Research Report

Does Cross-Sectional Variances of Fama-French Factors Improve Predictability of Stock Returns?

A research report submitted in partial fulfillment of the requirements for the Degree of Master of Finance at Massey University.

November 2007

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Acknowledgment

I wish to acknowledge and express my sincerest thank to my supervisor, Associate Professor Russell Gregory-Allen, who has provided the inspiration for this research, and also provide invaluable encouragement and guidance in the completion of this research report.

I would also like to thank Prof. Henk Berkman, Dr. John Pinfold, and Jeffrey Stangl who have provided me professional advices on the data analysis and acted as sounding boards for my ideas on various occasions.

Abstract

This research report aims to lend a better understanding of the predictability of Fama-French factors (book-to-market ratio, price-earning ratio and size) to stock returns over a wider dimension by taking into consideration the influence from the cross-sectional variances of each factor.

Unlike previous studies, which have been largely based on the joint effect of these factors in testing stock average returns, this study emphasizes how each factor's cross-sectional variance can improve predictability of stock returns in the US market over the period from 1988 to 2005. It is believed that the larger the cross-sectional volatility of a factor, the stronger its explanatory power.

This research reveals that, of the three Fama-French factors, the book-to-market factor and the size factor show significant improvement in the explanatory power of stock returns by integrating their cross-sectional variance in the regressions, while the results show little evidence of this with regard to the price-earning factor. Moreover, the findings also reveal that the positive relationship of the book-to-market factor to stock return is no longer unswervingly positive. This study finds evidence that the book-to-market ratio had a significant positive relationship with stock returns during the period from 1988 to 1996, while it had a significantly negative relationship to stock returns from 1997 to 2005, due to value stocks and growth stocks reacting differently across these different business cycles.

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I. Introduction

The Capital Asset Pricing Model (CAPM), developed by Harry (1959) and William F. Sharp (1964), has long orientated the method by which academic researchers and practitioners seek to predict average stock returns in regard to the relationship between risk and return. It is also widely used by financial analysts, investors and corporations. Despite the CAPM's intuitive appeal, however, a number of studies have raised concerns about its validity. In particular, there are several empirical contradictions for CAPM. The most prominent are the studies by Fama and French (1992a&b, 1993), which cast doubt on the CAPM. They hypothesize that the security market line should have three factors rather than one, and developed a three-factor asset-pricing model which includes the market risk factors related to the book-to-market ratio and the size of the company. This new model seems to capture the cross-section of average stock returns, which seriously challenged the CAPM. Fama and French (1998) suggested important reasons why those fundamental accounting variables: book-to-market ratio, price-earning ratio and size, are consistently related to stock average returns. The selection of these variables was made more by economic intuition and popularity among researchers, rather than by any theoretical models. The purpose of this research is to test how the cross-sectional variance of these fundamental variables will influence their explanatory power in regards to stock returns in the US market over the period 1988 to 2005. In other words, the purpose of this research is to explore how significant the cross-sectional variation of such variables will be in improving the explanatory power of stock returns.

Firstly, the firm's book-to-market ratio (B/M) (measured by the book value of equity divided by the market value of equity) captures much of the cross-section of the average stock returns. Generally speaking, if stocks are priced rationally, the differences in average stock returns are due to differences in the systematic risk. Fama and French (1993) find that, with rationally priced stocks, B/M must proxy for sensitivity to common risk factors in stock returns. If the market value is smaller than the book value (high B/M), which signals sustained higher earnings on a firm's book equity (value firms), then investors are optimistic about the stock's future. On the other hand, the market value being larger than the book value (low B/M) is typical of firms with lower earnings on book equity (growth firms). In such case, investors are pessimistic about the stock's future. In other words, a stock with a high B/M ratio (i.e., book value of the equity is larger than the market value) might be seen as risky, in which case investors would require a higher expected return to induce them to invest in the stock. Stocks with low B/M ratios, however, tend to be strong growth firms with persistently high earnings. Thus, investors bear less risk when investing in such stocks and receive lower returns. Fama and French (1993; 1996) assert that portfolios of companies with high B/M have earned sharply higher returns than do low B/M firms for the 1963 to 1990 period. Yet, value and growth stocks do not always react constantly to different market performance across different business cycles. Perkova and Zhang (2003) find that the conditional beta dispersion between value and growth firm is asymmetric across business cycles. That is, it is positive in bad times, but negative in good times. The results of this report's test sample of 200 stocks selected from the S&P 500 shows a significant, positive B/M coefficient displaying stock returns in the first half of the period (from 1988 to 1996), but a negative B/M coefficient to stock returns in the second half of the period (from 1997 to 2005).

Secondly, a firm's price-earning (P/E) ratio is measured by the firm's stock price per share divided by the earnings per share. Basu (1983) finds that the price-earnings ratio helps to explain the cross-section of stock returns on the US market, with his results confirming that the common stocks of NYSE firms with a low P/E earn, on average, higher returns than the common stocks of firms with a high P/E. In particular, the price-earning ratio and earnings yield are correlated with stock returns, since they are capable of being a proxy for underlying risks, rather than risk measures of the market betas. Generally speaking, the higher P/E ratio (prices are relatively higher than earnings) firms have strong growth opportunities (growth firm), while the lower P/E ratio (prices are relative lower than earnings) firms have slow growth and are riskier (value firm). Thus, lower P/E firms bear higher risks and are likely to have higher expected returns, than are higher P/E firms, which have less risk and are likely to have lower expected returns. Ball (1987) also suggests that P/E is a catch-all proxy for unnamed factors in stock returns, whereby low P/E firms have higher risks and expected returns, whatever the unnamed sources of risk. Also, many practitioners believe that the price-earning ratio is an important indicator of stock selection and future investment. Basu (1997) stated the price-earning ratio hypothesis that lower P/E stocks tend to outperform higher P/E stocks. The results of the current report strongly confirm this hypothesis: The P/E ratio shows a significant negative relationship with average stock returns over the entire sample period of 1988 to 2006.

Thirdly, the firm's size (market equity, ME), as measured by a firm' market price times the total shares outstanding, also captures much of the cross-section of average stock returns. Banz (1981) finds that market equity, when added to the explanation of the cross-section of average stock returns provided by the market betas, shows that large size firms' stocks tend to have higher returns than do the stocks of small size firms. Fama and French (1993) also point out that portfolios constructed to mimic risk factors related to firm size bring substantial variation to stock returns, as explained by a market portfolio. Size can be seen to have a certain relationship with profitability. Large size firms typically tend to have larger earnings on book equity, while smaller size firms tend to have lower earnings than do large size firms. Chan, Chen and Hsieh (1985) emphasize that small and large stocks have different sensitivities to the underlying risk factors. Generally, small size firms are more exposure to production risk and cash flow risk, such as high financial leverage, cash flow problems and situation changes, which are reflected in the risk premium. It is obvious that small size firms are generally riskier than large size firms. Thus, small size firms are expected to have higher returns than are large size firms. The test results of this research also clearly confirm that firm size is significantly, negatively related to average stock returns for the entire study period of 1988 to 2005.

Fama and French (1993) study the joint roles of the market beta, book-to-market ratio and size, and successfully develop the three-factor asset-pricing model based on their previous results. They find that when these variables are used alone, or in combination with other variables, the market beta (the slope in the regression of a stock's return on the market return) has little information about average stock returns. So they develop a new model based on the CAPM, but add second and third factors. These two easily measured variables are discussed above (book-to-market and size), and are combined in order to capture the cross-sectional variation in average stock returns associated with the market risk premium. Brigham and Ehrhardt (2005) state that, to date, the Fama-French three-factor model has been used primarily by academic researchers, rather than by managers of actual companies, the majority of whom use the CAPM. Early studies have shown relevant evidence that the three factor model has certain explanatory power regarding stock returns.

Unlike Fama French's three-factor model, which was used to test the joint effects of those fundamental variables' predictability to stock returns, this research will analyse how those fundamental variables' cross-sectional variance influence their explanatory power regarding stock returns in the US market, using data from 1988 to 2005. The fundamental variables have been proven in many studies to possess significant explanatory power over stock returns whether individually, or in the combination with each other. Thus, it is possible that their cross-sectional volatility would have a certain influence on enhancing their explanatory power regarding stock returns. Imagine an extreme case where, if all the stocks in the US market, have the same, or similar, values for each of the three factors, then those factors would undoubtedly lose their explanatory power over stock returns. The larger the cross-sectional volatility within each factor, the wider the dimension they bring to a better explanatory power level of average stock returns. Also, it is possible that, in different business cycles, the whole market performance will change accordingly. In such a case, the whole market performance appears to be optimistic in good times, while the opposite during the bad times. The sensitivity of value firms (with high B/M and low P/E) and growth firms (with low B/M and high P/E) will react somewhat differently towards different market performance. The results of this research show strong evidence that the cross-sectional variances of these factors add to the explanation of the cross-section of average returns provided by market beta and each of the factors accordingly, all of the factors' predictability for stock returns have been clearly improved, especially on the B/M and size factor.

II. Literature Review

A large number of empirical studies have found strong evidence that these three easily measured fundamental variables (book-to-market ratio, price-earning ratio and size) play an important role in explaining the cross-section of average returns in the global market, both on their own, or in combination. It is also of interest to determine how the cross-sectional variance of such variables would provide more powerful characterisation of their predictability over stock returns. On the other hand; based on the test result that B/M has a different sign to the stock returns during different time periods, further studies regarding value and growth stocks will also be referred to. The following five sub-sections review the early studies which regard these three Fama-French variables and also provide an initial overview of the influence of their cross-sectional variance on stock returns.

2.1 The book-to-market ratio factor

The ratio of the book value of common equity to its market value is regarded as a highly significant, positive coefficient for stock returns by some of the early literatures. Fama and French (1992) find that stock returns from all of the non-financial firms which are listed on all three of the NASDAQ, NYSE and AMEX are systematically higher for firms with high book-to-market ratios in the period of 1962 to 1989, than for other stocks. Low BE/ME stocks have a low average return, because their future earnings growth is weaker than market expectations, while high BE/ME stocks have high average returns because their earnings growth is stronger than expected.

Chan and Chen (1991) find that it is possible that the risk captured by B/M is the relative distress factor. They assert that firms' earnings are associated with a risk factor in returns. In other words, firms that are judged as being poor are signaled by low stock prices and high B/M, as well as having higher returns (they are penalized with a higher cost of capital) than firms which are judged to be strong. Stattman (1980) and Rosenberg, Reid and Lanstein (1985) also find that average returns on US stocks are positively related to the ratio of a firm's book value of common equity (BE) to its market value (ME).

Miles and Tinmermann (1995) analyze the monthly stock returns for a large cross-section of UK non-financial companies for the period of 1979 to 1991. They find that the book-to-market ratio and, to a lesser extent company size, are the only company attributes which appear to provide information regarding average stock returns.

Chan, Hamao and Lakonishok (1991) find that book-to-market equity (BE/ME), also has a strong role in explaining the cross-section of average returns on Japanese stocks. BE/ME variables are widely used by the Japanese financial community as important indicators of value. Their sample includes both manufacturing and non-manufacturing firms, companies from both sections of the Tokyo Stock Exchange, and also some delisted stocks. The positive coefficient on the BE/ME variable of average stocks returns is found to be highly significant for the period from 1971 to 1988 (Chan, Hamao and Lakonishok).

Yet, there are also some empirical studies which have recently advocated that growth stocks (low B/M) are riskier than value stocks in good times. Thus, such stocks have higher expected returns. Conversely, the finding that value stocks (high B/M) are riskier than growth stocks and have higher returns occurs mostly in bad market times. (The detail of this finding will be reviewed in Section 2.4)

2.2 The price-earning ratio factor

Many investors and researchers believe that the price-earning ratio is a simple, but most important indicator for stock investment selection. Basu (1977), shows strong evidence that price-earning ratios (P/E) have a negative relationship with the stock returns in the case if NYSE firms. The P/E ratio helps to explain the cross-section of average returns on US stock markets in tests which also include firm size and the market risk premium. P/E ratios are higher for firms with strong growth opportunities, while P/E ratios are lower for riskier firms. Thus, lower P/E ratio firms are likely to have higher risks and higher expected returns.

Ball (1978) argues that the P/E ratio is a catch-all proxy for unnamed factors in expected stock returns, P/E is likely to be lower; that is, prices are lower relative to earnings; for stocks with higher risks and higher expected returns. The empirical relationship between P/E ratio, firm size and returns on the common stock of NYSE firms is examined in Ball (1978). The results confirm that the common stocks of low P/E ratio firms earn, on average, higher risk-adjusted returns than does the common stock of high P/E ratio firms, and that this effect is clearly significant even if experimental control is exercised over differences in firm size.

Basu (1983) claims that in an efficient capital market; where stock prices are fully reflected by available information; the price-earning ratio hypothesis of low P/E stocks will tend to outperform high P/E stocks. His results strongly confirm the hypothesis and reveal that returns on stocks with low P/E tend to be higher than warranted through the underlying risk, even after adjusting for any additional transaction costs and taxes (Basu,1983).

2.3 The size factor

The empirical evidence that small size firms, on average, earn substantially higher average returns than large size firms has attracted much attention from researchers and investors. Banz (1981) and Reinganum (1981) are the first researchers in this area to find that firm size has significant predictability for stock returns. Banz (1981) finds that firm size (ME) adds to the explanation of the cross-section of average returns provided by market betas. Average returns on small (low ME) stocks are too high given their beta estimates, and average returns on larger (high ME) stocks are too low. His study examines the empirical relationship between stock returns and the total firm size of NYSE common stocks. Banz's (1981) results show that smaller firms have higher risk and higher expected returns, on average, than do larger firms.

Fama and French (1992) find that size is a significant factor in relation to company profitability. Small stocks will tend to have larger earnings on book equity than will large stocks. Their results show that size has a significantly negative relationship to stock returns, especially in light of the low profits from small stocks after 1980.

Heston (1995) finds that equally weighted portfolios of growth firm (small ME) stocks tend to have higher average returns than value firm (large ME) portfolios in twelve European markets. He concludes that there is also an international size effect across different markets. Huberman, Kandel and Karolyi (1987) find that size is a critical measurement of average stock returns. They also find that returns of firms within the same size range tend to respond to risk factors in similar ways, with their stock returns tending to move together (Huberman, Kandel and Karolyi, 1987).

Chan, Chen and Hsieh (1985) find that small firms are more exposed to production risk and changes in the risk premium. Their study suggests that the small firms examined in the empirical literature tend to be what are referred to as marginal firms. Such firms have lost market value due to their poor performance. These firms are also inefficient producers and are likely to have high financial leverage, as well as cash flow problems. They are marginal in the sense that their prices tend to be more sensitive to changes in the economy and, as a result, they are less likely to survive adverse economic conditions. Thus, small firms are expected to have higher returns.

2.4 Value and growth stocks

The literature mentioned in Section 2.1, as well as some other early studies, assert that the book-to-market ratio is a systematic risk factor which is significantly related to stock returns. Some current researches have, however, asked the question of whether value stocks are always riskier than growth stocks. The test results of this report has shown strong evidence that value stocks (high B/M) are not permanently riskier than are growth stocks (low B/M) across different time periods.

Lakonishok, Shleifer and Vishny (1994) and Haugen (1995) stated that the value premium in average stock returns arises because the value stocks have been undervalued by the market, while the growth stocks have been overvalued. In fact, the evidence is that value stocks are not always riskier than growth stocks across all states of market performance.

Shleifer (2000, p.392) states that, "Consistent with overreaction, historically, portfolios of companies with low book-to-market have earned substantial lower returns than those with high book-to-market companies do. However, high book-to-market (value stocks) portfolios appear to have lower market risk than do low book-to-market (growth stocks) portfolios, especially in a healthy markets, thus, high B/M portfolios are expected to have lower returns by bearing the lower risk in good times."

Petkova and Zhang (2003, p.5) also documented that, "growth stocks are riskier than value stocks in good times when the expected market risk premium is low due to the growth stocks betas are negatively related to market risk premium. Conversely, value stocks are riskier than growth stocks in bad times when the expected market risk premium is high."

2.5 The cross-sectional variance

The selection of such fundamental variables has been guided more by economic intuition and by their popularity among practitioners than by any explicit theoretical model. All these variables can be regarded as different ways to scale stock prices, and to extract the information in prices regarding risk and expected returns (Keim, 1988). The most prominent research about these fundamental variables is that of Fama and French (1992), who have evaluated every single variable's predictability and have also documented the joint roles of the market beta, firm size and book-to-market ratio equity in cross section of average returns on the NYSE, AMEX, and NASDAQ stocks. The study shows significant results regardingtheir hypothesis.

To the best of the author's knowledge there are no other papers which document similar assumptions that the cross-sectional variance of the Fama-French factors would have a certain influence on their explanatory power for stock returns. Moreover, this assumption makes absolute economic sense that, taking an opposite example, if all the stocks have the same, or similar, values to each of those three factors, then those factors would undoubtedly lose their explanatory power for stock returns. Thus, it can be assumed that the larger the cross-sectional volatility within the factor, the more powerful its predictability regarding stock returns.

III. Aims of Research

Through the review of the literature, regarding the explanatory power of Fama-French factors to stock returns, no studies were found which test the hypothesis that the cross-sectional variance of Fama-French factors would improve their predictability of stock returns. The inspiration for studying these new variables stems from a wish to examine the existing evidence of strong predictability of Fama-French factors to returns on the internationally stage. Thus, the aim of this research is to develop an economical analysis of the relationship between the cross-sectional variance of Fama-French factors to stock returns, as well as to test this hypothesis and explore the factors' explanatory power in a wider dimension.

To achieve the aims of this research, the process can be divided into three parts, as below:

- The first part will test whether there is an explanatory power for each of the three Fama-French factors (book-to-market ratio, size and price-earning ratio to average returns) from the S&P 500 stocks in the period of 1988 to 2006, as well as how significant they are.

- The second part, which is also the most important part of this research, will test the influence of the cross-sectional variance of each of these three Fama-French factors, in order to determine how significant a change they will bring to the three factors' original explanatory power of stock returns, when integrated into the initial regressions respectively. This step will be based on the test results from the first part.

- The last part will test the joint effect of these three Fama-French factors' explanatory power regarding average stock returns, as well as to further analyse how significant is the change to their original joint role of describing stock returns, when adding all of the cross-sectional variance variables together into the initial regression.

IV. Hypothesis

This research applies three main hypotheses in order to examine the influence of the cross-sectional variance of the Fama-French factors to stock returns.

4.1 Hypothesis regarding the Fama-French factors

Book-to-market ratio: The book-to-market ratio has shown strong evidence that it has a strong role in explaining the cross-section of average returns in the global market. Fama and French (1992), Chan and Chen (1991) and Chan, Hamao and Lakonishok (1991) find that stock returns are systematically higher for firms with high book-to-market ratios in the pre-1991 period.

Price/earning ratio: The price-earning ratio is simple, but it is the most important indicator for stock investment selection. Basu (1977; 1983) and Ball (1978) argue that the P/E ratio is a catch-all proxy for unnamed factors in expected stock returns. They find that P/E ratios are higher for firms with strong growth opportunities, while they are lower for riskier firms. Thus, lower P/E ratio firms are likely to have higher risks and expected returns.

Size: Empirical evidence shows that small size firms, on average, earn substantially higher average returns than do large size firms. Fama and French (1992), Heston (1995) and Chan, Chen, and Hsieh (1985) find that small firms are more exposed to production risk and changes in the risk premium, thus they bear a higher market risk and are expected to have a higher return.

Hypothesis 1a: *Stocks with a high B/M ratio might be seen as risky, in which case investors would require a higher expected return to induce them to invest in such stock. This, results in a positive relationship to stock returns.*

Hypothesis 1b: *P/E ratios are higher for firms with strong growth opportunities, while they are lower for slow growth and riskier firms. Thus, lower P/E firms bearing higher risks are likely to have higher expected returns, which results in a negative relationship to stock returns.*

Hypothesis 1c: *Small size firms are generally riskier than are large firms. Thus, small firms are expected to have higher returns than are larger firms, which results in a negative relationship to stock returns.*

4.2 Hypothesis regarding the cross-sectional variance of Fama-French factors

The assumption that the cross-sectional variance of Fama-French factors will improve their predictability for stock returns is guided by economic intuition. All of the previous studies and research regarding the Fama-French factors have shown strong evidence for their explanatory power regarding stock returns. The main reason for this is that these factors have different values across different firms, and yet these different values of each different individual firm will naturally provide a chance to explain the difference in stock returns between every firm. Thus, it makes absolute economic sense that the more the difference in value, and the larger the cross-sectional volatility of the factor between each firms, the greater the chance it will capture the difference in stock returns. Thus, it is possible to believe that the larger the cross-sectional volatility of a factor, the more powerful the predictability for stock returns.

Hypothesis 2: *The cross-sectional variance of each factor captures the omni-directional information of cross-sectional average stock returns, which can significantly improve such a factor's explanatory power for stock returns.*

4.3 Hypothesis regarding the jointly effect of all the variables

The joint roles of the Fama-French factors have been previously extensively evaluated in terms of the cross section of average returns. Previous studies show strong evidence that the joint effect leads to a better explanation of stock returns (Fama and French, 1992; Chan, Hamao and Lakonishok, 1991; Chan, Chen and Hsieh, 1985). Thus, this research will also combine the cross-sectional variance of each factor to capture a more powerful predictability for stock returns.

Hypothesis 3: *The combined Fama-French factors and their associated cross-sectional variance capture the cross-section of average stock returns, which greatly enhances their predictability of stock returns.*

V. Methodology

5.1 Data Collection

In order to test the three hypotheses, this research uses 200 stocks selected from the S&P 500 index; as listed in 1988; as the test sample. The S&P 500 index listings for 1988 were collected from the McGraw-Hill Company and the Standard and Poor's website, with their accounting variables sourced from COMPUSTA. The reason for the selection of these 200 stocks from the S&P 500 in the first year of the test period is that the test data will then include the historical data for firms which de-listed within the sample period of 1988 to 2005, but it does not include the historical data of any newly added index firms. This means that there are no backfilling problems. Moreover, the test data are relatively free of survivor bias.

The accounting variables are usually available once a year, thus, annual data is used in this study. The price-earning ratio and market equity are downloaded from COMPUSTA, while the book-to-market ratio is not directly available and needs to be computed by the researcher. To ensure that these three fundamental accounting variables are known before the stock returns which they are used to explain, this research follows Fama and French by matching the accounting variables for all of the fiscal yearends in the calendar year $\boldsymbol{t-1}$ (1987 to 2004) with the stock returns for July in year $\boldsymbol{t}$ to June in year $\boldsymbol{t+1}$ (1988 to 2005). There is a six-month's information gap between the accounting fiscal yearend and the stock returns, which in this research test is conservative. For example, this research uses a firm's price-earning ratio at the end of December in year $\boldsymbol{t-1}$ and its market equity for June in year $\boldsymbol{t}$ to measure its size, as well as using a firm's market equity at the end of December in year $\boldsymbol{t-1}$ to compute the value of its book-to-market ratio to explain the stock returns from July in year $\boldsymbol{t}$ to June in year $\boldsymbol{t+1}$.

This research also uses the average return of 90-day Treasury Bills from July in year $\boldsymbol{t}$ to June of in year $\boldsymbol{t+1}$ (1988 to 2005) as the risk-free rate and the total average return of S&P 500 from July in year $\boldsymbol{t}$ to June of in year $\boldsymbol{t+1}$ as the average market portfolio returns.

5.2 Research Question

The objective of this research is, firstly, to find evidence of explanatory power of each Fama-French factor regarding stock returns. Secondly, and most importantly, it is to develop a further analysis of the influence of each factor's predictability to stock returns when adding the new variable, of the cross-sectional variance. Finally, it is to test the joint effect of all factors and their cross-sectional variances for stock returns, since the evidence from the previous two assumptions can help to shed further light on developing a more powerful explanation regression in cross-sectional stock returns. Thus, the research questions are:

1. Does each of these three Fama-French factors (book-to-market ratio, price-earning ratio and size) have significant explanatory power over average stock returns in the US market during the period of 1988 to 2005? Does their explanatory power for returns maintain a constant sign in accordance with different business cycles?

2. Based on the test result of the first question, do each of these three Fama-French factors' cross-sectional variance; when integrated into the equation developed in the first question, show significant improvement of their original explanatory level to stock returns?

3. Based on the test results of the first two research questions, does the joint effect of all these Fama-French factors and their cross-sectional variances provide a more meaningful improvement of their predictability to stock returns?

4. If significant improvements of these factors' explanatory power are present when taking into account their cross-sectional variances from the test results of the first three questions, what are the implications?

5.3 Research Methodology

A panel data approach is applied in this research. All statistical tests are conducted by using the STATA 9.0 system.

Approach Selection

The panel data approach uses data sets which contain two-dimensional observations (e.g. data sets containing multiple firms in multiple time periods). Panel data is becoming increasingly popular among academic researchers and social practitioners, due to its powerful capacity in reducing standard errors when handling multi-dimensional data research. Petersen (2007, p. 2) stated that "...in corporate finance and asset pricing empirical work, researchers are often confronted with panel data, in these data sets, the residuals may be correlated across firms or across time, and OLS standard errors can be biased." This research aims to test the cross-sectional variance of the Fama-French factors of 200 individual stocks' predictability to average returns across the time period from 1988 to 2005. Thus, it is ideal to conduct this study using a panel data approach.

Variable Defining

There are, in total, six variables tested in this study. To ensure that the annual value of these three Fama-French factors are determined before the annual stock returns are (from July in year t to June in year $t + 1$, 1988 to 2005), the annual book-to-market ratio and price-earning ratio at the end of December of year $t - 1$ are selected to explain the returns. On the other hand, the market equity for June in year **t** is also used to measure its size when explaining the returns. The other three variables of cross-sectional variance of each factor should also be known before the stock returns are determined. Thus, it can simply be drawn by computing the standard deviation of all of the factors of the 200 stocks in each year. Therefore, each single year will have only one observation of each factor.

Research Equation

This research tests how significant the explanatory power of each of these three factors is to stock returns and, most importantly, it aims to compare the regression results from adding the new variable: the cross-sectional variance of each factor; individually, with their single role of explaining average stock returns. The study also aims to determine whether there is any evidence for the cross-sectional variance of Fama-French factors providing a better interpretation of stock return movements. Accordingly, the research regressions can be divided into three steps.

Step one: First formulate the equation as a capital asset pricing model and add the Fama-French factors individually in order to test their singular role in explaining average returns.

$$R_{i,t} - R_f = \alpha_1 + \beta_{1.1}(R_m - R_f) + \beta_{1.2}B/M_{i,t-1} + \varepsilon_{1,t} \quad (1.1)$$

$$R_{i,t} - R_f = \alpha_2 + \beta_{2.1}(R_m - R_f) + \beta_{2.2}P/E_{i,t-1} + \varepsilon_{2,t} \quad (1.2)$$

$$R_{i,t} - R_f = \alpha_3 + \beta_{3.1}(R_m - R_f) + \beta_{3.2}MV_{i,t-1} + \varepsilon_{3,t} \quad (1.3)$$

where the risk-free rate (Rf), is the average return of the 90-day Treasury Bill from July in year ***t*** to June in year ***t* + 1**; the average market return (Rm), is the total average return of the S&P 500 from July in year ***t*** to June in year ***t* + 1**. a is a constant and ε_t is the error term. Equations (1.1) to (1.3) provide a compact summary of the relationship between stock returns and the three Fama French factors.

Based on the regression results of the first step, the next stage integrates the new variable; the cross-sectional variance of each of the three factors; to the above three regressions respectively. The cross-sectional variance of each factor has one value across the 200 stocks in each single year. This approach is designed to reveal that a large frustration in each factor would certainly influence the stock movement. Thus, taking into consideration the cross-sectional variance of each factor respectively will provide a better interpretation of stock movements, and better explain the regression to stock returns which can be achieved.

Step two: Formulated the regression equation as in step one, then combine with the cross-sectional variance of each factor, respectively.

$$R_{i,t} - R_f = \alpha_1 + \beta_{1.1}(R_m - R_f) + \beta_{1.2}B/M_{i,t-1} + \beta_{1.3}\sigma_{B/M_{t-1}} + \varepsilon_{1,t} \quad (2.1)$$

$$R_{i,t} - R_f = \alpha_2 + \beta_{2.1}(R_m - R_f) + \beta_{2.2}P/E_{i,t-1} + \beta_{2.3}\sigma_{P/E_{t-1}} + \varepsilon_{2,t} \quad (2.2)$$

$$R_{i,t} - R_f = \alpha_3 + \beta_{3.1}(R_m - R_f) + \beta_{3.2}MV_{i,t-1} + \beta_{3.3}\sigma_{MV_{t-1}} + \varepsilon_{3,t} \quad (2.3)$$

where σ_t is cross-sectional variance of each factor across the 200 stocks in each single year. a is a constant and ε_t is the error term. The cross-sectional variance of each factor is expected to have improvement effects on the explanatory power of stock returns. If the regression in step two shows significant improvement compared with that in step one, then the cross-sectional variance of each factor provides a better, and more powerful, method of explaining average returns. Alternatively, two other regression equations will also be formulated in order to assess the joint effect of the variables.

Step three: Start with the same formula as in steps one and two, integrating all three Fama-French factors together into the regression. Further combine all six variables together to test their joint effect on explaining stock returns.

$$R_{i,t} - R_f = \alpha + \beta_1(R_m - R_f) + \beta_2 B/M_{i,t-1} + \beta_3 P/E_{i,t-1} + \beta_4 MV_{i,t-1} + \varepsilon_t \quad (3.0)$$

$$R_{i,t} - R_f = \alpha + \beta_1(R_m - R_f) + \beta_2 B/M_{i,t-1} + \beta_3 P/E_{i,t-1} + \beta_4 MV_{i,t-1}$$
$$+ \beta_5 \sigma_{B/M_{t-1}} + \beta_6 \sigma_{P/E_{t-1}} + \beta_7 \sigma_{MV_{t-1}} + \varepsilon_t \quad (3.1)$$

where a is a constant and ε_t is the error term.

VI. Results

Of the three Fama-French factor variables considered, the book-to-market ratio and the size factor have the most significant impact on stock returns. Moreover, the cross-sectional variance of these two factors brings a certain improvement of their prediction power to returns. Interestingly, the book-to-market ratio shows a different sign to stock returns across different time periods. The results show, however, little evidence of improvement with the price-earning ratio factor. The joint effect of all the variables provides a more powerful explanation regression to stock returns, which sheds further light on the assumption of the explanatory power of cross-sectional variance of Fama-French factors.

Results of the book-to-market factor

The book-to-market ratio has been advocated in a great number of studies to possess a significant, positive, linear relationship with stock returns in the pre-2000 period. Fama and French (1993; 1996) assert that portfolios of companies with high B/M have earned sharply higher returns than those with low B/M firms for the 1963 to 1990 period. Nevertheless, this research shows a significant opposite result to earlier studies. *Table 1* illustrates that, in the test sample, the 200 stocks selected from the S&P 500 index in 1988, their cross-sectional returns in the period form 1988 to 2005 are significantly negatively related to their book-to-market ratio (BM), with a coefficient of -0.015 and a t-value of -11.77. This suggests that high B/M firms do not necessarily earn higher returns than low B/M firms in the test sample.

Table 1: Regression Results from Equation (1.1) and (2.1)

Variables	β BM	t-value	$\beta\ \sigma_{BM}$	t-value	R-sq
BM	**-0.015**	**-11.77**			0.08
BM + σ BM	-0.1426	-11.30	0.0098	7.53	0.10

Indeed, there some recent research has addressed the problem of whether, or not, value firms are riskier than growth firms. This issue indicates that value stocks (high B/M), consistently earn higher returns than do growth stocks (low B/M). A later paper by Fama and French (1998) reveals that, out of thirteen major markets, the US and Japan have negatively signed B/M to stock returns, even through the t-value is not very strong with (-0.85 in the US market and -1.27 in the Japanese market). Shleifer (2000) also claims that, historically, portfolios of firms with low book-to-market ratios have earned substantially lower returns than those with high book-to-market ratios. It is not necessarily the case, however, that when market conditions are change, "...high book-to-market (value stocks) portfolios appear to have lower market risk than do low book-to-market (growth stocks) portfolios, especially in a healthy markets, thus, high B/M portfolios are expected to have lower returns by bearing the lower risk in good times."(Shleifer, 2000, p.392) The test results of this research also indicate that the explanation of B/M to stock returns reacts differently in different business cycles. Thus, further analysis is conducted in this study in order to test the B/M's sensitivity explanation to stock returns in two sample periods (1988 to 1996 and 1997 to 2005).

Table 2: Regression Results from Equation (1.1) and (2.1) in Different Time Periods

Time Period	Variables	β BM	t-value	$\beta\ \sigma_{BM}$	t-value	R-sq
1988—1996	BM	0.1559	6.80			0.17
	BM + σ BM	0.1631	6.86	-0.0809	-1.16	0.17
1997—2005	BM	-0.1680	-9.98			0.07
	BM + σ BM	-0.016	-9.66	0.0125	7.15	0.10

The results illustrated in *Table 2*; that B/M is significantly positively related to stock returns in the period from 1988 to 1996, with the coefficient of 0.1559 and a t-value of 6.80; strongly agrees with most early studies and also with the findings of Fama and French's for the period of 1963 to 1990. These results indicate that value stocks have higher returns than do growth stocks. On the other hand, this study also shows a significant, opposite result for the second period of 1996 to 2005, that B/M is strongly negatively in relation to stock returns. This finding indicates that growth stocks, on the contrary, earn higher returns than do value stocks for this period. Grinblatt and Titman (2001, p. 246) claim that "...growth opportunities are usually the source of high betas, because growth options (assets-in-place) tend to be most valuable in good times and have implicit leverage, which tends to increase beta, they contain a great deal of systematic risk." From this it can be seen that, in good times, growth firms derive more growth opportunities, while there is a need to reform the firm's capital structure and production systems in order to pursue these opportunities. This implies a higher total systematic risk, thus leading to the desired higher return. Therefore, B/M is negatively related to stock returns in good time. This finding is also clearly illustrated in the current study.

From *Table 1* it can also be seen that, the cross-sectional variance of B/M of each single year from 1988 to 2005 does significantly enhance the B/M's explanatory power for stock returns. The value of R-square increases greatly from 0.80 in Regression (1.1) to 0.10 in Regression (2.1); when adding the cross-sectional variance of the B/M variable. Moreover, the cross-sectional variance of B/M itself has a strong role in explaining the average returns on the 200 stocks in the test sample. That is to say, the results strongly agree with the assumption that cross-sectional variance of B/M can provide an enhancement in B/M's explanatory power over stock returns. The central role of Regression 2.1 is to analyse how a change occurs in B/M's predictability to returns when taking into consideration the annual volatility of B/M's movement across the 200 individual stocks. The result suggests that the larger the change in B/M cross-sectionally, the more powerful the B/M factor can be when used to explain the average stock returns.

Results of the price-earning factor

There are substantial empirical researches claiming that the price-earnings ratio is the most sophisticated investment indicator of future performance of a stock. From the earliest findings of Basu (1997); which assert that low P/E stocks will tend to outperform high P/E stocks; it can be seen that low P/E stocks earn substantially higher returns than high P/E stocks. The results of this research also strongly agree with early studies. From *Table 3* we can clearly see that P/E is negatively related to cross-sectional average stock returns during the entire sample period (1988 to 2005), with the coefficient equal to -0.00028. The t-value of -2.11 does, however, suggest relatively low significance, which is also firmly agreed by some pervious empirical studies regarding the three fundamental variables; book-to-market ratio, price-earnings ratio, and size. The price-earnings ratio has relatively with lower explanatory power compared with the other ratios. In the combination regression of all the three factors together, B/M and size seems to absorb the role of P/E's explanation in stock returns (details will be discussed later in the report). As well as a study by Chan, Hamao and Lakonishok (1991), which finds that P/E can be used to predict cross-sectional average returns in the Japanese market in the period of 1971 to 1988, the result does not show high significant impact to returns, as does B/M.

Table 3: Regression Results from Equation (2.1) and (2.2)

Variables	β PE	t-value	$\beta\ \sigma_{PE}$	t-value	R-sq
PE	-0.00028	-2.11			0.050
PE + σ PE	-0.00028	-2.07	-0.00004	-0.73	0.051

Table 3 also illustrates that, with the combination of the cross-sectional variance of the P/E variable, the regression result does not show a significant improvement compared with the results from the B/M factor. The R-square from Regression (1.2) only increases slightly; from 0.050 to 0.51; and the t-value of the cross-sectional variance of the P/E variable itself being equal to -0.73, which does not indicate any improvement in P/E's predictability of stock returns.

Results of the size factor

Compared with the second set's regression results from this research regarding the B/M factor and the P/E factor, the variable of the cross-sectional variance of size, provids the most significant improvement in prediction power for the size (MV) factor, in order to describe the cross-sectional average returns in the sample period from 1988 to 2005 in the US market. As illustrated in *Table 4*, the t-value of the size coefficient is -6.33 when derived using Regression (1.3), but increases substantially to -8.41 when derived using Regression (2.3), which adds the cross-sectional variance of the size variable. On the other hand, the value of the R-square also greatly increases; from 0.056 to 0.069; which implies a better explanation of stock returns when using the new regression. Moreover, the variable of the cross-sectional variance of size itself also suggests significant predictability of average returns, with a t-value of 6.75. Size is the key indicator of a firm's profitability. Historically, small size firms tend to have lower earnings on book equity than do large size firms, due to their high financial leverage and low production level. The test results firmly agree with this point that firm size is negatively related to stock returns.

Table 4: Regression Results from Equation (1.3) and (2.3)

Variables	β MV	t-value	$\beta\ \sigma_{MV}$	t-value	R-sq
MV	-1.55e-06	-6.33			0.056
MV + σ MV	-2.20e-06	**-8.41**	2.33e-06	**6.75**	**0.069**

All the results from this study also strongly agree with the assumption that, by integrating the cross-sectional variance of the size variable into the single size factor's regression, the explanatory power of size for stock returns is significantly enhanced. The size effect has, in fact, been studied by many researches, as one of the most significant Fama-French factors to predict stock returns. The most prominent study of the size effect is Banz (1981), who studied his effect in the US market. Through economical intuition, therefore, it can be seen that the larger the difference size between firms, the more likely it is that the size factor can be used to capture cross-sectional stock returns. It is shown in the current results that the cross-sectional variance of size can definitely improve size's explanation of returns.

Results of the jointly-effect

Fama and French (1988) suggest important reasons why these three variables possess significant predictability for stock returns. In their later multivariate tests they attempted to combine all three factors, along with the market beta, in order to capture the cross-sectional average returns. Evidence from another of their paper's, (Fama and French, 1993) shows that B/M and size have the more significant explanatory power for stock returns than does P/E in the US market, using data from NYSE, AMEX and NASDAQ stocks from 1963 to 1990. Their finding also indicates that in the combination regression of B/M, P/E and size, B/M and size seems to absorb the role of P/E in explaining average stock returns in the same sample period. Thus they have developed the well-known three factor model of market beta, B/M and size in order to predict average stock returns. The results of the current study strongly agree with those of Fama and French. As shown in *Table 5*, both B/M and size having significant t-value of 3.66 and -5.29, respectively, while the t-value of P/E drops from -2.11 in Regression (1.2) (lone effect) to -1.52 when combine with B/M and size in the regression. The possible explanation for this change is that B/M, P/E and size are all scaled versions of stock price, thus it is reasonable to expect that some of these factors are redundant in the regression when explaining stock returns.

Table 5: Regression Results from Equation (3.0) and (3.1)

Variables	β BM	t-value	β PE	t-value	β MV	t-value	R-sq
BM+PE+MV	0.0812	3.66	-0.00020	-1.52	-1.22e-06	-5.29	0.072
BM+PE+MV+ $\sigma_{BM}+\sigma_{PE}+\sigma_{MV}$	0.1028	**4.57**	-0.00026	**-2.04**	-1.85e-06	**-7.62**	**0.096**

The second row of *Table 5* also shows a significant overall improvement in the results from Regression (3.0) to Regression (3.1), all these three factors't-values having substantially increased. Most importantly, the R-square increases from 0.072 to 0.096, implying a better description of stock returns in Regression (3.2). Thus, these results provide further prominence to the study assumption of the enhancing power of the cross-sectional variances of Fama-French factors' predictability for stock average returns.

VII. Conclusion

The predictability of the Fama-French factors for stock returns has been examined in many previous studies, however, most of the studies have placed emphasis on their single role in describing average stock returns, or have developed the joint effect of these factors associated with the market beta to capture the stock returns, as does the three factor model of Fama and French. Unlike the earlier studies, this research develops a new assumption that the cross-sectional variance of the Fama-French factors can significantly improve their predictability of stock returns. This assumption makes absolute economic sense. Consider an extreme case, in which all the stocks in a certain market have the same, or similar, values in regards to each of the three factors. In such a case these factors would undoubtedly lose their explanatory power over stock returns. Thus, the reason of why these factors possess important explanatory power for stock returns is that different individual firms, with different accounting variables, earn substantially different returns to each other. That is to say, the larger the variance of these factors cross-sectionally, the greater the chance they will provide to describe the cross-sectional stock returns.

The results from this research clearly and strongly endorse the assumption that, out of the three Fama-French factors, the book-to-market factor and the size factor show significant improvement in the explanatory power of stock returns by integrating their cross-sectional variance into the regressions, while the results show only little evidence of this regards to the price-earning factor. Nevertheless, the results also suggest significant improvement of the joint role explanation of these three factors when taking into consideration the joint role of their cross-sectional variance in the new regression. This sheds further light on the earlier assumptions. Moreover, the study findings also reveal that the book-to-market ratio have a significant positive relationship to stock returns in the period from 1988 to 1996, while it shows a significant, negative relationship to stock returns from year 1997 to 2005, due to value stocks and growth stocks reacting differently across different business cycles.

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Appendix 1: Entire Sample Period of 1988—2005

Regression 1.1: BM

Fixed-effects (within) regression
R-sq = 0.0798
Prob > F = 0.0000

R	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
RM	.4992595	.0405089	12.32	0.000	.4198352	.5786839
bm	-.0149466	.0012696	-11.77	0.000	-.0174357	-.0124574
cons	.0371652	.006018	6.18	0.000	.0253659	.0489644

F test that all u_i=0: F(199, 3384) = 0.88 Prob > F = 0.8765

Regression 2.1: BM + cross-sectional variance of BM

Fixed-effects (within) regression
R-sq = 0.0950
Prob > F = 0.0000

R	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
RM	.4740151	.040319	11.76	0.000	.394963	.5530671
bm	-.0142607	.0012625	-11.30	0.000	-.016736	-.0117853
bmsd	.0097572	.0012955	7.53	0.000	.0072171	.0122973
cons	.0190659	.0064347	2.96	0.003	.0064497	.0316821

F test that all u_i=0: F(199, 3383) = 0.89 Prob > F = 0.8627

Regression 1.2: PE

Random-effects GLS regression
R-sq = 0.0504
Prob > chi2 = 0.0000

R	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
RM	.4916156	.0392162	12.54	0.000	.4147532	.568478
pe	-.00028	.0001329	-2.11	0.035	-.0005405	-.0000195
cons	.0329233	.0067073	4.91	0.000	.0197772	.0460693

Regression 2.2: PE + cross-sectional variance of PE

Random-effects GLS regression
R-sq = 0.0506
Prob > chi2 = 0.0000

R	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
RM	.4973548	.03999	12.44	0.000	.4189758	.5757338
pe	-.0002757	.0001331	-2.07	0.038	-.0005365	-.0000149
pesd	-.0000403	.0000548	-0.73	0.463	-.0001477	.0000672
cons	.0351045	.0073359	4.79	0.000	.0207264	.0494826

Regression 1.3: MV

Fixed-effects (within) regression
R-sq = 0.0563
Prob > F = 0.0000

R	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
RM	.47082	.0392346	12.00	0.000	.393894	.5477459
mv	-1.55e-06	2.45e-07	-6.33	0.000	-2.03e-06	-1.07e-06
cons	.057456	.0070369	8.16	0.000	.043659	.0712531

F test that all u_i=0: F(199, 3382) =1.05 Prob > F = 0.2933

Regression 2.3: MV + cross-sectional variance of MV

Fixed-effects (within) regression
R-sq = 0.0689
Prob > F = 0.0000

R	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
RM	.5792521	.0421585	13.74	0.000	.4965933	.6619108
mv	-2.20e-06	2.62e-07	-8.41	0.000	-2.72e-06	-1.69e-06
mvsd	2.33e-06	3.46e-07	6.75	0.000	1.66e-06	3.01e-06
cons	-.0035512	.0114257	-0.31	0.756	-.0259532	.0188509

F test that all u_i=0: F(199, 3381) = 1.18 Prob > F = 0.0451

Regression 3.0: BM + PE + MV

Fixed-effects (within) regression
R-sq = 0.0722
Prob > F = 0.0000

R	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
RM	.482667	.0371036	13.01	0.000	.4099163	.5554177
bm	.0811631	.0221785	3.66	0.000	.0376767	.1246496
pe	-.000197	.00013	-1.52	0.129	-.0004524	.0000572
mv	-1.22e-06	2.31e-07	-5.29	0.000	-1.67e-06	-7.67e-07
cons	.0130329	.0131791	0.99	0.323	-.0128079	.0388737

F test that all u_i=0: F(199, 3045) =1.10 Prob > F = 0.1599

Regression 3.1: BM + PE + MV + σ_{BM} + σ_{PE} + σ_{MV}

Fixed-effects (within) regression
R-sq = 0.0959
Prob > F = 0.0000

r	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rm	.5674033	.043605	13.01	0.000	.4819051	.6529015
bm	.1028057	.022511	4.57	0.000	.0586675	.1469439
pe	-.0002627	.0001289	-2.04	0.042	-.0005155	-9.85e-06
mv	-1.85e-06	2.43e-07	-7.62	0.000	-2.33e-06	-1.37e-06
bmsd	.00653	.001311	4.98	0.000	.0039595	.0091005
pesd	-.0000792	.0000543	-1.46	0.145	-.0001856	.0000272
mvsd	1.91e-06	3.80e-07	5.02	0.000	1.16e-06	2.65e-06
cons	-.0502033	.0170878	-2.94	0.003	-.083708	-.0166985

F test that all u_i=0: F(199, 3043) = 1.27 Prob > F = 0.0076

Appendix 2a: Sample Period of 1988—1996

Regression 1.1: BM

Fixed-effects (within) regression
R-sq = 0.1687
Prob > F = 0.0000

R	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
RM	.8401239	.0477848	17.58	0.000	.7463959	.9338519
bm	.1558631	.0229307	6.80	0.000	.1108854	.2008408
cons	-.0934721	.01453	-6.43	0.000	-.1219721	-.0649721

F test that all u_i=0: F(199, 1589) = 1.52 Prob > F = 0.0000

Regression 2.1: BM + cross-sectional variance of BM

Fixed-effects (within) regression
R-sq = 0.1694
Prob > F = 0.0000

R	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
RM	.8197077	.0509062	16.10	0.000	.7198573	.9195582
bm	.1631207	.0237633	6.86	0.000	.11651	.2097315
bmsd	-.0808733	.069582	-1.16	0.245	-.2173555	.0556089
cons	-.0650198	.0284664	-2.28	0.022	-.1208555	-.0091841

F test that all u_i=0: F(199, 1588) = 1.52 Prob > F = 0.0000

Regression 1.2: PE

Random-effects GLS regression
R-sq = 0.1684
Prob > chi2 = 0.0000

R	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
RM	.7929969	.0459829	17.25	0.000	.702872	.8831218
pe	-.0000876	.0001513	-0.58	0.563	-.0003841	.000209
cons	-.0108372	.0087288	-1.24	0.214	-.0279454	.006271

Regression 2.2: PE + cross-sectional variance of PE

Random-effects GLS regression
R-sq = 0.1686
Prob > chi2 = 0.0000

r	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
rm	.8110363	.0476937	17.01	0.000	.7175584	.9045142
pe	-.000124	.0001526	-0.81	0.416	-.0004232	.0001751
pesd	.000324	.0002039	1.59	0.111	-.0000751	.0007243
cons	-.023285	.011687	-1.99	0.046	-.0461928	-.0003778

Regression 1.3: MV

Fixed-effects (within) regression
R-sq = 0.1497
Prob > F = 0.0000

r	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
rm	.835618	.0502707	16.62	0.000	.7370147	.9342225
mv	-3.91e-06	1.11e-06	-3.53	0.000	-6.09e-06	-1.74e-06
cons	.0168055	.0099764	1.68	0.092	-.0027627	.0363738

F test that all u_i=0: F(199, 1591) = 1.35 Prob > F = 0.0015

Regression 2.3: MV + cross-sectional variance of MV

Fixed-effects (within) regression
R-sq = 0.1567
Prob > F = 0.0000

r	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
rm	.6337135	.0747757	8.47	0.000	.4870441	.7803828
mv	-5.15e-06	1.16e-06	-4.46	0.000	-7.42e-06	-2.88e-06
mvsd	9.47e-06	2.60e-06	3.64	0.000	4.36e-06	.0000146
cons	-.061019	.0235988	-2.59	0.010	-.1073077	-.0147316

F test that all u_i=0: F(199, 1590) = 1.40 Prob > F = 0.0004

Regression 3.0: BM + PE + MV

Fixed-effects (within) regression
R-sq = 0.1797
Prob > F = 0.0000

R |	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
RM |	.8576274	.0491958	17.43	0.000	.7611239	.9541309
bm |	.0977315	.0294689	3.32	0.001	.0399247	.1555383
pe |	.0000363	.0001634	0.22	0.824	-.0002842	.0003568
mv |	-2.56e-06	1.06e-06	-2.41	0.016	-4.65e-06	-4.77e-07
cons |	-.046904	.019517	-2.40	0.016	-.0851906	-.0086191

F test that all u_i=0: F(199, 1434) = 1.54 Prob > F = 0.0000

Regression 3.1: BM + PE + MV + σ_{BM} + σ_{PE} + σ_{MV}

Fixed-effects (within) regression
R-sq = 0.1871
Prob > F = 0.0000

R |	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
RM |	.7157343	.098524	7.26	0.000	.5224674	.9090012
bm |	.1057863	.0306435	3.45	0.001	.0456753	.1658974
pe |	1.83e-06	.0001645	0.01	0.991	-.0003209	.0003246
mv |	-3.72e-06	1.11e-06	-3.35	0.001	-5.89e-06	-1.54e-06
bmsd |	.047959	.0829544	0.58	0.563	-.1147661	.210684
pesd |	.000207	.0002859	0.73	0.468	-.0003532	.000768
mvsd |	7.95e-06	2.99e-06	2.66	0.008	2.09e-06	.0000138
cons |	-.142352	.0428428	-3.32	0.001	-.2263935	-.058310

F test that all u_i=0: F(199, 1431) = 1.58 Prob > F = 0.0000

Appendix 2b: Sample Period of 1997—2005

Regression 1.1: BM

Fixed-effects (within) regression
R-sq = 0.0742
Prob > F = 0.0000

R	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
RM	.3328118	.0657148	5.06	0.000	.2039153	.4617083
bm	-.0168045	.0016843	-9.98	0.000	-.0201082	-.0135008
cons	.0524193	.0093719	5.59	0.000	.0340367	.0708018

F test that all u_i=0: F(199, 1593) = 0.76 Prob > F = 0.9941

Regression 2.1: BM + cross-sectional variance of BM

Fixed-effects (within) regression
R-sq = 0.1030
Prob > F = 0.0000

R	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
RM	.2027202	.067212	3.02	0.003	.0708861	.3345542
bm	-.0160488	.001661	-9.66	0.000	-.0193083	-.0127893
bmsd	.0125348	.001752	7.15	0.000	.0090971	.0159726
cons	.0114923	.01085	1.06	0.290	-.0098055	.0327901

F test that all u_i=0: F(199, 1592) = 0.77 Prob > F = 0.9907

Regression 1.2: PE

Random-effects GLS regression
R-sq = 0.0178
Prob > chi2 = 0.0000

r	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
rm	.3014512	.0630803	4.78	0.000	.177816	.4250864
pe	-.0004787	.0002117	-2.26	0.024	-.000893	-.0000637
cons	.0527119	.0107972	4.88	0.000	.0315498	.073874

Regression 2.2: PE + cross-sectional variance of PE

Random-effects GLS regression
R-sq = 0.0179
Prob > chi2 = 0.0000

r	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
rm	.2936497	.0704781	4.17	0.000	.1555152	.4317843
pe	-.0004787	.0002118	-2.26	0.024	-.0008939	-.0000636
pesd	.0000192	.0000772	0.25	0.804	-.0001322	.0001706
cons	.0511154	.012567	4.07	0.000	.0264844	.0757463

Regression 1.3: MV

Fixed-effects (within) regression
R-sq = 0.0469
Prob > F = 0.0000

r	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
rm	.274592	.0624744	4.40	0.000	.1520514	.3971331
mv	-4.06e-06	5.78e-07	-7.02	0.000	-5.19e-06	-2.92e-06
cons	.143494	.0161336	8.89	0.000	.1118494	.1751401

F test that all u_i=0: F(199, 1590) = 0.96 Prob > F = 0.6487

Regression 2.3: MV + cross-sectional variance of MV

Fixed-effects (within) regression
R-sq = 0.0481
Prob > F = 0.0000

r	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
rm	.4224853	.119758	3.53	0.000	.187585	.657385
mv	-4.16e-06	5.82e-07	-7.14	0.000	-5.30e-06	-3.02e-06
mvsd	2.70e-06	1.87e-06	1.45	0.148	-9.59e-07	6.36e-06
cons	.0243604	.083879	0.29	0.772	-.1401648	.188885

F test that all u_i=0: F(199, 1589) = 0.97 Prob > F = 0.6182

Regression 3.0: BM + PE + MV

Fixed-effects (within) regression
R-sq = 0.0661
Prob > F = 0.0000

r	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rm	.2709251	.0583663	4.64	0.000	.1564308	.3854195
bm	.2226839	.0459951	4.84	0.000	.1324575	.3129102
pe	-.000399	.000211	-1.89	0.059	-.0008128	.0000148
mv	-3.35e-06	5.39e-07	-6.22	0.000	-4.41e-06	-2.29e-06
cons	.0406082	.0261623	1.55	0.121	-.010713	.0919294

F test that all u_i=0: F(198, 1408) = 1.08 Prob > F = 0.2207

Regression 3.1: BM + PE + MV + σ_{BM} + σ_{PE} + σ_{MV}

Fixed-effects (within) regression
R-sq = 0.0952
Prob > F = 0.0000

r	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rm	-.0359905	.1450917	-0.25	0.804	-.3206102	.2486293
bm	.1814755	.0459322	3.95	0.000	.0913724	.2715787
pe	-.0003474	.0002082	-1.67	0.096	-.0007559	.0000611
mv	-3.54e-06	5.35e-07	-6.61	0.000	-4.59e-06	-2.49e-06
bmsd	.0112083	.0017206	6.51	0.000	.007833	.0145835
pesd	.000215	.0000797	2.70	0.007	.0000589	.0003715
mvsd	-1.79e-06	1.93e-06	-0.92	0.356	-5.58e-06	2.01e-06
cons	.087338	.0858067	1.02	0.309	-.0809845	.2556616

F test that all u_i=0: F(198, 1405) = 1.07 Prob > F = 0.2447