess returns on 25 stock portfolios formed on ME and BE/ME Book-to-market equity (BE/ME) quintiles</i>										
Size quintile	Low	2	3	4	High	Low	2	3	4	High
	Means					Standard deviations				
Small	0.77	1.13	1.35	1.42	1.74	12.41	10.71	9.29	8.05	9.60
2	0.88	1.26	1.35	1.41	1.53	8.01	7.90	7.33	7.61	8.70
3	0.98	1.20	1.28	1.31	1.43	7.66	6.57	6.73	6.79	8.67
4	0.99	1.05	1.19	1.27	1.40	6.23	6.25	6.32	7.01	9.01
Big	0.90	0.92	0.99	1.04	1.25	5.48	5.24	5.71	6.92	7.25
<i>t-statistics for means</i>										
Small	1.95	3.29	4.54	5.53	5.65					
2	3.42	4.97	5.76	5.80	5.49					
3	4.02	5.70	5.96	6.04	5.15					
4	4.97	5.27	5.87	5.68	4.85					
Big	5.16	5.50	5.43	4.73	5.09					

Note: RM is the return of CRSP's value-weighted index on all NYSE, AMEX and NASDAQ stocks, and RF is the one-month T-bill rate obtained from Ibbotson and Associates. SMB (small minus big) is the difference each month between the simple average of the percent returns on the three small-stock portfolios and the simple average of the returns on the three big-stock portfolios. HML (high minus low) is the difference each month between the simple average of the returns on the two high-BE/ME portfolios and the average of the returns on the two low-BE/ME portfolios.

percent returns on the three small-stock portfolios and the simple average of the returns on the three big-stock portfolios. The third regressor high minus low (HML) is the difference each month between the simple average of the returns on the two high-BE/ME portfolios and the average of the returns on the two low-BE/ME portfolios. From the second panel on the dependent variable, we can see that for 25 portfolios formed on ME and BE/ME, the range of average excess returns varies from 0.77 to 1.74 per cent per month. Except one extreme situation (small size and low BE/ME), the significant *t*-statistics justify the robustness of the average excess returns.

Once we combine the evidence on the dependent variable with descriptive statistics from Table 1, it is evident that in all but the

big-high portfolio, average returns tend to increase with BE/ME quintiles, whereas the average annual number of firms goes down as we move from small to big size portfolios. The relationship is opposite when we compare the average of annual *B/E* ratios for different portfolios. In other words, both excess returns and BE/ME tend to increase with the BE/ME quintiles, suggesting a positive correlation between those two variables. Regarding explanatory variables, the average value of the market premium (RM-RF) is quite high at 0.54 per cent per month, and is statistically significant. Regarding the other two variables, size-related factor premium (average SMB returns) is 0.15 per cent with an insignificant *t*-statistics of 1.45 and book-to-market factor premium (average HML returns) is 0.51 per

Table 3 Regressions of excess stock returns (in percent) on the excess market return (RM-RF) and the mimicking returns for the size (SMB) and book-to-market (HML) factors: May 1926–June 2007, 972 observations

$$R(t) - RF(t) = a + b[RM(t) - RF(t)] + s \text{ SMB}(t) + h \text{ HML}(t) + e(t)$$

Dependent variable: Excess returns on 25 stock portfolios formed on size and book-to-market equity										
Book-to-market equity (BE/ME) quintiles										
Size quintile	Low	2	3	4	High	Low	2	3	4	High
	<i>b</i>					<i>t(b)</i>				
Small	1.38	1.14	1.12	1.01	1.02	10.13	14.71	22.47	34.06	31.61
2	1.09	1.06	0.97	1.00	1.08	26.53	48.70	47.44	57.78	43.00
3	1.16	1.02	1.02	0.96	1.18	47.17	53.37	35.55	59.88	43.92
4	1.07	1.03	1.00	1.05	1.25	53.86	44.55	45.84	40.10	41.65
Big	1.03	0.95	0.96	1.06	1.12	103.01	54.73	44.32	34.95	9.27
	<i>s</i>					<i>t(s)</i>				
Small	1.06	1.39	1.04	0.79	1.28	5.11	5.32	7.89	4.45	11.91
2	0.89	0.90	0.82	0.78	0.88	6.82	7.95	9.47	12.63	18.79
3	0.66	0.49	0.42	0.50	0.51	6.15	10.71	13.24	12.55	9.33
4	0.16	0.25	0.26	0.20	0.37	2.09	9.22	6.09	5.71	6.35
Big	-0.14	-0.12	-0.13	-0.06	0.09	-6.15	-3.41	-2.53	12.53	0.54
	<i>h</i>					<i>t(h)</i>				
Small	0.49	0.44	0.50	0.53	0.91	-1.76	2.47	5.21	7.79	12.35
2	-0.17	0.22	0.34	0.55	0.81	-2.02	4.44	8.72	14.32	16.82
3	-0.12	0.08	0.32	0.47	0.86	-2.12	2.27	9.16	14.08	15.24
4	-0.28	0.13	0.26	0.56	0.90	-6.43	4.51	5.33	10.34	15.72
Big	-0.24	-0.03	0.26	0.64	0.77	-14.18	-1.29	6.97	12.53	4.80
	<i>R</i> ²									
Small	0.61	0.75	0.82	0.85	0.91					
2	0.84	0.90	0.92	0.94	0.93					
3	0.89	0.92	0.92	0.92	0.92					
4	0.89	0.93	0.90	0.91	0.89					
Big	0.95	0.91	0.88	0.89	0.29					

Note: For excess returns the 25 portfolios constructed at the end of each June, are the intersections of five portfolios formed on size (ME) and five portfolios formed on the ratio of book equity to market equity. $R(t)$ denotes the return on each of the 25 portfolios from July 1926 to June 2007, $RM(t)$ is the return of CRSP's value-weighted index on all NYSE, AMEX and NASDAQ stocks, and $RF(t)$ is the one-month T-bill rate obtained from Ibbotson and Associates. Small minus big (SMB) is the difference each month between the simple average of the percent returns on the three small-stock portfolios and the simple average of the returns on the three bog-stock portfolios. High minus low (HML) is the difference each month between the simple average of the returns on the two high-BE/ME portfolios and the average of the returns on the two low-BE/ME portfolios. All t -values are corrected for autocorrelation (with lag=3) and heteroskedasticity as suggested by Newey and West (1987).

cent per month with a significant t -statistics of 4.47. Therefore, our preliminary investigation suggests a statistically robust role for only market premium and book-to-market factor premium. Also, very low correlations across regressors suggest the absence of multicollinearity and further influence their effectiveness as independent variables.

Table 3 reports monthly time-series regression results of excess returns of CRSP's

25 size and book-to-market portfolios on market factor and excess market returns. All t -values are corrected for autocorrelation (with lag = 3) and heteroskedasticity as suggested by Newey and West (1987). The result shows that all three stock market factors capture strong variation in stock returns. The slope on market premium (RM-RF) varies between 0.96 and 1.38 and is always significant in statistical terms. The slope coefficient of SMB produces a wide

Table 4 Regressions of excess stock returns (in percent) on the excess market return (RM-RF) and the mimicking returns for the size (SMB) and book-to-market (HML) factors: May 1926–June 2007, 972 observations

$$R(t) - RF(t) = a + b[RM(t) - RF(t)] + s \text{ SMB}(t) + h \text{ HML}(t) + e(t), \quad e(t) | F(t-1) \sim N(0, h(t)), \quad h(t) = d_0 + d_1 e^2(t) + d_2 h(t-1)$$

Dependent variable: Excess returns on 25 stock portfolios formed on size and book-to-market equity										
Book-to-market equity (BE/ME) quintiles										
Size quintile	Low	2	3	4	High	Low	2	3	4	High
<i>b</i>										
Small	1.12	1.05	1.02	0.95	1.04	40.15	45.43	29.10	56.02	40.52
2	1.13	1.01	0.96	0.97	1.09	41.69	78.71	67.88	96.04	70.43
3	1.07	1.01	0.96	0.97	1.10	41.64	75.98	68.48	81.03	55.87
4	1.08	1.02	1.01	1.02	1.15	86.98	61.81	68.57	48.19	47.29
Big	1.04	0.97	0.93	0.99	1.21	102.9	70.05	50.56	58.05	37.03
<i>t(b)</i>										
Small	1.31	1.18	0.95	1.02	1.14	23.64	28.85	5.75	28.45	15.52
2	1.12	0.91	0.82	0.78	0.88	22.32	36.78	41.48	42.44	35.11
3	0.86	0.60	0.52	0.48	0.63	6.16	28.17	24.33	22.11	16.92
4	0.25	0.29	0.23	0.24	0.39	7.54	13.00	8.74	7.64	8.88
Big	-0.14	-0.16	-0.17	-0.08	-0.04	-6.59	-8.21	-4.84	-2.12	-1.23
<i>s</i>										
Small	-0.06	0.18	0.29	0.47	0.77	-1.05	3.82	1.79	16.18	22.12
2	-0.50	-0.008	0.21	0.46	0.77	-7.27	-0.31	7.90	24.25	27.23
3	-0.42	0.01	0.24	0.44	0.83	-4.52	0.46	10.24	20.00	23.27
4	-0.29	0.02	0.21	0.51	0.80	-9.54	1.14	8.36	17.07	21.07
Big	-0.27	-0.04	0.18	0.51	0.87	-12.8	-2.22	5.00	13.16	25.95
<i>t(s)</i>										
Small	0.36	0.49	0.79	0.31	0.55	2.53	3.06	2.31	1.57	1.63
2	0.44	0.33	0.18	0.19	0.12	2.15	2.13	2.23	4.36	2.33
3	0.34	0.20	0.15	0.13	0.09	0.80	3.38	4.21	3.18	3.94
4	0.26	0.16	0.21	0.09	0.07	3.01	4.27	4.60	3.17	3.61
Big	0.08	0.13	0.17	0.20	0.31	3.27	5.34	4.10	3.38	1.82
<i>d₁</i>										
Small	0.74	0.61	0.55	0.76	0.57	11.29	8.66	4.77	6.79	2.92
2	0.73	0.71	0.81	0.77	0.86	12.44	7.61	13.56	20.59	20.34
3	0.76	0.73	0.84	0.84	0.88	3.50	10.97	25.98	16.90	36.09
4	0.70	0.80	0.75	0.87	0.90	14.90	18.26	18.65	21.23	42.46
Big	0.90	0.82	0.79	0.77	0.38	31.34	32.19	25.68	21.96	2.10
<i>t(d₁)</i>										
Small	0.84	0.83	0.86	0.87	0.74					
2	0.67	0.91	0.90	0.93	0.90					
3	0.83	0.89	0.87	0.88	0.89					
4	0.89	0.81	0.85	0.76	0.76					
Big	0.91	0.85	0.73	0.79	0.60					
<i>d₂</i>										
Small	0.84	0.83	0.86	0.87	0.74					
2	0.67	0.91	0.90	0.93	0.90					
3	0.83	0.89	0.87	0.88	0.89					
4	0.89	0.81	0.85	0.76	0.76					
Big	0.91	0.85	0.73	0.79	0.60					
<i>R²</i>										

Note: For excess returns the 25 portfolios constructed at the end of each June, are the intersections of five portfolios formed on size (ME) and five portfolios formed on the ratio of book equity to market equity. $R(t)$ denotes the return on each of the 25 portfolios from July 1926 to June 2007, $RM(t)$ is the return of CRSP's value-weighted index on all NYSE, AMEX, and NASDAQ stocks, and $RF(t)$ is the one-month T-bill rate obtained from Ibbotson and Associates. Small minus big (SMB) is the difference each month between the simple average of the percent returns on the three small-stock portfolios and the simple average of the returns on the three big-stock portfolios. High minus low (HML) is the difference each month between the simple average of the returns on the two high-BE/ME portfolios and the average of the returns on the two low-BE/ME portfolios. $F(t-1)$ is the information set and $h(t)$ is the conditional variance of the residual of the three factor regression.

range of estimates from -0.14 to 1.06 and they are almost always significant (except big-high portfolio). Among the 25

portfolios, the SMB slope coefficients are higher for lower BE/ME portfolios. We observe a reverse picture for the case of the

estimate of the book-to-market factor premium. The HML slope coefficient estimates range from -0.28 to 0.91 and are statistically significant in all but two cases. The pattern in HML slope estimates, the mimicking return for the book-to-market factor, suggests that returns on high stocks are more sensitive to the risk captured by HML than to the returns on low stocks. Similarly, the evidence on SMB, the mimicking return for the size factor, suggests that returns on small stocks are more sensitive to the risk captured by SMB than to the returns on big stocks. The negative slope on HML for the four largest low stocks corresponds to the pattern observed by Fama and French (1993). For almost all BE/ME quintiles, the HML slope shows a declining trend as we move from smaller to bigger size quintiles. The value of R^2 , a measure of overall performance of the model fit, also shows consistent patterns. Except for the big-high portfolio, almost all of the portfolios have a value greater than 0.89 . The precision of the model fit is better for the largest size and higher BE/ME quintiles.

To investigate the dependence structure of the disturbance term, we looked at the behaviour of the autocorrelations of the OLS residuals and their squares. The evidence suggests that for all 25 portfolios, squared residual series has a strong serial correlation with their lag values, which indicates the presence of GARCH effects. Ljung-Box tests for the cross products of residuals do not reject the hypothesis of no serial correlation for all 25 portfolios. Additionally, we found that using standard normality tests based on Jarque-Bera test statistic, the basic regression model has strong evidence of departures from both homoskedasticity and normality.

Finally, in Table 4, we report our main results concerning monthly time-series regressions that incorporate conditional heteroskedasticity. As we can see, re-examining the basic model by adding conditional heteroskedasticity does not fundamentally change the results. The only

major difference is the gain in efficiency due to more precise standard errors for the regression parameters with the incorporation of conditional heteroskedasticity.

Unsurprisingly, the three stock market factors still capture the strong common variation in average stock returns. The slopes on SMB in Table 4 range from about -0.17 for portfolios in the biggest size quintile to values near 1.31 in the smallest size quintile. The slopes on HML range from about -0.5 for portfolios in the lowest-BE/ME quintile to 0.87 in the highest-BE/ME quintile. Even though the slope magnitude for three factors varies, the signs are consistent with our earlier results from Table 2. The slope coefficient for excess market return is significant for all 25 portfolios in both practical and statistical terms. With one exception, the t -statistics for slope coefficient on SMB is greater than 2.00 in all portfolios. Most importantly, similar to our earlier results from Table 1, with conditional heteroskedasticity the slopes on SMB are inversely related to the size of the firm. For all BE/ME quintiles, the SMB slope declines in its value as we move from small to big size firms. Moreover, the slopes on HML, the mimicking return for the book-to-market factor, are positively related to BE/ME quintiles. For the lowest BE/ME quintiles the slope coefficient on HML is always negative and as we move to higher BE/ME quintiles HML slopes increases gradually. For two highest BE/ME quintiles, the HML slope shows consistent pattern, it increases in value as we move from small to big size quintiles. The results strongly support the evidence in Fama and French (1992a, 1993) that BE/ME is negatively correlated with average stock returns. In other words, in order to hold stocks with high BE/ME, investors require high expected returns.

Therefore, adding the conditional heteroskedasticity aspect has no killing effect on the explanatory power of the stock market factors. The coefficients for the variance equation show significant GARCH

effects for almost all of the 25 portfolios. The coefficient of squared residuals is significant for almost 21 out of the 25 portfolios. The coefficient of lag conditional variance is statistically significant for all 25 portfolios. For all BE/ME quintile portfolios, the value of the estimated coefficient of the squared residual is highest among the smallest size quintile portfolios. The estimated coefficient of the lagged conditional variance shows no such clear pattern, even though its value is consistently higher compared to the estimated coefficient of the squared residuals. Given the statistically significant values of the three market factors and the estimated coefficients of the GARCH equation, it is not surprising that the overall performance of the model becomes better as a result of the incorporation of conditional heteroskedasticity. For two extreme portfolios, the smallest size-lowest BE/ME quintile and the biggest size-highest BE/ME quintile, the value of R^2 increases from 0.61 to 0.84 and 0.29 to 0.60, respectively. The only loss in the measures of model fit is for the lowest BE/ME quintile and the second lowest size quintile, where R^2 drops from 0.84 (without conditional heteroskedasticity) to 0.67 (with conditional heteroskedasticity). Overall, we can say that a three-factor model that uses conditional heteroskedasticity in its variance equation performs as well as the three-factor model with constant variance assumption. Even after modifying model specification, we found robust evidence that the average stock returns are higher for stocks with relatively low market values.

Conclusion

In this paper, we re-examine the role of market factor and two firm level factors — based on book-to-market value of equity and size — as one of the important determinants of average stock returns. We specify and estimate a conditional heteroskedastic three-factor model to explore the role of alternative specifications followed by

time-varying conditional second moments. The empirical findings indicate that allowing conditional heteroskedastic specification in the model slightly improves the explanatory power and makes the model parameter estimate more precise, but do not significantly affect the nature of premiums related to excess market return and mimicking risk factors based on size and BE/ME. For all 25 portfolios, we have found that BE/ME plays a stronger role in average stock returns and our empirical results strongly support earlier findings by Fama and French (1992a, 1993). This also re-emphasises the role of conditional volatility in risk–return relationships illustrated by Jegannathan and Wang (1996), Durack *et al.* (2004) and Guo *et al.* (2008). Given the documented correlations between squared residuals, it is safe to say that our analysis provides a stronger endorsement of the volatility model for the asset pricing model involving common risk factors.

Note

1. One can access all the market data used in this paper from the following link: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#Research.

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