Expected Returns and Volatility of Fama-French Factors

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First Version August 15, 2009

Abstract

In this paper, I show that the variance of Fama-French factors and the momentum factor, as well as the correlation among these factors, predicts an important fraction of the time-series variation in post-1990 aggregate stock market returns. This predictability is particularly strong from one month to one year, and it dominates that afforded by the variance risk premium and other popular predictor variables such as P/D ratio, the P/E ratio, the default spread, and the consumption-wealth ratio. In a simple representative agent economy with recursive preferences, I model the portfolio weight in each asset as a function of a stock's characteristics and show that the market return can be predicted by these variances.
(JEL C22, C51, C52, G12, G13, G14)

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Abstract

In this paper, I show that the variance of Fama-French factors and the momentum factor, as well as the correlation among these factors, predicts an important fraction of the time-series variation in post-1990 aggregate stock market returns. This predictability is particularly strong from one month to one year, and it dominates that afforded by the variance risk premium and other popular predictor variables such as P/D ratio, the P/E ratio, the default spread, and the consumption-wealth ratio. In a simple representative agent economy with recursive preferences, I model the portfolio weight in each asset as a function of a stock's characteristics and show that the market return can be predicted by these variances.

(JEL C22, C51, C52, G12, G13, G14)

I. Introduction

Recently, Bollerslev et al. (2009) and Zhou (2009) show that the difference between "model-free" implied and realized variances, which they term the variance risk premium, predicts an important fraction of the variation in post-1990 aggregate stock market returns with high (low) values of the premium associated with subsequent high (low) returns. They show that the magnitude of the predictability is particularly strong at the intermediate three months return horizon, in which it dominates that afforded by other popular predictor variables, such as the P/E ratio, the default spread, and the consumption–wealth ratio. It seems that the predictability of the variance risk premium is the strongest at a short horizon but the predictability of variables such as P/E ratio, the default spread, and the consumption–wealth ratio is strongest at the medium and long horizons. The variance risk premium has been interpreted as an indicator of the representative agent's risk aversion. Recent papers rely on the non-standard recursive utility framework of Epstein and Zin (1991) and Weil (1989) to show that the variance risk premium is due to the macroeconomic uncertainty risk.

I utilize stock's characteristics such as the firms market capitalization, book-to-market ratio, or lagged return to study the predictability of market returns. In a simple representative agent economy with recursive preferences, I allow the portfolio weights to be a function of the asset's characteristics, as in Brandt et al. (2009), and show that the market return can be predicted by the variance of the Fama and French factors: size (SMB), book-to-market factor (HML); the variance of the momentum factor (MOM), as well as the correlation between these factors. Asset's characteristics, such as the firms market capitalization, book-to-market ratio, or lagged return, are related to the stocks expected return. Fama and French (1996) find that these three characteristics robustly describe the cross-section of expected returns.

I use S&P500 returns to compute the holding period returns from January 1990 to December 2008, and look first at the predictability of the aforementioned variables. The degree of predictability offered by the HML variance starts out fairly high at the monthly horizon with an R^2 of 4.94%. The robust t-statistic for testing the estimated slope coefficient associated with the HML variance is -2.78. The three-month return regression results in a much more impressive t-statistic of -3.59 with a corresponding adjusted R^2 of 9.69%. The R^2 remains high and ranges from 9% to 13% from six-month to two-year horizon. The t-statistic also remains highly significant and ranges from -5.02 to -3.52 for all horizons. Also noteworthy is that the monthly HML variance series is less correlated with the variance risk premium. The correlation of the monthly HML variance series with the variance risk premium is 0.07 for the 1990-2007 period, and -0.18 for the 1990-2008 period. The degree of predictability offered by the HML variance dominates that afforded by the variance risk premium. With the variance risk premium, the adjusted R^2 starts out at the monthly horizon with an R^2 of 3.24% . The robust t-statistic for testing the estimated slope coefficient associated with the variance risk premium is 4.47. The three-month return regression also results in an impressive t-statistic of 3.30 with a corresponding R^2 of 6.02%, but the numerical values and significance gradually taper off for longer return horizons.

The degree of predictability offered by the MOM variance starts out fairly high at the monthly horizon with an R^2 of 3.61% . The quarterly return regression results in a much more impressive R^2 of 11.40%. The R^2 remains high at six-month horizon (14.84%) and ranges from 14% to 15% from nine-month horizon to eighteen-month horizon, then decreases to 11.18% at the two-year horizon. The t-statistic also remains highly significant and ranges from -4.51 to -3.25 for all horizons. Although the degree of predictability of the MOM variance series exceeds the degree of predictability offered by the variance risk premium, it is important to point out that the MOM variance series is less correlated with the variance risk premium. The correlation of the monthly MOM variance series with the variance risk premium is -0.07 for the 1990-2007 period, and -0.14 for the 1990-2008 period. Also noteworthy is that, at monthly and quarterly horizons, the degree of predictability offered by the HML or MOM variance dominates that afforded by other popular predictor variables, such as the P/D ratio, P/E ratio, the default spread, and the consumption−wealth ratio (CAY). Surprisingly, taken alone, the monthly SMB variance series cannot predict the S&P 500 at all horizons. The degree of predictability offered by the SMB variance is low at 1.6% at the one-month horizon and 2.12% at the two-year horizon.

The correlation series between the market and the HML factor is less correlated with the variance risk premium series (-0.34). The degree of predictability afforded by this correlation measure is similar but slightly higher than that afforded by the variance risk premium at all horizons, except one-month horizon. The adjusted R^2 is 5.09% at the three-month horizon, then peaks around the six-month horizon at 10.65%, and the nine-month horizon at 10.12%, then gradually tapers off at longer return horizons. The degree of predictability afforded by the correlation between the market and the SMB factor starts high at 6.12% at nine-month horizon, then gradually increases for longer return horizons. The degree of predictability afforded by the correlation between the HML and the SMB factors starts fairly high at 4.42% at the six-month horizon, then gradually increases for longer return horizons. The other correlation measures have a negligible impact on the S&P 500 returns.

Second, I look at the predictability afforded by a combination of these variables. I show that the combination of the HML and MOM variance series, as well as the aforementioned correlation measures predicts an important fraction of the variation in post-1990 aggregate stock market returns. The magnitude of the predictability is particularly strong and dominates that afforded by other popular predictor variables. The degree of predictability offered by this combination starts at 8.85% at the monthly horizon, then increases to 20.96% at the three-month horizon, reaches 24.79% at the semi-annual return horizon, and 29.19% at the nine-month horizon. Combining the variance risk premium with the HML and MOM variance series as well as the monthly correlation series results in even greater return predictability and joint significance of the predictor variables. The adjusted R^2 starts at 10.07% at the one-month horizon, then increases to 22.51% at three-month horizon, reaches 26% at semi-annual return horizon, and peaks at 29.45% at the nine-month return horizon. Combining the aforementioned predictor variables, the variance premium, and some of standard predictor variables results in an impressive adjusted R^2.

My model may be seen as an extension of the variance risk premium model pioneered by Bollerslev et al. (2009) who emphasized the importance of variance risk premium for predicting the S&P 500 returns over short horizons. In contrast to Bollerslev et al. (2009), I allow the portfolio weights to depend on stock characteristics. This allows me to generate a testable model to investigate the degree of predictability afforded by the HML and MOM variances, and aforementioned correlation measures.

The plan for the rest of the paper is as follows. Section II outlines the theoretical model and corresponding predictability regressions that motivate my empirical investigations. Section III discusses the data that I use in empirically quantifying the predictor variables. Section IV presents my main empirical findings and robustness checks. Section V concludes.

II. Volatility Risk and Predictability of Returns

I consider an economy with a representative agent who is equipped with Epstein–Zin–Weil recursive preferences. The representative household maximizes recursive utility over consumption following Kreps and Porteus (1978), Epstein and Zin (1989), and Weil (1989):

$$U_t = \left\{ (1-\beta)\, C_t^{\rho} + \beta \left(E_t \left[U_{t+1}^{\alpha} \right] \right)^{\rho/\alpha} \right\}^{\frac{1}{\rho}} \tag{1}$$

where C_t denotes consumption and $\beta \in (0,1)$. Here, $\rho < 1$ captures time preference (the Elasticity of Intertemporal Substitution (EIS) is $1/(1-\rho)$). The EIS measures the agents willingness to postpone consumption overtime, a notion well-defined even under certainty. the $\alpha < 1$ captures risk aversion (the coefficient of relative risk aversion is $1-\alpha$). Relative risk aversion measures the agents aversion to atemporal risk across states. The innovation relative to additive utility is that ρ and α need not be equal. I refer to these preferences, as Kreps and Porteus do, to distinguish them from other preferences described by Epstein and Zin. We know from Epstein and Zin that the Euler equation for any return R_{it+1} can be stated as

$$E_t\left[M_{t+1}R_{i,t+1}\right] = 1,$$

with

$$M_{t+1} = \beta^{\gamma}\left(\frac{C_{t+1}}{C_t}\right)^{(\rho-1)\gamma} R_{p,t+1}^{\gamma-1}. \tag{2}$$

where $R_{p,t+1}$ is the gross return on the optimal portfolio. The logarithm of the pricing kernel (2) may be expressed as

$$m_{t+1} = \gamma \log\beta + (\rho-1)\gamma g_{t+1} + (\gamma-1) r_{p,t+1},$$

where

$$r_{pt+1} = \omega_t^{\intercal} r_{t+1}$$

is the representative agent's optimal portfolio return, r_{t+1} represents the vector of return on the risky assets, $\omega_t = \{\omega_{it}\}_{i=1,\ldots N}$ represents the optimal portfolio weight in this economy, and g_{t+1} is the log consumption growth rate. I closely follow Brandt et al. (2009) and parameterize the optimal portfolio weights as a function of the stock's characteristics x_{it};

$$\omega_{it} = f\left(x_{it};\phi\right). \tag{3}$$

I use the following simple linear specification for the portfolio weight function:

$$\omega_{it} = \overline{\omega}_{it} + \frac{1}{N_t}\phi^{\intercal}\widehat{x}_{it}, \tag{4}$$

where $\overline{\omega}_{it}$ is the weight of stock i at date t in a benchmark portfolio, such as the value-weighted market portfolio; ϕ is a vector of coefficients; and $\widehat{x}_{it}$ are the characteristics of stock i , standardized cross-sectionally to have zero mean and unit standard deviation across all stocks at date t. As shown in Brandt et al. (2009), the linear policy (4) conveniently nests the long–short portfolio constructions of Fama and French (1993) or their extension in Carhart (1997). To understand how this is the case, assume that the portfolio policy in equation (3) is parameterized in a linear manner as in (4). Let the benchmark weights be the market capitalization weights and the characteristics are defined as 1 if the stock is in a top quantile; -1 if it is in the bottom quantile; and 0 for intermediate quantiles of market capitalization (me), book to market ratio (btm), and the past return (mom). Then, the optimal portfolio return is

$$r_{pt+1} = r_{Mt+1} + \phi_{me} r_{SMBt+1} + \phi_{btm} r_{HMLt+1} + \phi_{mom} r_{MOMt+1} \tag{5}$$

with

$$r_{Mt+1} = \sum_{i=1}^{N_t} \overline{\omega}_{it} r_{it+1}, \tag{6}$$

and

$$r_{SMBt+1} = \sum_{i=1}^{N_t} \left(\frac{1}{Q_t} me_{i,t} \right) r_{it+1}, \tag{7}$$

$$r_{HMLt+1} = \sum_{i=1}^{N_t} \left(\frac{1}{Q_t} btm_{i,t} \right) r_{it+1}, \tag{8}$$

$$r_{MOMt+1} = \sum_{i=1}^{N_t} \left(\frac{1}{Q_t} mom_{i,t} \right) r_{it+1}, \tag{9}$$

where r_{SMBt+1}, r_{HMLt+1}, and r_{MOMt+1} are the returns of "small-minus-big"(SMB), "high-minus-low," (HML) and "winners-minus-losers"(MOM) portfolios, and Q_t is the number of firms in the quantile. The phi coefficients are the weights put on each of the factor portfolios. The expected excess return on the optimal portfolio is

$$E_t r_{pt+1} - r_f = -cov_t \left(m_{t+1}, r_{pt+1} \right) \tag{10}$$

which can be expressed as

$$E_t \left[r_{Mt+1} \right] - r_f = (1-\rho) \gamma \Lambda_t^{(1)} - \Lambda_t^{(2)} + (1-\gamma) \sigma_{pt}^2, \tag{11}$$

with

$$\Lambda_t^{(1)} = cov_t \left(g_{t+1}, r_{pt+1} \right) \quad \text{and} \quad \Lambda_t^{(2)} = \phi_{me} E_t r_{SMBt+1} + \phi_{btm} E_t r_{HMLt+1} + \phi_{mom} E_t r_{MOMt+1},$$

where σ_{pt}^2 is the variance of the optimal portfolio return. The premium is composed of three separate terms. The first term $\Lambda_t^{(1)}$ represents the return tradeoff relationship that includes Cahart's (1997) four factors. The second term $\Lambda_t^{(2)}$ represents the expected return on the Fama-French and momentum factors. The last term σ_{pt}^2 represents the volatility of the optimal portfolio return. The impact of this term on the optimal portfolio expected excess return depends on the assumption that $\gamma = 1$. When $\phi_{me} = \phi_{btm} = \phi_{mom} = 0$, Bollerslev et al. (2009) show that, under reasonable assumption of the consumption growth process, the expected excess return on the market return is a function of the variance risk premium. In my model the coefficients ϕ_{me}, ϕ_{btm} and ϕ_{mom} are not equal to zero[1]. The volatility term σ_{pt}^2 can be expressed as the sum of volatilities and correlation factors. I investigate whether these volatilities and correlation factors predict the market return. A convenient way to study this predictability is to consider the following simple regression ($h = 1$) and longer multi-period regression ($h > 1$) of the form

$$\begin{aligned}\frac{1}{h}\sum_{j=1}^{h} r_{Mt+j} &= a_0(h) + a_1(h)\,\sigma_{Mt}^2 + a_2(h)\,\sigma_{SMBt}^2 + a_3(h)\,\sigma_{HMLt}^2 + a_4(h)\,\sigma_{MOMt}^2 \\ &\quad + a_5(h)\,\rho_{M,SMB}(t) + a_6(h)\,\rho_{M,HML}(t) + a_7(h)\,\rho_{M,MOM}(t) \\ &\quad + a_8(h)\,\rho_{SMB,HML}(t) + a_9(h)\,\rho_{SMB,MOM}(t) + a_{10}(h)\,\rho_{HML,MOM}(t) \\ &\quad + u_{t+h}\end{aligned} \tag{12}$$

where σ_{Mt}^2, σ_{SMBt}^2, σ_{HMLt}^2, and σ_{MOMt}^2 represent the volatility of the market, size, book-to-market, and momentum factors, respectively. The $\rho_{M,SMB}(t)$, $\rho_{M,HML}(t)$, and $\rho_{M,MOM}(t)$ represent the correlation of the market with the size, the book-to-market, and momentum factors, respectively. The $\rho_{SMB,HML}(t)$ is the correlation of the size with the book-to-market factor. The $\rho_{SMB,MOM}(t)$ and $\rho_{HML,MOM}(t)$ represent the correlation of the momentum factor with Fama and French factors respectively. Because Bollerslev et al. (2009) show that the predictability afforded by the difference between the volatility under the risk neutral measure σ_{Mt}^{2*} and the realized volatility measure σ_{Mt}^2, namely variance risk premium ($\sigma_{Mt}^{2*} - \sigma_{Mt}^2$), is stronger than the predictability offered by the realized volatility. So I consider the following regression

$$\begin{aligned}\frac{1}{h}\sum_{j=1}^{h} r_{Mt+j} &= a_0(h) + a_1(h)\left[\sigma_{Mt}^{2*} - \sigma_{Mt}^2\right] \\ &\quad + a_2(h)\,\sigma_{SMBt}^2 + a_3(h)\,\sigma_{HMLt}^2 + a_4(h)\,\sigma_{MOMt}^2 \\ &\quad + a_5(h)\,\rho_{M,SMB}(t) + a_6(h)\,\rho_{M,HML}(t) + a_7(h)\,\rho_{M,MOM}(t) \\ &\quad + a_8(h)\,\rho_{SMB,HML}(t) + a_9(h)\,\rho_{SMB,MOM}(t) + a_{10}(h)\,\rho_{HML,MOM}(t) \\ &\quad + u_{t+h},\end{aligned} \tag{13}$$

in the rest of the paper, and investigate the predictability of the market return. When $a_k(h) = 0$ for $k \geq 2$, equation (13) reduces to the Bollerslev et al. (2009) return predictability framework.

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[1] In an expected utility framework, Brandt et al. (2009) estimated these parameters and found that they are statistically significant at the conventional level.

III. Data Description

My empirical analysis is based on the aggregate S&P 500 composite index as my proxy for the aggregate market portfolio. For comparison purposes, I extend the same sample period in Bollerslev et al. (2009) to December 2008. Their data spans the period from January 1990 to December 2007. My limited post-1990 sample prevents me from effectively studying issues having to do with longer return horizons. I use the realized variance and the VIX index to compute the variance risk premiums. The VIX index is based on the S&P500 Index, the core index for U.S. equities, and estimates expected volatility by averaging the weighted prices of SPX puts and calls over a wide range of strike prices. I obtain the VIX from the Chicago Board of Options Exchange (CBOE). The intraday data for the S&P 500 composite index is used to compute the so-called "model-free" realized variance[2].

In addition to the variance risk premium, I consider the volatility of the Fama and French and momentum factors. I also consider the correlation among these factors. I use daily returns to compute these measures. The daily Fama-French returns and momentum returns are obtained from Kenneth French's website. I also consider some traditional predictor variables. Specifically, I obtain monthly log(P/E) ratios and the price–dividend ratio log(P/D) for the S&P 500 directly from Robert Shiller's website[3]. Data on the three-month T-bill, the default spread (between Moody's BAA and AAA corporate bond spreads), and the term spread (between the ten-year T-bond and the three-month T-bill yields) are taken from the public Web site of the Federal Reserve Bank of St. Louis. The CAY as defined in Lettau and Ludvigson (2001) is downloaded from their website.

Figure 1 plots the monthly time series of the S&P 500 realized variance, and the variance of SMB, HML, and MOM factors. To compare the S&P500 realized variance to the variance of SMB, HML and MOM factors, I scale the monthly variance of SMB, HML and MOM factors by the number of observations each month. They are moderately high during the 1990 and 2001 recessions, and much higher around the 1997-1998 Asia-Russia-LTCM crisis and the 2002-2003 corporate accounting scandals. There is a huge spike of the variances during October 2008. Both variance series show similar patterns, except that the increase in the S&P 500 realized volatility

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[2] Thanks to Tim Bollerslev and Hao Zhou for making the monthly series of realized volatility available on Hao Zhou's website. As shown in Bollerslev and Zhou (2009) and Zhou (2009), the realized variance measure is based on the summation of the 78 within day five-minute squared S&P 500 returns which covers the normal trading hours from 9:30am to 4:00pm plus the close-to-open overnight returns. Assuming that the average day for in a month is 22, this leads to a total of $n = 22 \times 78 = 1,716$ "five-minute" returns (See Anderson et al. (2001), Andersen et al. (2000), Barndoff-Nielsen et al. (2002), Bollerslev et al. (2009), and Zhou (2009) for an extensive discussion about the theory behind the realized variance).

[3] Thanks to Robert Shiller for making the monthly P/D and P/E ratios available.

during October 2008 already surpasses the increase in the SMB, HML, and MOM variances. Figure 2 shows the monthly series of the S&P500 variance risk premium with similar patterns. Although these variances exhibit similar patterns, it is important to point out that they are less correlated. Tables I and II present the correlation among these variances for the 1990-2007 and 1990-2008 sample periods. As shown in Table I, the correlation between the variance risk premium and the realized variance is 0.21. The correlation between the SMB, HML, and MOM variances and the variance risk premium is 0.01, 0.07, and -0.07 respectively. When I extend the sample period from December 2007 to December 2008, the correlations among these measures are slightly higher (-0.42,-0.18, and -0.14 respectively) due to the huge spike in October 2008, but remain small in magnitude.

The mean level of the variance risk premium is 18.30 with a standard deviation of 15.13. When I extend the sample from December 2007 to December 2008, the mean level of the variance risk premium is around 17.07 with a standard deviation of 19.99. The numbers are percentage-squared, not annualized. As shown in Table II, the mean level of the SMB, HML, and MOM variances is 6.4, 6.6, and 12.93 with a standard deviation of 8, 10, and 25 respectively. Also noteworthy is that, if the 2000-2007 sample period is used, the monthly time series of variance risk premium has a skewness of 2.14, but the SMB, HML, and MOM monthly variance series has high positive skewness (5.88, 3.19, and 4.81 respectively). When, I extend the sample from December 2007 to December 2008, the variance risk premia has a negative skewness of -3.3. The SMB, HML, and MOM monthly variance series has high positive skewness (5.88, 3.17, and 4.26 respectively). The negative skewness is entirely driven by the one observation of a negative spike in October 2008. As shown in Table II, the variance risk premium and the SMB variance have the highest kurtosis (46.41 and 45.37 respectively), while the kurtosis of the HML monthly variance series is 13.76, and the kurtosis of the MOM monthly variance series is 23.92.

Figure 3 plots the monthly time series of the correlation among the S&P 500, SMB, HML, and MOM returns. I use daily returns to compute the correlation every month. These correlations are highly negative during the 1990 and 2001 recessions, around the 1997-1998 Asia-Russia-LTCM crisis, and during the 2008 recession period. As shown in Tables I and II, these correlation measures are less correlated among themselves, less correlated with the variance risk premium series, and less correlated with other variance measures plotted in Figure 1. The mean level of monthly correlation series ranges from -0.44 (with a standard deviation 0.48) to 0.16 (with a standard deviation of 0.53).

IV. Forecasting Stock Market Returns

My forecasts are based on simple linear and multivariate regressions of the S&P 500 excess returns on different sets of lagged predictor variables as shown in equation (13). I use monthly observations to compute the holding period returns. All of the reported t-statistics are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West (1987)). I focus my analysis on the estimated slope coefficients, their statistical significance as determined by their t-statistics, and the forecast accuracy of the regressions as measured by the adjusted R^2s. The R^2s for the overlapping multi-period return regressions need to be interpreted with great caution[4].

A. Variance Series

In this section, I look at the degree of predictability offered by each of the predictor variables. Taken alone, the degree of predictability of the HML and MOM variance series exceeds that afforded by the variance risk premium at short, medium, and long horizons. First, I look at the degree of predictability offered by the variance risk premium. I use (13) and focus on the regression of S&P500 returns on the predictor variance risk premium,

$$\frac{1}{h}\sum_{j=1}^{h} r_{Mt+j} = a_0\left(h\right) + a_1\left(h\right)\left[\sigma_{Mt}^{2*} - \sigma_{Mt}^{2}\right] + u_{t+h}, \tag{14}$$

where $\frac{1}{h}\sum\limits_{j=1}^{h} r_{Mt+j}$ is the horizon-scaled market excess return and the horizon h goes out to two years. I use one-month returns to compute the holding period returns. In Table III, Panel A shows that the degree of predictability, offered by the variance risk premium starts out fairly high at the one-month horizon with an adjusted R^2 of 3.24%. The robust t-statistic for testing the estimated slope coefficient, associated with the variance risk premium is impressive (4.47). The quarterly return regression also results in a much more impressive t-statistic of 3.30 with a corresponding R^2 of 6.02%. The t-statistic remains significant at the six-month horizon, but the numerical values and significance then gradually taper off for longer return horizons. Taken as a whole, the results in Panel A reveal a clear pattern in the degree of predictability afforded by the variance risk premium with the largest t-statistic occurring at the one-month horizon. Figure 4 plots the adjusted R^2 and the slope coefficients for all horizons. The estimated slope coefficient is positive, and peaks at

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[4] As shown in Kirby (1997) and Boudoukh, Richardson, and Whitelaw (2008), in the absence of any increase in the true predictability, the values of the R^2s with highly persistent predictor variables and overlapping returns will by construction increase in rough proportional to the return horizon and the length of the overlap. At horizons of one year or longer, the t-statistics based on heteroskedasticity and serial correlation consistent standard errors should explicitly take into account of the overlap in the regressions Hodrick (1992).

the one-month horizon. The sign of the slope suggests that higher (lower) values of the variance premium are associated with higher (lower) future returns. The adjusted R^2's peaks around three-month horizon, and declines toward zero. Next, I focus on the regression of S&P500 returns on the predictor SMB variance,

$$\frac{1}{h}\sum_{j=1}^{h} r_{Mt+j} = a_0\left(h\right) + a_1\left(h\right)\sigma^2_{SMBt} + u_{t+h} \tag{15}$$

In Table III, the bottom row of Panel B shows that the degree of predictability, starts out fairly low at the one-month horizon with an R^2 of 1.59%, and remains extremely low at two-years horizon (2.12%). I then focus on the regression of S&P500 returns on the predictor HML variance,

$$\frac{1}{h}\sum_{j=1}^{h} r_{Mt+j} = a_0\left(h\right) + a_1\left(h\right)\sigma^2_{HMLt} + u_{t+h}. \tag{16}$$

Panel C of Table III shows that the degree of predictability, starts out fairly high at the monthly horizon with an R^2 of 4.94%. The robust t-statistic for testing the estimated slope coefficient associated with the HML variance risk is -2.78. The quarterly return regression results in a much more impressive t-statistic of -3.59 with a corresponding R^2 of 9.69%. The R^2 remains high and ranges from 9% to 13% from six-month to two-year horizon. The t-statistic also remains highly significant and ranges from -5.02 to -3.52 for all horizons. Taken as a whole, the results in Table V reveal a clear and stable pattern in the degree of predictability afforded by the HML variance with the largest t-statistic occurring at the nine-month horizon. Figure 5 plots the adjusted R^2 and the slope coefficients for all horizons ranging from one month to two years. The estimated slope coefficient is low at one-month horizon, then gradually increases and remains stable after 20 one-month horizons. In contrast to the variance risk premium, the negative slope suggests that lower (higher) values of the HML variance are associated with higher (lower) future returns. The estimated R^2 peaks around the three-month horizon, and then increases gradually for the remaining horizons, reaching the maximum at twenty one-month horizon. It is insightful to notice that the degree of predictability offered by the HML variance is much more higher than that afforded by the variance risk premium at any horizon. Also noteworthy is that the correlation between the HML variance and the variance risk premium is 0.07 when I use the sample period 1990-2007 (see Table I). When I extend the sample period from December 2007 to December 2008, the correlation is -0.18 (see Table II). Now, I consider the regression of S&P500 returns on the predictor MOM variance,

$$\frac{1}{h}\sum_{j=1}^{h} r_{Mt+j} = a_0\left(h\right) + a_1\left(h\right)\sigma^2_{MOMt} + u_{t+h}. \tag{17}$$

Panel D of Table III shows that the degree of predictability, begins fairly high at the monthly horizon with an R^2 of 3.61%. The robust t-statistic for testing the estimated slope coefficient associated with the MOM variance risk is -3.66. The quarterly return regression results in a much more impressive t-statistic of -3.25 and a corresponding R^2 of 11.40%. The R^2 remains high at six-month horizon (14.84%) and ranges from 14% to 15% from nine-month horizon to an eighteen-month horizon, then decreases to 11.18% at the two-year horizon. The t-statistic also remains highly significant and ranges from -4.51 to -3.25 for all horizons. Taken as a whole, the results in Table VI reveal a clear pattern in the degree of predictability afforded by the MOM variance with the smallest R^2 occurring at one-month horizon (3.61%) and the highest R^2 occurring at nine-month horizon (15.34%). Figure 6 plots the adjusted R^2 and the slope coefficients for all horizons in the range of one month to two years. The estimated slope coefficient is low at the one-month horizon, then gradually increases and remains stable after the one-year horizon. Similarly to the HML variance, the negative slope suggests that lower (higher) values of the MOM variance are associated with higher (lower) future returns. This observation indicates that the degree of predictability offered by the MOM variance is much higher than the degree of predictability of the variance risk premium at any horizon. Also noteworthy is that the correlation between MOM variance and the variance risk premium is -0.07 when I use the sample period 1990-2007 (see Table I). When I extend the sample period from December 2007 to December 2008, the correlation is 0.14 (see Table II).

B. Correlation Series

I look at the degree of predictability offered by each of the correlation series. Taken alone, it appears that the degree of predictability offered by the correlation measures $\rho_{M,SMB}(t)$, $\rho_{SMB,HML}(t)$, and $\rho_{M,MOM}(t)$ exceeds that afforded by the variance risk premium at, medium and long horizons. I focus on the regression of S&P500 returns on the correlation between the market return and the SMB factor,

$$\frac{1}{h}\sum_{j=1}^{h} r_{Mt+j} = a_0\left(h\right) + a_1\left(h\right)\rho_{M,SMB}(t) + u_{t+h}. \tag{18}$$

Panel A of Table IV shows that the degree of predictability, starts out extremely low with an adjusted R^2 of -0.31% at the one-month horizon, 6.12% at the nine-month horizon, and starts to increase gradually until it reaches the maximum of 12.32% at two-year horizon. Figure 7 plots the adjusted R^2 and the slope coefficients for all of the monthly horizons in the range of one month to two years. The estimated slope coefficient is high at one month horizon, then gradually decreases when the horizon increases. I thereafter focus the regression of S&P500 returns on the correlation between the market return and the HML factor,

$$\frac{1}{h}\sum_{j=1}^{h} r_{Mt+j} = a_0\left(h\right) + a_1\left(h\right)\rho_{M,HML}(t) + u_{t+h}. \tag{19}$$

Surprisingly, Panel B of Table IV shows that the degree of predictability, offered by $\rho_{M,HML}(t)$, is similar to the degree of predictability afforded by the variance risk premium. The degree of predictability offered by $\rho_{M,HML}(t)$ starts out fairly low at the monthly horizon with an R^2 of 1.55%, then peaks around the three-month horizon with an R^2 of 6.02%, and then declines toward zero. The robust t-statistic for testing the estimated slope coefficient associated with $\rho_{M,HML}(t)$ is -1.79 at six-month horizon. Figure 8 plots the adjusted R^2 and the slope coefficients for all of the monthly horizons in the range of one month to two years. The estimated slope coefficient is low at one-month horizon, then gradually increases when the horizon increases. Also noteworthy is that the correlation between $\rho_{M,HML}(t)$ and the variance risk premium is -0.32. Next, I analyze the regression of S&P500 returns on the correlation between the market return and the MOM factor,

$$\frac{1}{h}\sum_{j=1}^{h} r_{Mt+j} = a_0\left(h\right) + a_1\left(h\right)\rho_{M,MOM}(t) + u_{t+h}. \tag{20}$$

Panel C of Table IV shows that the degree of predictability, is roughly similar to the degree of predictability afforded by the variance risk premium. The degree of predictability offered by $\rho_{M,MOM}(t)$ starts out fairly low at the monthly horizon with an R^2 of 1.42%, increases around three-months horizon with an R^2 of 5.09% , then peaks around six-month horizon with an R^2 of 10.65%, and declines toward zero. The robust t-statistic for testing the estimated slope coefficient associated with $\rho_{M,MOM}(t)$ is 2.19 at six-month horizon. Figure 9 plots the adjusted R^2 and the slope coefficients for horizons ranging from one month to two years. The estimated slope coefficient is high at one-month horizon, and gradually decreases when the horizon increases. Next, I focus on the regression of S&P500 returns on the correlation of the SMB with the HML factor,

$$\frac{1}{h}\sum_{j=1}^{h} r_{Mt+j} = a_0\left(h\right) + a_1\left(h\right)\rho_{SMB,HML}(t) + u_{t+h}. \tag{21}$$

Panel D of Table IV shows that the degree of predictability, starts out fairly low at the monthly horizon with an R^2 of 1.10%, increases around the six-month horizon with an R^2 of 4.42%, then reaches 7% at the nine-month horizon and remains stable for other horizons. The highest t-statistic (3.01) is obtained at nine-month horizon. Figure 10 plots the adjusted R^2 and the slope coefficients for horizons in the range of one month to two years. The estimated slope coefficient is fairly low at one month horizon, peaks at six-month, and gradually remains stable when the horizon increases. Panels E and F in Table IV show that, taken alone, the correlation series $\rho_{SMB,MOM}(t)$ and $\rho_{HML,MOM}(t)$ cannot predict the market return. The adjusted R^2 is less than 1% at all horizons.

C. Combining the predictor variables

I first focus on the regression of S&P500 returns on the variances and correlation measures as shown in equation (13), excluding the variance risk premium ($a_1(h) = 0$). I also exclude the variables associated with the coefficients $a_8(h)$, $a_9(h)$, and $a_{10}(h)$, due to their poor performance in predicting the market returns. I, thereafter, look at the improvement of the degree of predictability by including the variance risk premium.

C.1. Regressions without variance risk premium

Table V shows that the degree of predictability, offered by the variances and correlation measures starts out fairly high at the monthly horizon with an R^2 of 8.85%, which is higher than the variance risk premium. Although the robust t-statistic for testing the estimated slope coefficient associated with the HML variance and the correlation $\rho_{M,HML}$ are -1.96, and -2.19, respectively, the slopes of the remaining variables are not significant. The three-month return regression results in an impressive R^2 of 20.96%. The t-statistic for testing the estimated slope coefficient associated with the HML variance and the correlation $\rho_{M,HML}$ are impressive (-2.82 and -3.56 respectively). The adjusted R^2 increases to 24.79% at the six- month horizon, 29.19% at the nine-month horizon, then starts to decrease and reaches 27.16% at two-year horizon.

C.2. Regressions with variance risk premium

I first investigate the predictability of the market return by combining each of the predictor variables with the variance risk premium. Panels A and B in Table VI show the estimated coefficients and adjusted R-squared. As shown in Panel A, combining the momentum variance with the variance risk premium results in an adjusted R-squared of 6.8% at the one-month horizon, 16.19% at the three-month horizon, and 18.17% at the six month horizon. Panel B presents similar results when the HML variance is used. The t-statistics associated to the MOM and HML variances are impressive at all horizons. The t-statistics of the coefficients associated to the MOM variance ranges from

-4.45 to -2.66. The t-statistics of the coefficients associated to the HML variance ranges from -4.32 to -2.68. I, thereafter, focus on the regression (13) and exclude the variables that correspond to variables associated to the coefficients $a_8(h)$, $a_9(h)$, and $a_{10}(h)$. Table VII shows that the degree of predictability that is offered by the combination of the variance risk premium, HML, and MOM variances, and the correlation measures starts out fairly high at the monthly horizon with an R^2 of 10.07%. The robust t-statistic for testing the estimated slope coefficient that is associated with the variance risk premium is 1.89. The t-statistic associated with the HML variance is -1.82. The slopes of the remaining variables are not significant. The quarterly return regression results in an impressive R^2 of 22.51%. The t-statistics for testing the estimated slope coefficient that is associated with the HML variance and the correlation $\rho_{M,HML}$ are above two (-2.08, and -2.42 respectively). The adjusted R^2 increases to 26% at six-month horizon, 29.45% at nine-month horizon, then starts to decrease and reaches 27.18% at twenty-four month horizon. The estimated slope coefficient associated with the variance risk premium is significant at one-month and becomes insignificant when the horizon is greater than one month.

D. Comparison with standard predictor variables

To appreciate these findings in a wider empirical context, Table XIII reports the results from comparable holding period returns, involving the more traditional predictor variables. Not surprisingly, the degree of predictability of traditional predictor variables, at the monthly horizon is systematically very low. The individual regressions for both the $log(P/E)$ ratio and the CAY ratio do result in t-statistics slightly above two. The quarterly regressions show that the degree of predictability offered by the $log(P/E)$ ratio, the $log(P/D)$ ratio and the CAY ratio is -0.06%, 1.02% and 3.63% respectively. The degree of predictability afforded by the different valuation ratios and predictor variables included in Table XII tends to be the strongest over longer holding period horizons. Figures 11-12 show the adjusted R^2 from the univariate regression of the S&P 500 returns on the CAY ratio, the variance risk premium, the SMB, HML, and MOM variances; as well as the correlation measures defined in equation (13).

Tables IX-XIII report the results from comparable holding period horizons, which use the predictor variables analyzed in the previous section. Taken alone, the regression of one-month returns on the CAY ratio produces an adjusted R-squared of 0.92%. Combining the variance risk premium with the CAY ratio results in an adjusted R-squared of 4.63% at one-month horizon. At the same return horizon, combining the HML variance with the CAY ratio results in an adjusted

R-squared of 6.10%. Adding the MOM variance to the CAY ratio results in an adjusted R-squared of 4.72% at one-month horizon. The degree of predictability at the monthly horizon is 8.30% when the variance risk premium, the HML variance, the MOM variance, and the CAY ratio are used. The R-squared increases to 18.29% at the three-month horizon, and 22% at the six month horizon. Adding the $log(P/E)$ ratio, the $log(P/D)$ ratio, the default spread (DFSP), and the term spread (TMSP) to the multiple regression marginally increases the (adjusted) R-squared [5]. But only the variance risk premium, HML variance, and the CAY ratio remain statistically significant.

Finally, I combine the correlation measure $rho_{M,MOM}$ with the variance risk premium, and the CAY ratio. Table XIV presents the results. The Adjusted R-squared is 6.69% at the one-month horizon, 15.63% at the three-month horizon and 23.19% at six month horizon.

My results indicate that, the standard predictor variables, the variance risk premium, the HML, and MOM variances, and the correlation $rho_{M,MOM}$ might jointly capture important short- and long-run risks embedded in the market returns.

V. Conclusion

I provide empirical evidence that the S&P500 returns are also predictable by the variance of the size, book-to-market and momentum factors. I also show that S&P500 returns are predictable by the monthly correlation series between these factors. My results appear remarkably robust across different specifications and/or the inclusion of alternative predictor variables. The degree of predictability measured by the adjusted R^2 is large at three-month, six-month, and one-year horizons. My empirical model is derived from a simple representative agent economy with recursive preferences, in which I allow the portfolio weights to be a function of the stock's characteristics as in Brandt et al. (2009). It would be interesting to investigate whether these new variables significantly predict bond returns, forward premiums, and credit spreads. Future works should further clarify the economic mechanisms behind the predictability afforded by the variances of Fama-French book-to-market factor, the momentum factor, and the correlation measures.

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[5] These results are available on request.

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Table I: Summary statistics.
The sample period extends from January 1990 to December 2007. All variables are reported in annualized percentage form whenever appropriate. $\sigma_M^{2*} - \sigma_M^2$ denotes the variance risk premium. RVt refers to the modelfree realized variance constructed from high-frequency five-minute returns. The predictor variables include the priceearning ratio $log(Pt/Et)$, the pricedividend ratio $log(Pt/Dt)$, the default spread DFSPt defined as the difference between Moodys BAA and AAA bond yield indices and the term spread TMSPt defined as the difference between the ten-year and three-month Treasury yields. Monthly observations on the consumptionwealth ratio CAYt are defined by the most recently available quarterly observations. Due to space limitation I denote $\rho_1 = \rho_{M,SMB}$, $\rho_2 = \rho_{M,HML}$, $\rho_3 = \rho_{M,MOM}$, $\rho_4 = \rho_{SMB,HML}$, $\rho_5 = \rho_{SMB,MOM}$, and $\rho_6 = \rho_{HML,MOM}$.

	$\sigma_M^{2*} - \sigma_M^2$	σ_M^2	σ_{SMB}^2	σ_{HML}^2	σ_{MOM}^2	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	$log(Pt/Et)$	$log(Pt/Dt)$	$CAYt$	$DFSPt$	$TMSPt$
Summary statistics																
Mean	18.30	18.77	5.71	5.78	9.79	-0.15	-0.48	0.20	-0.09	0.04	-0.07	3.25	3.94	0.40	0.84	1.69
Std.dev	15.13	20.74	6.35	8.75	17.88	0.48	0.34	0.51	0.33	0.38	0.53	0.26	0.33	2.03	0.20	1.19
Skewness	2.14	2.52	5.88	3.19	4.81	0.40	0.96	-0.71	0.09	0.18	0.09	0.27	-0.24	-0.07	0.90	0.09
Kurtosis	12.06	10.21	46.85	13.74	31.45	1.99	3.35	2.43	2.43	2.43	1.81	2.45	1.95	1.59	3.28	1.79
AR(1)	0.49	0.70	0.58	0.72	0.62	0.77	0.56	0.79	0.50	0.63	0.75	0.98	0.97	0.95	0.97	0.98
Correlation matrix																
$\sigma_M^{2*} - \sigma_M^2$	1.00	0.21	0.01	0.07	-0.07	-0.30	-0.34	-0.15	0.28	-0.30	-0.09	0.14	0.10	0.14	0.10	-0.08
σ_M^2		1.00	0.64	0.66	0.68	-0.02	-0.27	-0.25	0.04	-0.01	0.02	0.34	0.39	-0.21	0.27	-0.17
σ_{SMB}^2			1.00	0.55	0.65	0.08	-0.23	0.00	-0.14	0.15	-0.14	0.37	0.34	-0.21	0.04	-0.17
σ_{HML}^2				1.00	0.74	0.10	-0.44	-0.09	-0.23	-0.01	-0.07	0.51	0.47	-0.17	-0.03	-0.30
σ_{MOM}^2					1.00	0.12	-0.23	-0.27	-0.15	0.14	0.13	0.34	0.39	-0.21	0.15	-0.12
ρ_1						1.00	0.31	0.14	-0.54	0.46	0.23	0.16	0.33	-0.67	0.08	-0.14
ρ_2							1.00	0.15	-0.01	0.35	0.23	-0.28	-0.16	-0.26	0.08	0.20
ρ_3								1.00	0.03	0.13	-0.61	0.14	-0.04	-0.06	-0.50	-0.19
ρ_4									1.00	-0.21	-0.03	-0.12	-0.15	0.23	0.06	0.15
ρ_5										1.00	0.05	-0.12	0.01	-0.28	0.16	0.22
ρ_6											1.00	-0.11	0.11	-0.25	0.28	0.20
$log(Pt/Et)$												1.00	0.94	-0.28	0.28	0.25
$log(Pt/Dt)$													1.00	-0.75	-0.03	-0.38
$CAYt$														1.00	-0.16	0.36
$DFSPt$															1.00	0.21
$TMSPt$																1.00

Table II: Summary statistics.
The sample period extends from January 1990 to December 2008. All variables are reported in annualized percentage form whenever appropriate. $\sigma^{2*}_M - \sigma^2_M$ denotes the variance risk premium. σ^2_M refers to the modelfree realized variance constructed from high-frequency five-minute returns. The predictor variables include the priceearning ratio $log(Pt/Et)$, the pricedividend ratio $log(Pt/Dt)$, the default spread DFSPt defined as the difference between Moodys BAA and AAA bond yield indices and the term spread TMSPt defined as the difference between the ten-year and three-month Treasury yields. Monthly observations on the consumptionwealth ratio CAYt are defined by the most recently available quarterly observations. Due to space limitation I denote $\rho_1 = \rho_{M,SMB}$, $\rho_2 = \rho_{M,HML}$, $\rho_3 = \rho_{M,MOM}$, $\rho_4 = \rho_{SMB,HML}$, $\rho_5 = \rho_{SMB,MOM}$, and $\rho_6 = \rho_{HML,MOM}$.

	$\sigma^{2*}_M - \sigma^2_M$	σ^2_M	σ^2_{SMB}	σ^2_{HML}	σ^2_{MOM}	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	$log(Pt/Et)$	$log(Pt/Dt)$	$CAYt$	$DFSPt$	$TMSPt$
Summary statistics																
Mean	17.07	24.83	6.36	6.66	12.93	-0.15	-0.44	0.16	-0.10	0.03	-0.09	3.24	3.93	0.36	0.89	1.72
Std.dev	19.99	49.69	8.55	10.77	25.20	0.48	0.38	0.53	0.33	0.38	0.53	0.26	0.33	1.99	0.34	1.17
Skewness	-3.32	7.09	5.88	3.17	4.26	0.37	1.13	-0.57	0.12	0.20	0.10	0.29	-0.18	-0.04	3.71	0.04
Kurtosis	46.41	65.07	45.37	13.76	23.92	2.02	3.98	2.10	2.39	2.45	1.82	2.52	1.97	1.63	24.13	1.81
AR(1)	0.29	0.76	0.59	0.68	0.59	0.75	0.64	0.82	0.46	0.62	0.75	0.99	0.99	0.97	1.10	0.97
Correlation matrix																
$\sigma^{2*}_M - \sigma^2_M$	1.00	-0.42	-0.42	-0.18	-0.14	-0.20	-0.32	-0.01	0.17	-0.22	0.01	0.18	0.13	0.10	-0.22	-0.12
σ^2_M		1.00	0.79	0.63	0.58	-0.04	0.18	-0.30	0.03	0.02	-0.14	-0.06	0.02	-0.06	0.68	0.06
σ^2_{SMB}			1.00	0.64	0.55	0.02	0.04	-0.13	-0.08	0.12	-0.20	0.14	0.15	-0.13	0.39	-0.04
σ^2_{HML}				1.00	0.75	0.06	-0.05	-0.21	-0.16	0.00	-0.18	0.28	0.28	-0.13	0.31	-0.16
σ^2_{MOM}					1.00	0.09	0.18	-0.38	-0.07	0.06	-0.07	0.09	0.17	-0.17	0.52	0.01
ρ_1						1.00	0.27	0.12	-0.51	0.43	0.22	0.15	0.32	-0.67	0.07	-0.14
ρ_2							1.00	-0.04	0.01	0.26	0.07	-0.34	-0.20	-0.25	0.38	0.23
ρ_3								1.00	0.03	0.14	-0.48	0.20	0.01	-0.04	-0.52	-0.22
ρ_4									1.00	-0.22	-0.06	-0.11	0.02	0.21	0.06	0.14
ρ_5										1.00	0.06	-0.06	0.14	-0.26	0.06	0.22
ρ_6											1.00	-0.06	0.14	-0.23	0.02	0.17
$log(Pt/Et)$												1.00	0.56	-0.27	0.31	0.25
$log(Pt/Dt)$													1.00	-0.74	-0.12	-0.39
$CAYt$														1.00	-0.10	0.35
$DFSPt$															1.00	0.23
$TMSPt$																1.00

Table III: Variance series regressions.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

Panel A

Monthly return horizon	1	3	6	9	12	15	18	21	24
Constant	-5.72	-4.12	-1.89	-0.64	-0.14	-0.11	0.21	0.34	0.36
t-stat	-1.66	-1.30	-0.70	-0.27	-0.06	-0.05	0.09	0.16	0.17
$\sigma_M^{2*} - \sigma_M^2$	0.48	0.38	0.24	0.17	0.15	0.14	0.11	0.10	0.09
t-stat	4.47	3.30	2.74	2.37	2.33	2.25	2.18	2.12	2.05
Adj. R^2(%)	3.24	6.02	4.53	3.02	2.48	2.48	1.76	1.40	1.31

Panel B

Monthly return horizon	1	3	6	9	12	15	18	21	24
Constant	7.70	4.58	3.56	3.95	4.24	3.92	4.06	3.78	3.67
t-stat	2.30	1.55	1.20	1.37	1.51	1.46	1.54	1.47	1.47
σ_{SMB}^2	-0.83	-0.35	-0.21	-0.26	-0.30	-0.26	-0.30	-0.27	-0.27
t-stat	-1.76	-1.28	-1.39	-2.17	-2.23	-2.08	-1.94	-2.11	-2.16
Adj. R^2(%)	1.59	0.55	0.23	0.99	1.70	1.43	2.33	2.00	2.12

Panel C

Monthly return horizon	1	3	6	9	12	15	18	21	24
Constant	9.55	8.22	6.35	6.19	5.70	5.58	5.52	5.43	5.18
t-stat	2.94	3.00	2.28	2.24	2.12	2.15	2.19	2.20	2.15
σ_{HML}^2	-1.08	-0.89	-0.62	-0.59	-0.50	-0.50	-0.51	-0.51	-0.49
t-stat	-2.78	-3.59	-4.89	-5.02	-4.53	-4.29	-3.78	-3.57	-3.52
Adj. R^2(%)	4.94	9.69	9.08	11.18	9.48	10.53	12.12	13.26	12.92

Panel D

Monthly return horizon	1	3	6	9	12	15	18	21	24
Constant	7.56	7.61	6.55	6.06	5.70	5.41	5.26	4.79	4.46
t-stat	2.47	2.75	2.53	2.50	2.42	2.33	2.30	2.09	1.96
σ_{MOM}^2	-0.41	-0.42	-0.34	-0.30	-0.26	-0.25	-0.25	-0.22	-0.20
t-stat	-3.66	-3.25	-4.12	-4.37	-4.51	-4.19	-3.86	-3.73	-3.68
Adj. R^2(%)	3.61	11.40	14.84	15.34	14.01	13.96	15.13	12.64	11.18

Table IV: Correlation series regressions.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

Panel A

Monthly return horizon	1	3	6	9	12	15	18	21	24
Constant	1.89	1.35	1.37	0.84	0.95	0.76	0.67	0.53	0.40
t-stat	0.57	0.41	0.46	0.29	0.35	0.29	0.27	0.22	0.17
$\rho_{M,SMB}$	-3.84	-6.98	-5.93	-9.96	-9.63	-10.26	-10.14	-10.42	-10.71
t-stat	-0.65	-1.41	-1.41	-2.49	-2.60	-2.84	-2.93	-3.02	-3.06
Adj. R^2(%)	-0.31	0.80	1.26	6.12	6.69	8.61	9.40	10.78	12.32

Panel B

Monthly return horizon	1	3	6	9	12	15	18	21	24
Constant	-5.94	-6.67	-3.73	-2.38	-2.37	-1.69	-1.38	-1.09	-0.44
t-stat	-0.84	-1.05	-0.78	-0.59	-0.64	-0.46	-0.39	-0.32	-0.14
$\rho_{M,HML}$	-18.73	-20.19	-13.33	-10.46	-10.59	-8.85	-7.92	-7.03	-5.39
t-stat	-1.42	-1.79	-1.65	-1.56	-1.78	-1.45	-1.31	-1.20	-0.99
Adj. R^2(%)	1.55	6.01	4.91	4.05	4.91	3.74	3.28	2.73	1.56

Panel C

Monthly return horizon	1	3	6	9	12	15	18	21	24
Constant	0.38	0.24	0.05	0.48	0.86	0.90	1.00	1.18	1.31
t-stat	0.09	0.06	0.02	0.15	0.29	0.33	0.39	0.49	0.58
$\rho_{M,MOM}$	12.85	13.27	13.62	11.38	9.40	8.53	7.25	5.50	4.17
t-stat	1.57	1.86	2.19	2.03	1.87	1.84	1.74	1.44	1.18
Adj. R^2(%)	1.42	5.09	10.65	10.12	7.94	7.27	5.75	3.41	1.94

Panel D

Monthly return horizon	1	3	6	9	12	15	18	21	24
Constant	4.27	3.65	3.65	3.82	3.72	3.60	3.45	3.27	3.11
t-stat	1.25	1.13	1.29	1.53	1.55	1.55	1.57	1.56	1.55
$\rho_{SMB,HML}$	18.55	12.99	14.31	15.43	13.73	13.57	13.08	12.35	11.52
t-stat	2.01	1.96	2.45	3.01	2.89	3.07	3.05	2.85	2.50
Adj. R^2(%)	1.10	1.66	4.42	7.27	6.66	7.32	7.58	7.27	6.79

Panel E

Monthly return horizon	1	3	6	9	12	15	18	21	24
Constant	2.79	2.47	2.43	2.43	2.45	2.32	2.22	2.11	2.06
t-stat	0.80	0.74	0.80	0.86	0.90	0.89	0.89	0.88	0.89
$\rho_{SMB,MOM}$	-9.37	-2.32	-5.14	-3.39	-2.12	-1.27	-1.61	-1.18	-2.16
t-stat	-1.11	-0.32	-0.90	-0.62	-0.39	-0.24	-0.33	-0.26	-0.49
Adj. R^2(%)	0.06	-0.36	0.36	0.03	-0.23	-0.36	-0.29	-0.35	-0.12

Panel F

Monthly return horizon	1	3	6	9	12	15	18	21	24
Constant	2.48	2.40	1.98	2.19	2.32	2.14	2.03	1.98	1.97
t-stat	0.72	0.76	0.67	0.79	0.90	0.87	0.85	0.86	0.89
$\rho_{HML,MOM}$	0.26	0.26	-3.19	-1.46	-0.68	-1.60	-1.64	-1.06	-0.12
t-stat	0.03	0.04	-0.68	-0.35	-0.16	-0.38	-0.41	-0.28	-0.03
Adj. R^2(%)	-0.44	-0.44	0.17	-0.27	-0.40	-0.17	-0.12	-0.30	-0.44

Table V: Multivariate regressions without variance risk premium.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

	Const.	σ^2_{HML}	σ^2_{MOM}	$\rho_{M,SMB}$	$\rho_{M,HML}$	$\rho_{M,MOM}$
1 Month						
Coeff	-2.62	-1.29	0.14	0.28	-22.83	9.90
t-stat	-0.50	-1.96	0.49	0.05	-2.19	1.31
Adj. R^2(%)	8.85					
3 Month						
Coeff	-3.18	-0.78	-0.04	-3.20	-20.29	9.75
t-stat	-0.82	-2.82	-0.24	-0.74	-3.56	1.72
Adj. R^2(%)	20.96					
6 Months						
Coeff	-1.47	-0.34	-0.12	-4.28	-11.31	10.68
t-stat	-0.41	-1.34	-0.98	-1.38	-3.02	2.24
Adj. R^2(%)	24.79					
9 Months						
Coeff	-0.56	-0.37	-0.07	-9.14	-7.39	9.70
t-stat	-0.17	-1.46	-0.71	-3.20	-2.24	2.25
Adj. R^2(%)	29.19					
12 Months						
Coeff	-0.60	-0.30	-0.08	-8.57	-7.52	7.85
t-stat	-0.19	-1.32	-0.90	-3.12	-2.19	2.02
Adj. R^2(%)	27.08					
15 Months						
Coeff	0.05	-0.32	-0.06	-9.54	-5.65	7.27
t-stat	0.01	-1.70	-0.90	-3.60	-1.39	2.16
Adj. R^2(%)	28.11					
18 Months						
Coeff	0.75	-0.32	-0.07	-9.36	-4.73	5.81
t-stat	0.23	-1.84	-1.05	-3.74	-1.11	1.99
Adj. R^2(%)	28.60					
21 Months						
Coeff	0.91	-0.43	-0.02	-9.60	-4.56	4.60
t-stat	0.29	-2.15	-0.25	-3.81	-1.08	1.80
Adj. R^2(%)	28.01					
24 Months						
Coeff	1.60	-0.42	-0.01	-10.12	-2.76	3.46
t-stat	0.55	-2.40	-0.24	-3.75	-0.73	1.47
Adj. R^2(%)	27.16					

Table VI: Combining the Variance Risk Premium with HML and MOM variances.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

	Panel A			Panel B		
	Const.	$\sigma_M^{2*} - \sigma_M^2$	σ_{MOM}^2	Const.	$\sigma_M^{2*} - \sigma_M^2$	σ_{HML}^2
			1 Month			
Coeff	-0.17	0.42	-0.36	2.05	0.39	-0.95
t-stat	-0.05	3.99	-2.94	0.51	3.04	-2.68
Adj. $R^2(\%)$	6.80			7.72		
			3 Months			
Coeff	1.76	0.32	-0.38	2.32	0.31	-0.79
t-stat	0.56	2.64	-2.66	0.57	1.81	-3.11
Adj. $R^2(\%)$	16.19			14.17		
			6 Months			
Coeff	3.07	0.19	-0.32	2.70	0.19	-0.56
t-stat	1.28	2.12	-3.63	0.86	1.54	-3.89
Adj. $R^2(\%)$	18.17			12.44		
			9 Months			
Coeff	3.74	0.13	-0.28	3.85	0.12	-0.55
t-stat	1.82	1.74	-4.13	1.35	1.18	-4.32
Adj. $R^2(\%)$	17.51			13.24		
			12 Months			
Coeff	3.75	0.11	-0.25	3.71	0.10	-0.47
t-stat	1.79	1.71	-4.45	1.38	1.19	-4.18
Adj. $R^2(\%)$	15.86			11.28		
			15 Months			
Coeff	3.57	0.10	-0.24	3.74	0.10	-0.47
t-stat	1.71	1.65	-4.31	1.42	1.11	-4.08
Adj. $R^2(\%)$	15.81			12.26		
			18 Months			
Coeff	3.87	0.07	-0.24	4.19	0.07	-0.49
t-stat	1.84	1.47	-4.09	1.63	0.90	-3.82
Adj. $R^2(\%)$	16.43			13.29		
			21 Months			
Coeff	3.57	0.07	-0.21	4.38	0.05	-0.49
t-stat	1.65	1.39	-3.95	1.71	0.76	-3.71
Adj. $R^2(\%)$	13.80			14.17		
			24 Months			
Coeff	3.29	0.06	-0.19	4.20	0.05	-0.47
t-stat	1.49	1.36	-3.90	1.66	0.74	-3.69
Adj. $R^2(\%)$	12.34			13.80		

Table VII: Multivariate regressions with variance risk premium.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

	Const.	$\sigma^{2*}_M - \sigma^2_M$	σ^2_{HML}	σ^2_{MOM}	$\rho_{M,SMB}$	$\rho_{M,HML}$	$\rho_{M,MOM}$
				1 Month			
Coeff	-5.88	0.30	-1.12	0.10	1.64	-17.46	10.08
t-stat	-1.27	1.89	-1.82	0.42	0.30	-1.52	1.38
Adj. R^2(%)	10.07						
				3 Months			
Coeff	-5.38	0.20	-0.66	-0.06	-2.29	-16.66	9.88
t-stat	-1.39	1.17	-2.08	-0.40	-0.50	-2.42	1.79
Adj. R^2(%)	22.51						
				6 Months			
Coeff	-2.87	0.13	-0.26	-0.13	-3.70	-9.00	10.76
t-stat	-0.79	1.22	-0.99	-1.14	-1.12	-2.38	2.30
Adj. R^2(%)	25.99						
				9 Months			
Coeff	-1.13	0.05	-0.34	-0.08	-8.90	-6.46	9.73
t-stat	-0.34	0.64	-1.28	-0.77	-3.00	-2.14	2.27
Adj. R^2(%)	29.45						
				12 Months			
Coeff	-0.92	0.03	-0.28	-0.08	-8.44	-6.98	7.87
t-stat	-0.29	0.50	-1.22	-0.94	-2.99	-2.16	2.03
Adj. R^2(%)	27.18						
				15 Months			
Coeff	-0.26	0.03	-0.30	-0.07	-9.41	-5.14	7.29
t-stat	-0.08	0.48	-1.57	-0.95	-3.47	-1.29	2.18
Adj. R^2(%)	28.21						
				18 Months			
Coeff	0.71	0.00	-0.32	-0.07	-9.34	-4.66	5.81
t-stat	0.22	0.07	-1.80	-1.03	-3.67	-1.10	2.00
Adj. R^2(%)	28.61						
				21 Months			
Coeff	1.07	-0.01	-0.44	-0.01	-9.67	-4.82	4.59
t-stat	0.34	-0.31	-2.21	-0.22	-3.81	-1.16	1.80
Adj. R^2(%)	28.04						
				24 Months			
Coeff	1.71	-0.01	-0.42	-0.01	-10.17	-2.95	3.45
t-stat	0.58	-0.23	-2.45	-0.21	-3.75	-0.79	1.47
Adj. R^2(%)	27.18						

Table VIII: Univariate regressions using CAYt, log(Pt/Et) and log(Pt/Dt).
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

Monthly return horizon	1	3	6	9	12	15	18	21	24
$log(Pt/Et)$									
Const	22.20	25.16	26.56	35.18	46.03	51.62	55.08	59.18	62.55
t-stat	0.51	0.67	0.81	1.24	1.81	2.19	2.50	2.79	3.06
Slope	-6.09	-7.03	-7.50	-10.14	-13.47	-15.22	-16.32	-17.62	-18.68
t-stat	-0.46	-0.61	-0.74	-1.14	-1.68	-2.04	-2.33	-2.61	-2.88
Adj. R^2(%)	-0.34	-0.06	0.38	1.62	3.79	5.61	7.30	9.30	11.36
$log(Pt/Dt)$									
Const	44.40	46.25	46.26	52.53	60.73	63.98	65.69	67.78	69.43
t-stat	1.15	1.37	1.59	2.15	2.80	3.15	3.40	3.58	3.75
Slope	-10.68	-11.17	-11.21	-12.79	-14.86	-15.71	-16.17	-16.73	-17.17
t-stat	-1.09	-1.30	-1.50	-2.01	-2.61	-2.94	-3.18	-3.37	-3.56
Adj. R^2(%)	0.05	1.05	2.42	4.64	7.54	9.54	11.32	13.16	15.00
$log(CAYt)$									
Const	1.40	1.29	1.18	1.17	1.14	0.98	0.81	0.64	0.49
t-stat	0.40	0.39	0.39	0.42	0.44	0.40	0.35	0.30	0.24
Slope	2.91	3.02	2.95	3.17	3.41	3.57	3.74	3.94	4.11
t-stat	2.27	2.55	2.87	3.36	3.54	3.70	3.91	4.25	4.61
Adj. R^2(%)	0.92	3.63	6.96	11.20	15.26	18.83	23.06	27.70	32.54

Table IX: Combining the predictors when the return horizon is one month.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. The return horizon is one month. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

	Const.	$\sigma^{2*}_M - \sigma^2_M$	σ^2_{HML}	σ^2_{MOM}	$CAYt$
1 month					
Coeff	-5.72	0.48			
t-stat	-1.66	4.47			
Adj. $R^2(\%)$	3.24				
Coeff	9.55		-1.08		
t-stat	2.94		-2.78		
Adj. $R^2(\%)$	4.94				
Coeff	7.56			-0.41	
t-stat	2.47			-3.66	
Adj. $R^2(\%)$	3.61				
Coeff	1.40				2.91
t-stat	0.40				2.27
Adj. $R^2(\%)$	0.92				
Coeff	-6.20	0.45			2.46
t-stat	-1.63	4.43			1.85
Adj. $R^2(\%)$	4.63				
Coeff	8.40		-1.02		2.18
t-stat	2.50		-2.49		1.76
Adj. $R^2(\%)$	6.10				
Coeff	6.43			-0.38	2.10
t-stat	2.09			-3.42	1.74
Adj. $R^2(\%)$	4.72				
Coeff	2.05	0.39	-0.95		
t-stat	0.51	3.04	-2.68		
Adj. $R^2(\%)$	7.72				
Coeff	1.34	0.37	-0.91		1.89
t-stat	0.34	3.23	-2.63		1.53
Adj. $R^2(\%)$	7.29				
Coeff	-0.87	0.40		-0.34	1.78
t-stat	-0.27	4.15		-3.17	1.43
Adj. $R^2(\%)$	8.28				
Coeff	1.50	0.37	-0.74	-0.10	1.80
t-stat	0.41	3.41	-1.30	-0.54	1.49
Adj. $R^2(\%)$	8.38				

Table X: Combining the predictors when the return horizon is three months.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. The returns horizon is 3 months. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

	Const.	$\sigma^{2*}_M - \sigma^2_M$	σ^2_{HML}	σ^2_{MOM}	$CAYt$
		3 months			
Coeff	-4.12	0.38			
t-stat	-1.30	3.30			
Adj. R^2(%)	6.02				
Coeff	8.22		-0.89		
t-stat	3.00		-3.59		
Adj. R^2(%)	9.69				
Coeff	7.61			-0.42	
t-stat	2.75			-3.25	
Adj. R^2(%)	11.40				
Coeff	1.29				3.02
t-stat	0.39				2.55
Adj. R^2(%)	3.63				
Coeff	-4.63	0.35			2.67
t-stat	-1.41	3.34			2.16
Adj. R^2(%)	9.58				
Coeff	6.94		-0.83		2.43
t-stat	2.54		-3.19		2.27
Adj. R^2(%)	12.67				
Coeff	6.43			-0.38	2.19
t-stat	2.31			-2.99	2.09
Adj. R^2(%)	13.86				
Coeff	2.32	0.31	-0.79		
t-stat	0.57	1.81	-3.11		
Adj. R^2(%)	14.17				
Coeff	1.49	0.29	-0.74		2.20
t-stat	0.37	1.77	-2.95		1.98
Adj. R^2(%)	16.28				
Coeff	0.99	0.30		-0.35	1.95
t-stat	0.31	2.60		-2.72	1.80
Adj. R^2(%)	17.82				
Coeff	1.92	0.29	-0.29	-0.26	1.96
t-stat	0.52	2.09	-0.82	-1.43	1.82
Adj. R^2(%)	18.29				

Table XI: Combining the predictors when the return horizon is six months.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. The returns horizon is 6 months. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

	Const.	$\sigma^{2*}_M - \sigma^2_M$	σ^2_{HML}	σ^2_{MOM}	$CAYt$
		6 months			
Coeff	-1.89	0.24			
t-stat	-0.70	2.74			
Adj. $R^2(\%)$	4.53				
Coeff	6.35		-0.62		
t-stat	2.28		-4.89		
Adj. $R^2(\%)$	9.08				
Coeff	6.55			-0.34	
t-stat	2.53			-4.12	
Adj. $R^2(\%)$	14.84				
Coeff	1.18				2.95
t-stat	0.39				2.87
Adj. $R^2(\%)$	6.96				
Coeff	-2.41	0.21			2.74
t-stat	-0.82	2.62			2.60
Adj. $R^2(\%)$	11.25				
Coeff	5.01		-0.56		2.55
t-stat	1.78		-4.10		2.71
Adj. $R^2(\%)$	14.89				
Coeff	5.32			-0.31	2.28
t-stat	2.04			-3.77	2.53
Adj. $R^2(\%)$	19.49				
Coeff	2.70	0.19	-0.56		
t-stat	0.86	1.54	-3.89		
Adj. $R^2(\%)$	12.44				
Coeff	1.80	0.17	-0.51		2.42
t-stat	0.54	1.45	-3.50		2.49
Adj. $R^2(\%)$	17.28				
Coeff	2.22	0.17		-0.29	2.15
t-stat	0.87	1.98		-3.50	2.31
Adj. $R^2(\%)$	21.93				
Coeff	2.27	0.17	-0.01	-0.29	2.15
t-stat	0.79	1.87	-0.04	-1.83	2.31
Adj. $R^2(\%)$	21.94				

Table XII: Combining the predictors when the return horizon is nine months.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. The returns horizon is 9 months. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

	Const.	$\sigma_M^{2*} - \sigma_M^2$	σ_{HML}^2	σ_{MOM}^2	$CAYt$
		9 months			
Coeff	-0.64	0.17			
t-stat	-0.27	2.37			
Adj. $R^2(\%)$	3.02				
Coeff	6.19		-0.59		
t-stat	2.24		-5.02		
Adj. $R^2(\%)$	11.18				
Coeff	6.06			-0.30	
t-stat	2.50			-4.37	
	15.34				
Coeff	1.17				3.17
t-stat	0.42				3.36
Adj. $R^2(\%)$	11.20				
Coeff	-1.22	0.14			3.03
t-stat	-0.45	1.99			3.16
Adj. $R^2(\%)$	13.93				
Coeff	4.72		-0.52		2.79
t-stat	1.69		-4.57		3.20
Adj. $R^2(\%)$	20.44				
Coeff	4.65			-0.26	2.60
t-stat	1.90			-4.19	3.12
Adj. $R^2(\%)$	23.31				
Coeff	3.85	0.12	-0.55		
t-stat	1.35	1.18	-4.32		
Adj. $R^2(\%)$	13.24				
Coeff	2.83	0.10	-0.49		2.72
t-stat	0.91	1.01	-3.78		3.05
Adj. $R^2(\%)$	21.57				
Coeff	2.74	0.11		-0.25	2.52
t-stat	1.18	1.44		-3.97	2.95
Adj. $R^2(\%)$	24.58				
Coeff	3.17	0.10	-0.13	-0.21	2.52
t-stat	1.13	1.21	-0.37	-1.40	2.98
Adj. $R^2(\%)$	24.84				

Table XIII: Combining the predictors when the return horizon is twelve months.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. The return horizon is 12 months. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

	Const.	$\sigma_M^{2*} - \sigma_M^2$	σ_{HML}^2	σ_{MOM}^2	$CAYt$
12 months					
Coeff	-0.14	0.15			
t-stat	-0.06	2.33			
Adj. $R^2(\%)$	2.48				
Coeff	5.70		-0.50		
t-stat	2.12		-4.53		
Adj. $R^2(\%)$	9.48				
Coeff	5.70			-0.26	
t-stat	2.42			-4.51	
Adj. $R^2(\%)$	14.01				
Coeff	1.14				3.41
t-stat	0.44				3.54
Adj. $R^2(\%)$	15.26				
Coeff	-0.78	0.11			3.30
t-stat	-0.30	1.92			3.39
Adj. $R^2(\%)$	17.39				
Coeff	4.07		-0.43		3.11
t-stat	1.50		-4.19		3.36
Adj. $R^2(\%)$	22.61				
Coeff	4.12			-0.22	2.93
t-stat	1.73			-4.47	3.29
Adj. $R^2(\%)$	25.57				
Coeff	3.71	0.10	-0.47		
t-stat	1.38	1.19	-4.18		
Adj. $R^2(\%)$	11.28				
Coeff	2.57	0.08	-0.40		3.04
t-stat	0.86	0.99	-3.53		3.26
Adj. $R^2(\%)$	23.43				
Coeff	2.62	0.08		-0.21	2.86
t-stat	1.10	1.35		-4.20	3.17
Adj. $R^2(\%)$	26.48				
Coeff	2.87	0.08	-0.08	-0.19	2.87
t-stat	1.04	1.19	-0.27	-1.56	3.19
Adj. $R^2(\%)$	26.59				

Table XIV: Combining the correlation series with the CAYt and variance risk premium.
The sample period extends from January 1990 to December 2008. All of the regressions are based on monthly observations. All of the reported t-statistics (t-stat) are based on heteroskedasticity and serial correlation consistent standard errors (Newey and West, 1987). All variable definitions are identical to Table II.

	Const.	$\rho_{M,MOM}$	$\sigma_M^{2*} - \sigma_M^2$	$CAYt$
		1 month		
Coeff	0.38	12.85		
t-stat	0.09	1.57		
Adj. R^2(%)	1.42			
Coeff	-5.72		0.48	
t-stat	-1.66		4.47	
Adj. R^2(%)	3.24			
Coeff	1.40			2.91
t-stat	0.40			2.27
Adj. R^2(%)	0.92			
Coeff	-0.78	13.26		3.04
t-stat	-0.20	1.67		2.41
Adj. R^2(%)	3.33			
Coeff	-8.52	13.54	0.46	2.59
t-stat	-2.16	1.87	5.04	2.02
Adj. R^2(%)	6.69			
		3 months		
Coeff	0.24	13.27		
t-stat	0.06	1.86		
Adj. R^2(%)	5.51			
Coeff	-4.12		0.38	
t-stat	-1.30		3.30	
Adj. R^2(%)	6.02			
Coeff	1.29			3.02
t-stat	0.39			2.55
Adj. R^2(%)	3.63			
Coeff	-0.96	13.70		3.15
t-stat	-0.26	2.02		2.70
Adj. R^2(%)	9.92			
Coeff	-7.02	13.91	0.36	2.79
t-stat	-2.08	2.30	2.89	2.33
Adj. R^2(%)	15.63			
		6 months		
Coeff	0.05	13.62		
t-stat	0.02	2.19		
Adj. R^2(%)	10.65			
Coeff	-1.89		0.24	
t-stat	-0.70		2.74	
Adj. R^2(%)	4.53			
Coeff	1.18			2.95
t-stat	0.39			2.87
Adj. R^2(%)	6.96			
Coeff	-1.13	14.04		3.08
t-stat	-0.34	2.41		3.06
Adj. R^2(%)	19.10			
Coeff	-4.85	14.17	0.22	2.87
t-stat	-1.57	2.62	2.22	2.81
Adj. R^2(%)	23.19			

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	Const.	$\rho_{M,MOM}$	$\sigma_M^{2*} - \sigma_M^2$	$CAYt$
9 months				
Coeff	0.48	11.38		
t-stat	0.15	2.03		
Adj. R^2(%)	10.12			
Coeff	-0.64		0.17	
t-stat	-0.27		2.37	
Adj. R^2(%)	3.02			
Coeff	1.17			3.17
t-stat	0.42			3.36
Adj. R^2(%)	11.20			
Coeff	-0.78	11.82		3.28
t-stat	-0.26	2.25		3.62
Adj. R^2(%)	22.93			
Coeff	-3.27	11.91	0.15	3.13
t-stat	-1.14	2.36	1.83	3.42
Adj. R^2(%)	25.44			
12 months				
Coeff	0.86	9.40		
t-stat	0.29	1.87		
Adj. R^2(%)	7.94			
Coeff	-0.14		0.15	
t-stat	-0.06		2.33	
Adj. R^2(%)	2.48			
Coeff	1.14			3.41
t-stat	0.44			3.54
Adj. R^2(%)	15.26			
Coeff	-0.49	9.88		3.51
t-stat	-0.17	2.10		3.79
Adj. R^2(%)	24.84			
Coeff	-2.49	9.95	0.12	3.39
t-stat	-0.91	2.18	1.77	3.64
Adj. R^2(%)	26.72			

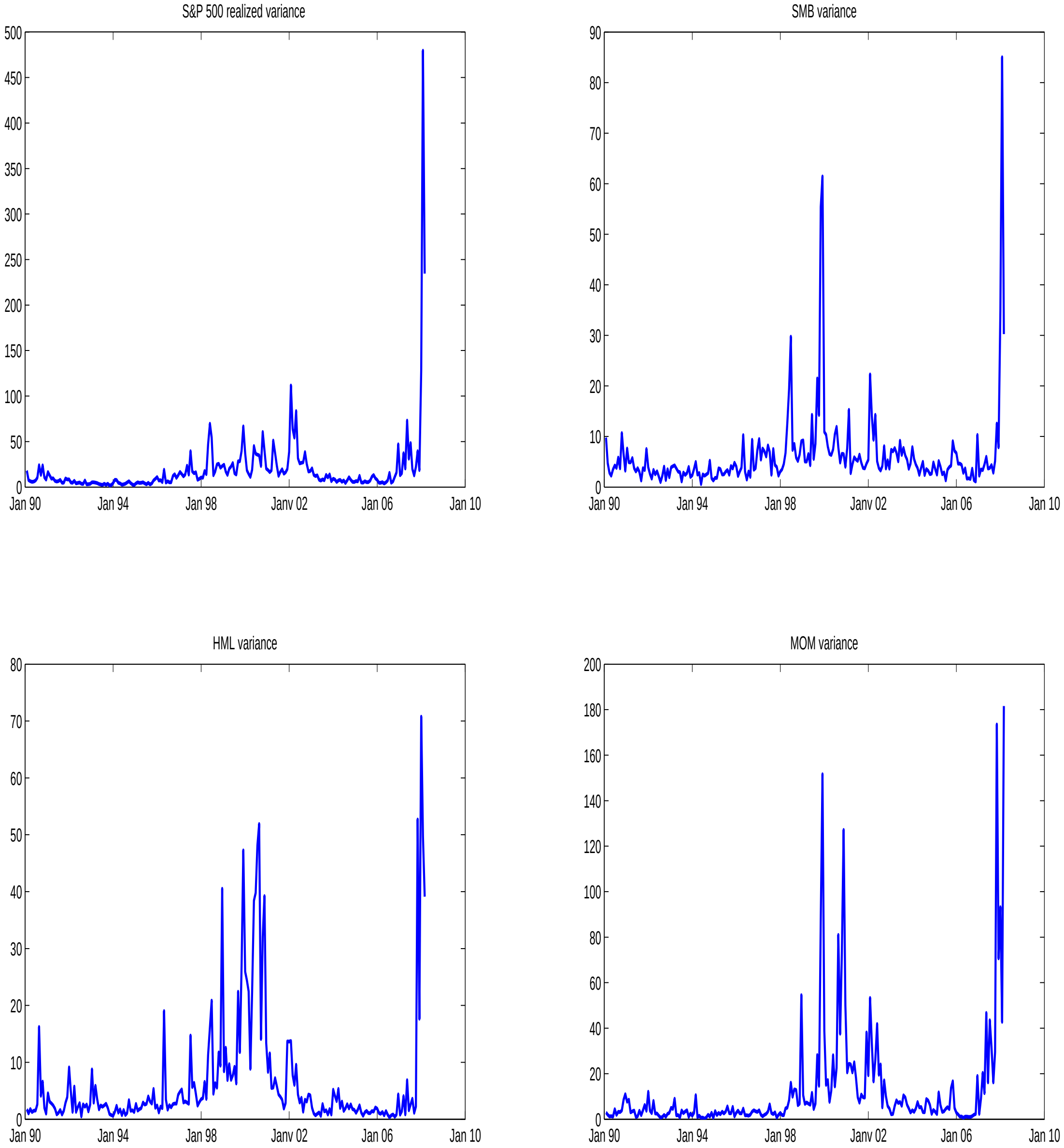

Figure 1: **Variance Series**
This figure plots the realized variance (the top left panel) for the SP 500 market index, the SMB variance (the top right panel), the HML variance ((the bottom left panel) and MOM variance (the bottom right panel). The sample period is from January 1990 to December 2008.

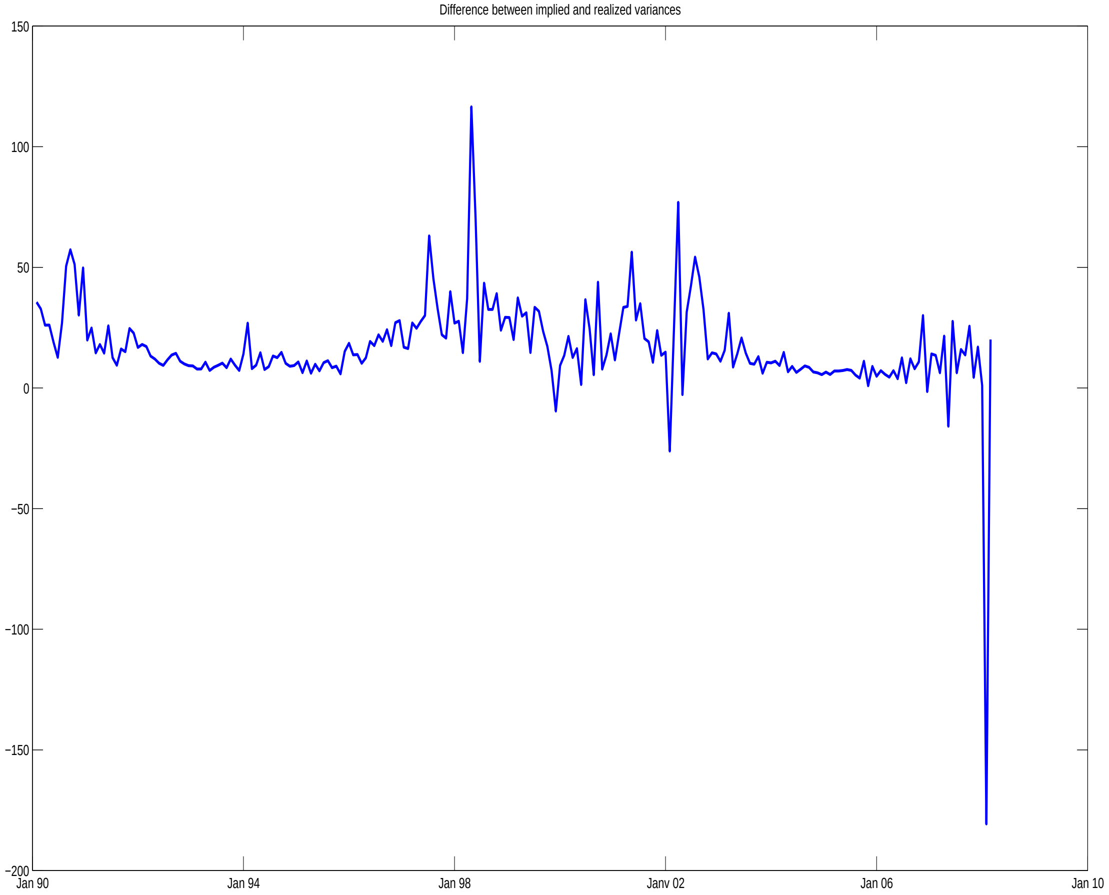

Figure 2: **Variance Risk Premium Series**
This figure plots the variance risk premium (difference between the implied variance and the realized variance). The sample period is from January 1990 to December 2008.

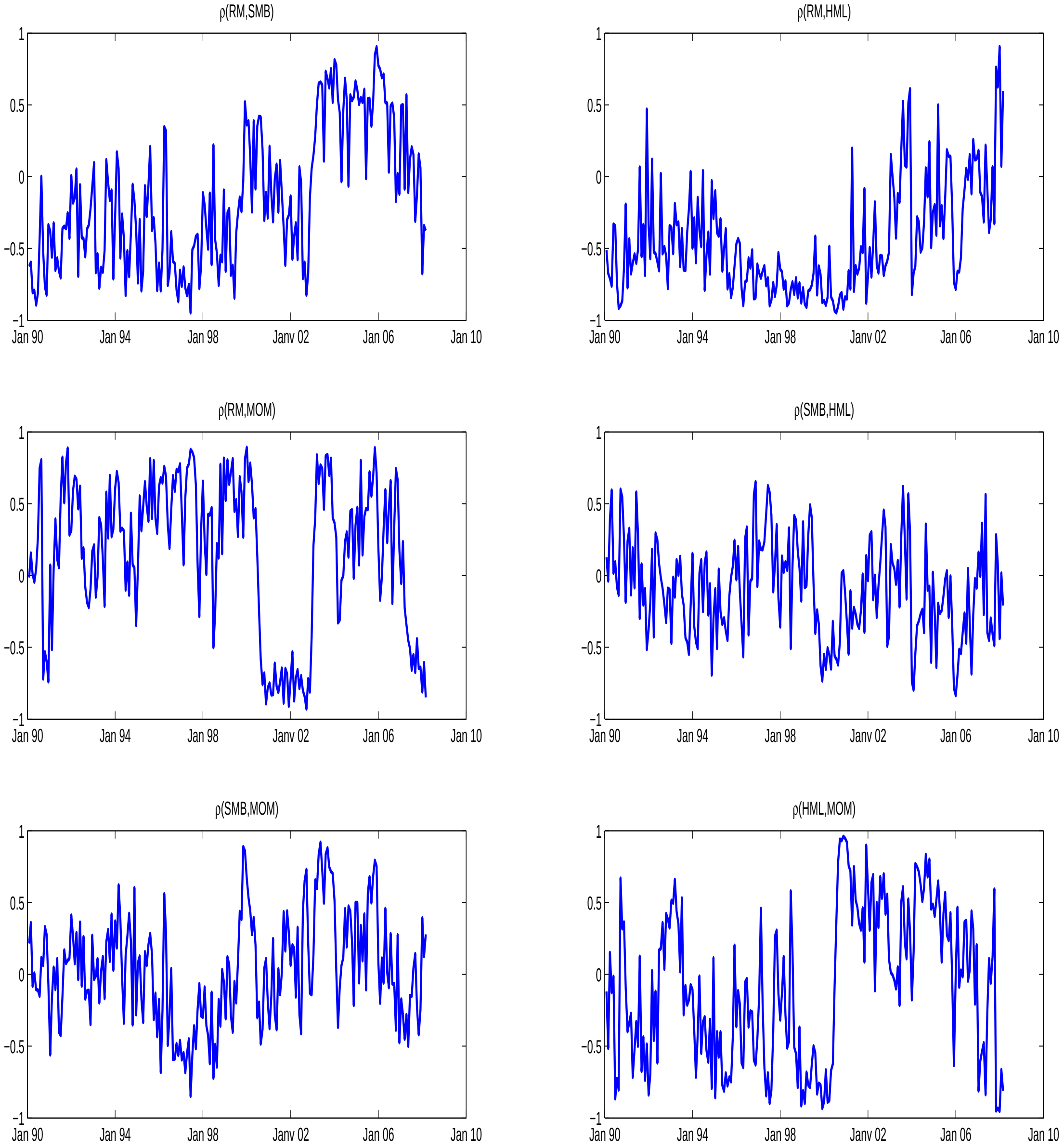

Figure 3: **Correlation Series**

This figure plots the correlations among the market, the size, the book-to-market, and momentum factor. I use daily returns to compute these correlation measures every month. The sample period is from January 1990 to December 2008.

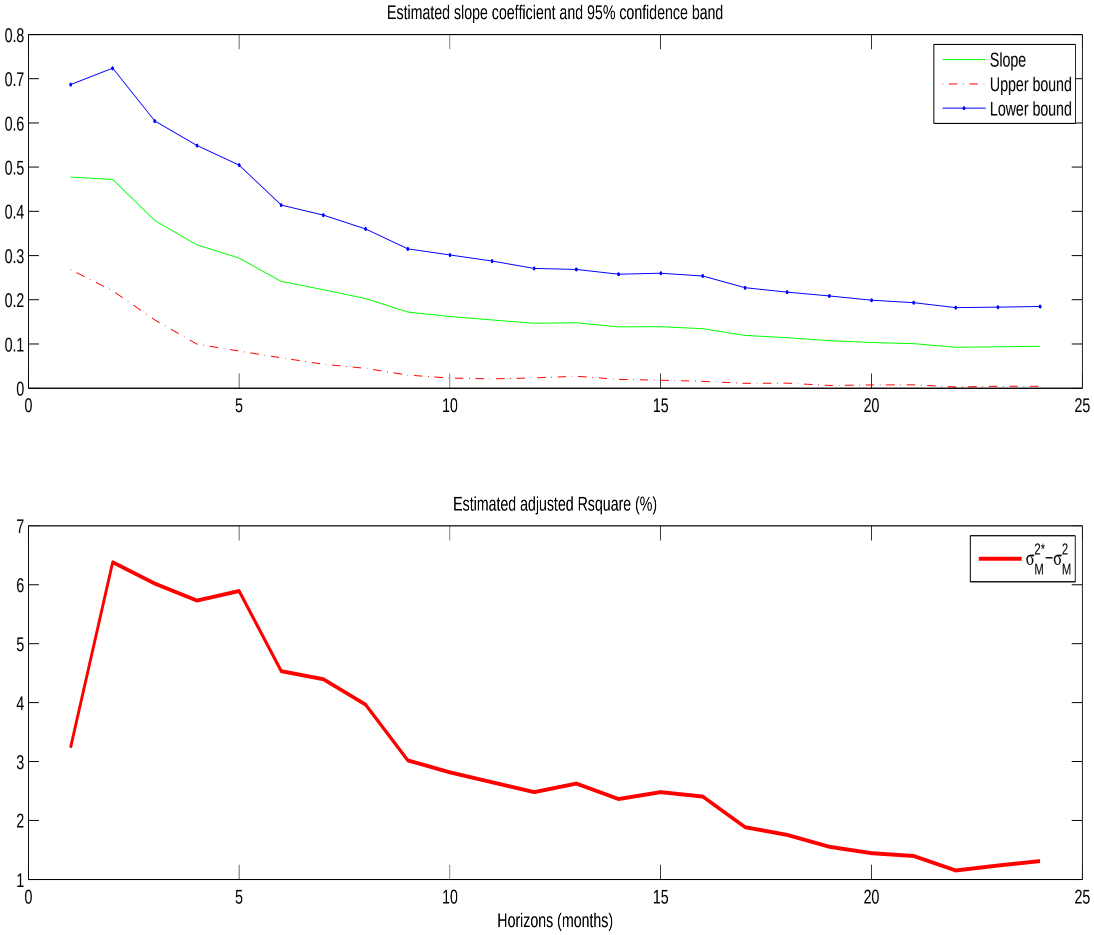

Figure 4: **Estimated Slopes and $R^2 s$**

The figure shows the estimated slope coefficients and pointwise 95% confidence intervals along with the corresponding R^2 s from the regressions of the scaled h-period S&P 500 returns on the variance difference. All of the regressions are based on monthly observations from January 1990 to December 2008.

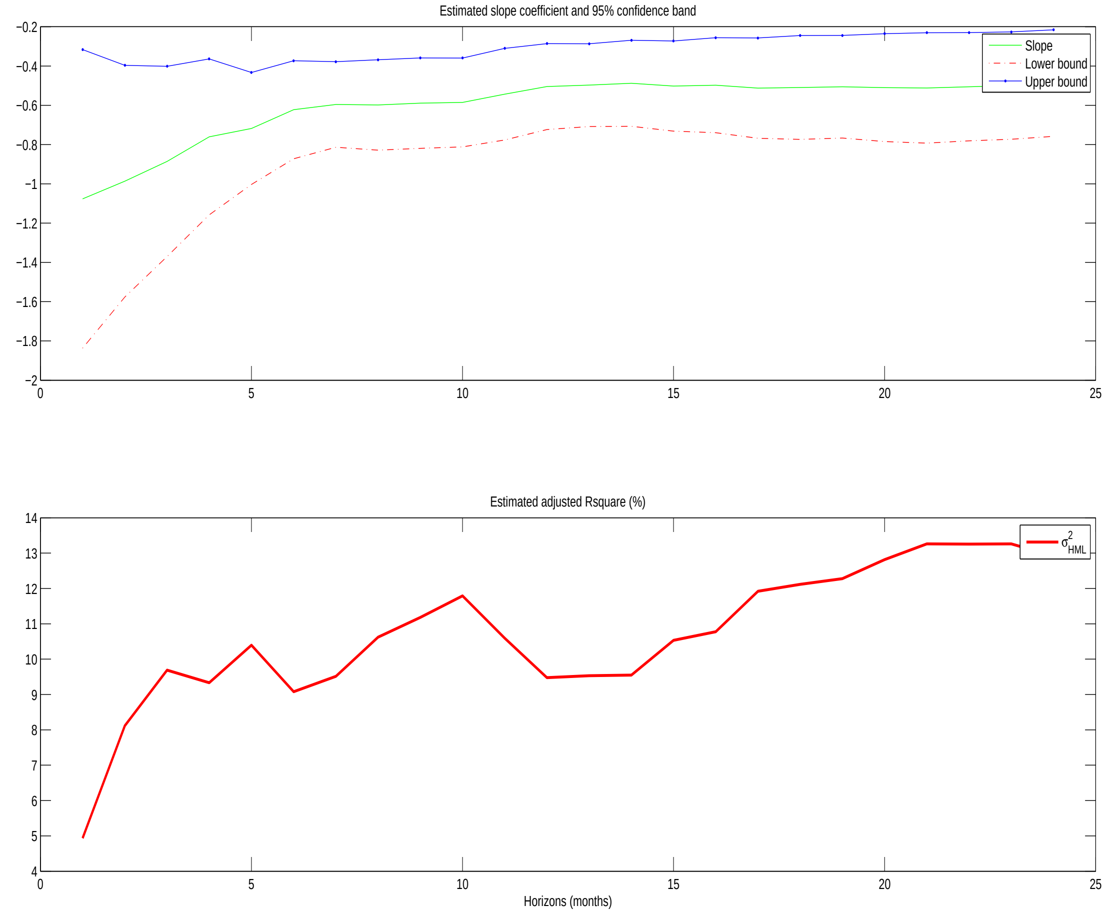

Figure 5: **Estimated Slopes and** R^2s

The figure shows the estimated slope coefficients and pointwise 95% confidence intervals along with the corresponding R^2 s from the regressions of the scaled h-period S&P 500 returns on the HML variance. All of the regressions are based on monthly observations from January 1990 to December 2008.

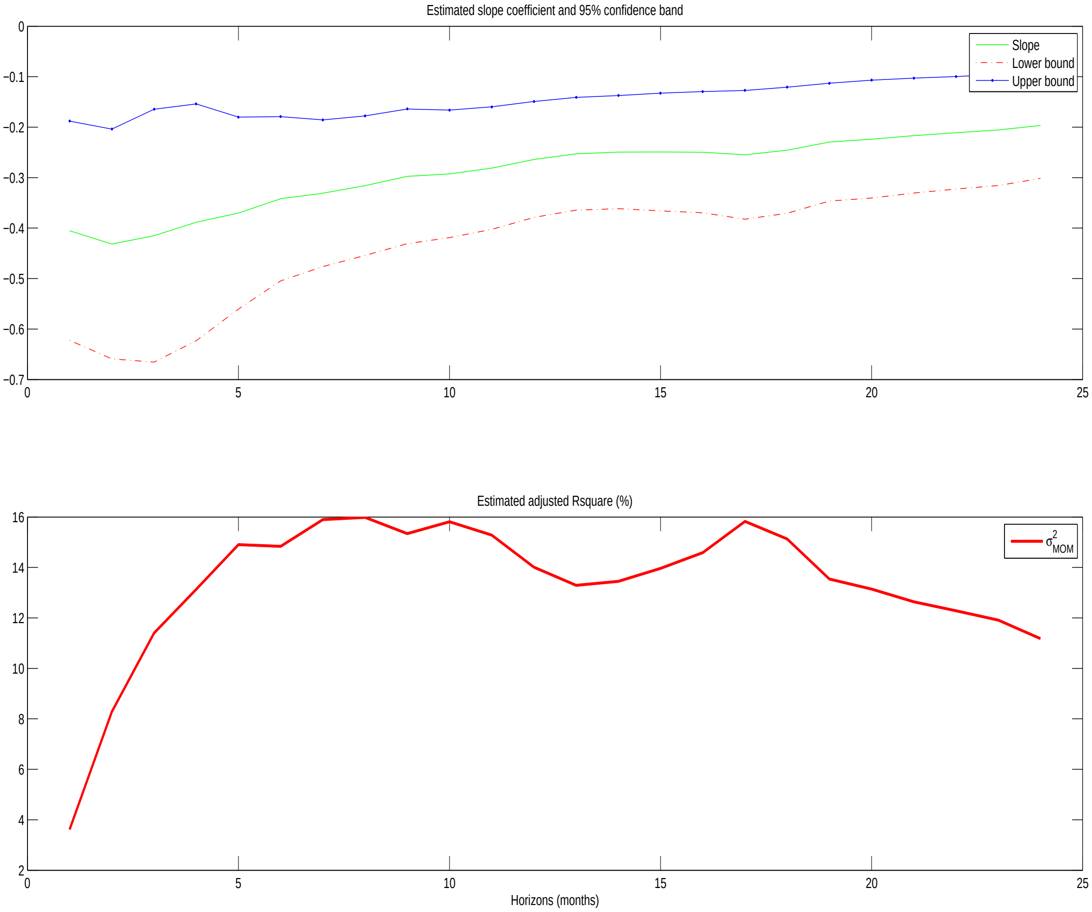

Figure 6: **Estimated Slopes and** R^2s

The figure shows the estimated slope coefficients and pointwise 95% confidence intervals along with the corresponding R^2 s from the regressions of the scaled h-period S&P 500 returns on the MOM variance. All of the regressions are based on monthly observations from January 1990 to December 2008.

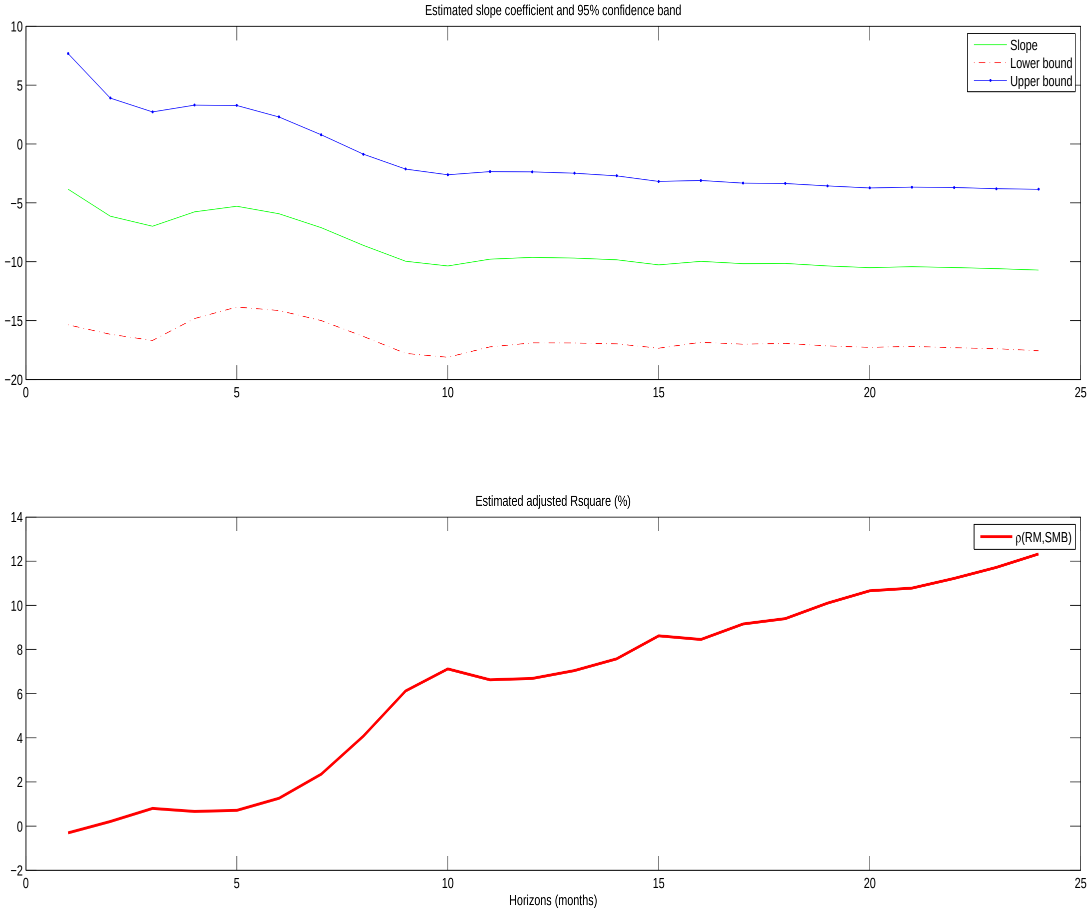

Figure 7: **Estimated Slopes and R^2s**

The figure shows the estimated slope coefficients and pointwise 95% confidence intervals along with the corresponding R^2 s from the regressions of the scaled h-period S&P 500 returns on the correlation $\rho_{M,SMB}$. All of the regressions are based on monthly observations from January 1990 to December 2008.

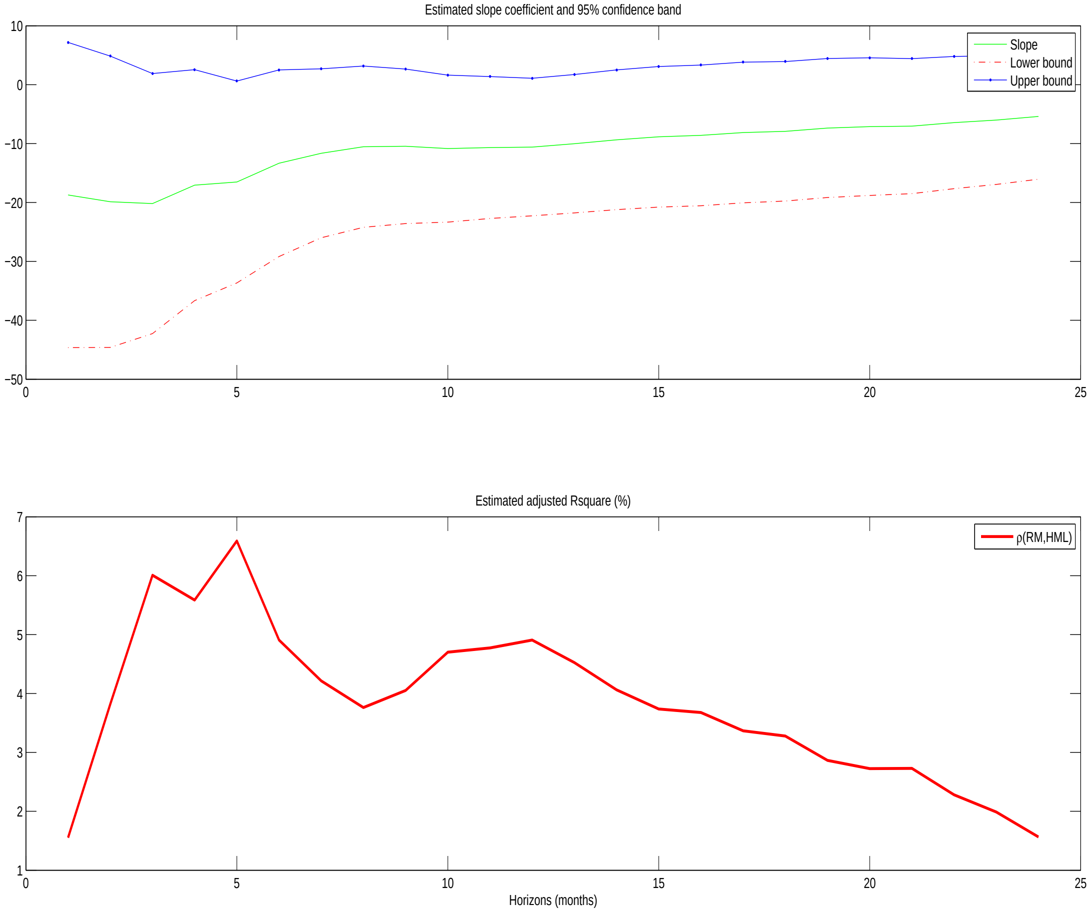

Figure 8: **Estimated Slopes and R^2s**

The figure shows the estimated slope coefficients and pointwise 95% confidence intervals along with the corresponding R^2 s from the regressions of the scaled h-period S&P 500 returns on the correlation $\rho_{M,HML}$. All of the regressions are based on monthly observations from January 1990 to December 2008.

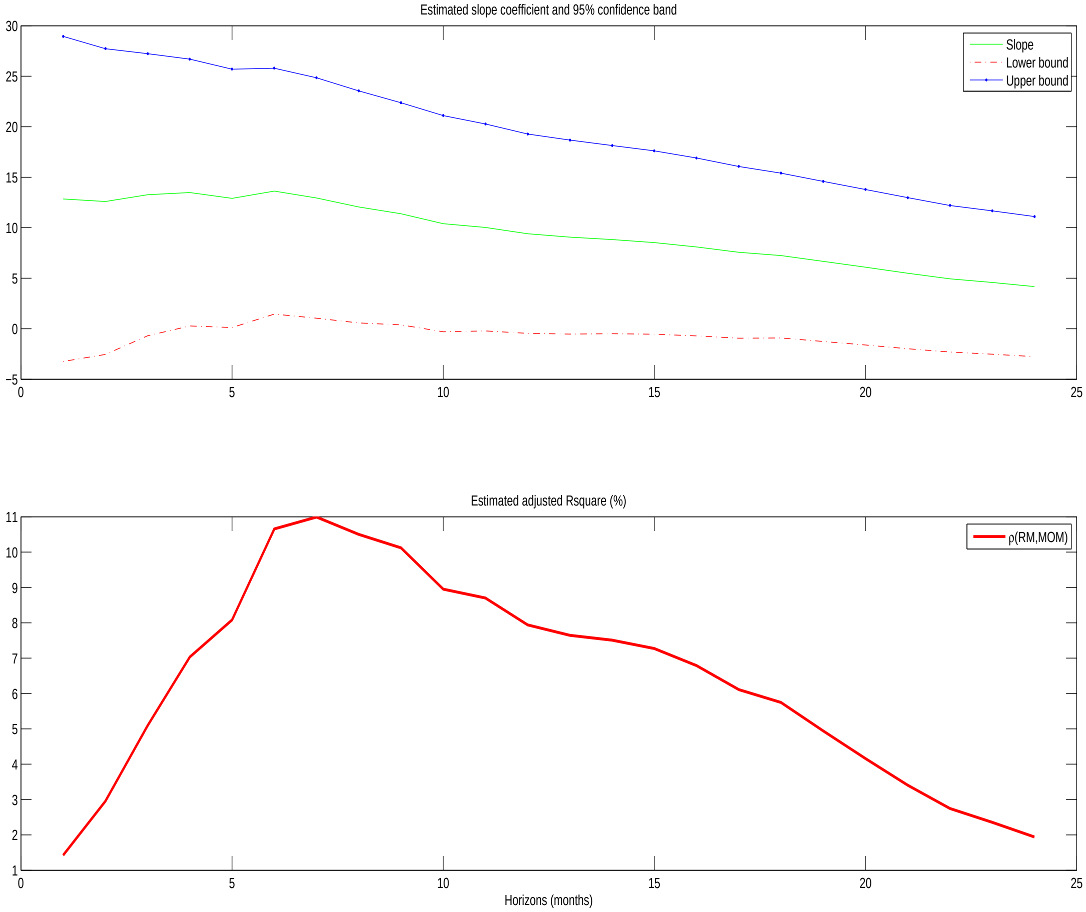

Figure 9: **Estimated Slopes and R^2s**
The figure shows the estimated slope coefficients and pointwise 95% confidence intervals along with the corresponding R^2 s from the regressions of the scaled h-period S&P 500 returns on the correlation $\rho_{M,MOM}$. All of the regressions are based on monthly observations from January 1990 to December 2008.

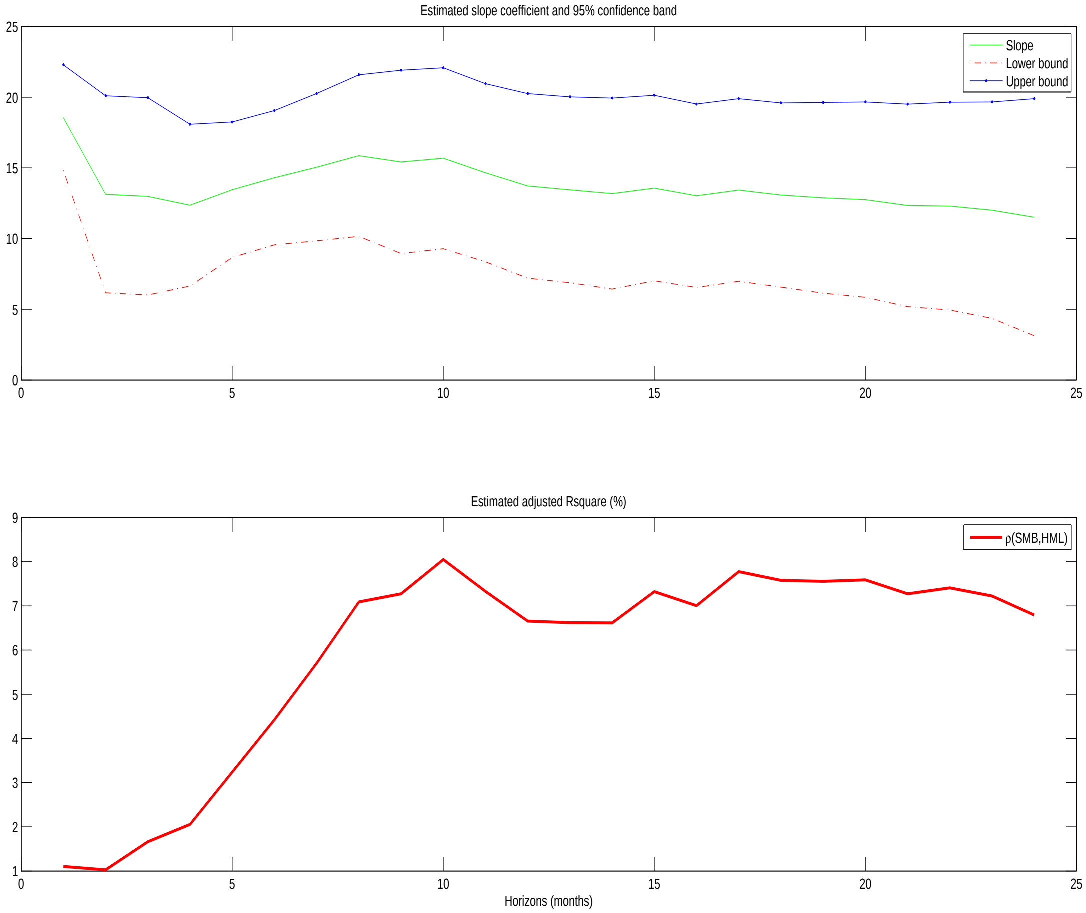

Figure 10: **Estimated Slopes and R^2s**
The figure shows the estimated slope coefficients and pointwise 95% confidence intervals along with the corresponding R^2 s from the regressions of the scaled h-period S&P 500 returns on the correlation $\rho_{SMB,HML}$. All of the regressions are based on monthly observations from January 1990 to December 2008.

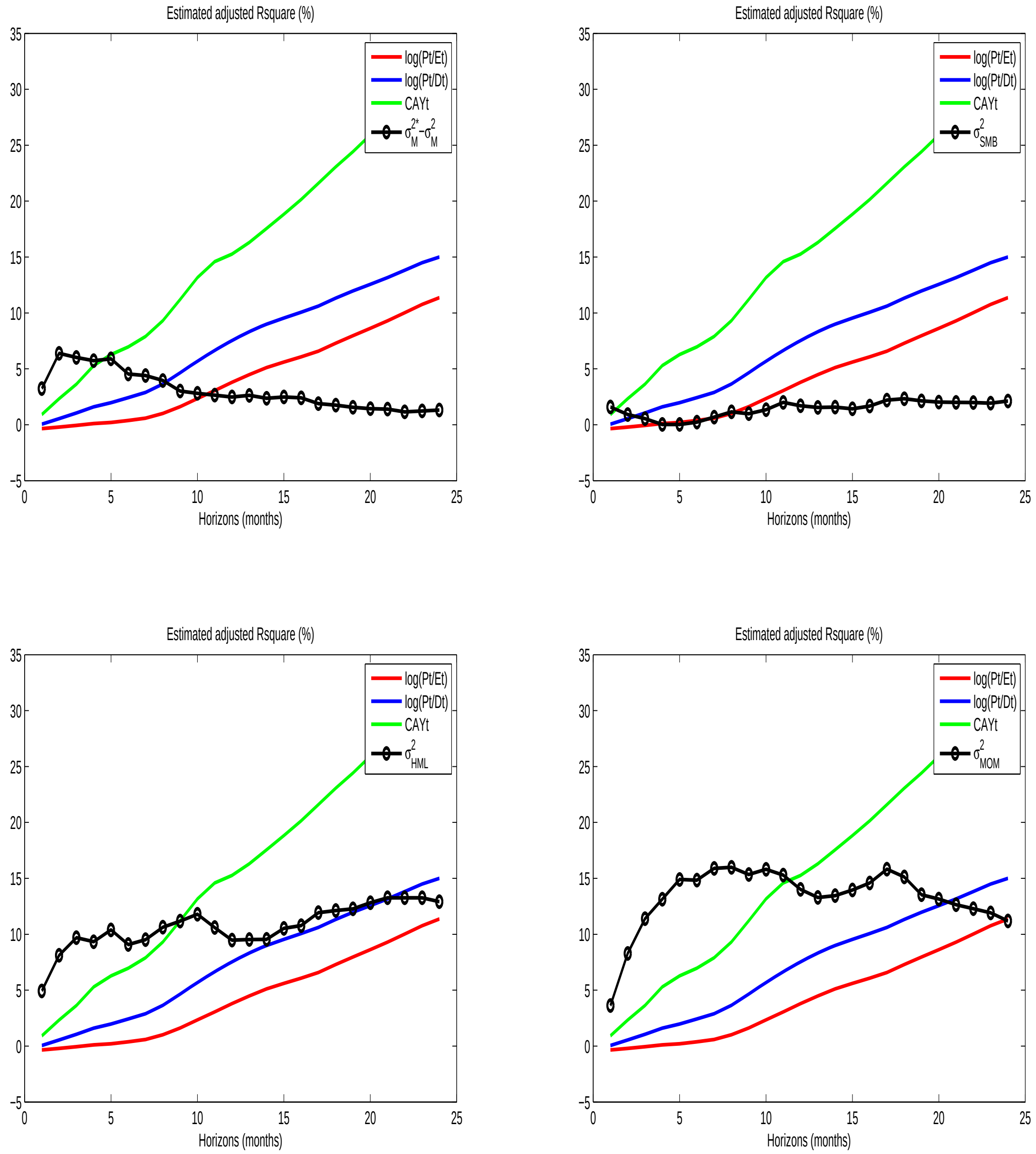

Figure 11: **Estimated** R^2s

The figure shows the R^2 s from the multivariate regressions of the scaled h-period S&P 500 returns on predictor variables. All of the regressions are based on monthly observations from January 1990 to December 2008.

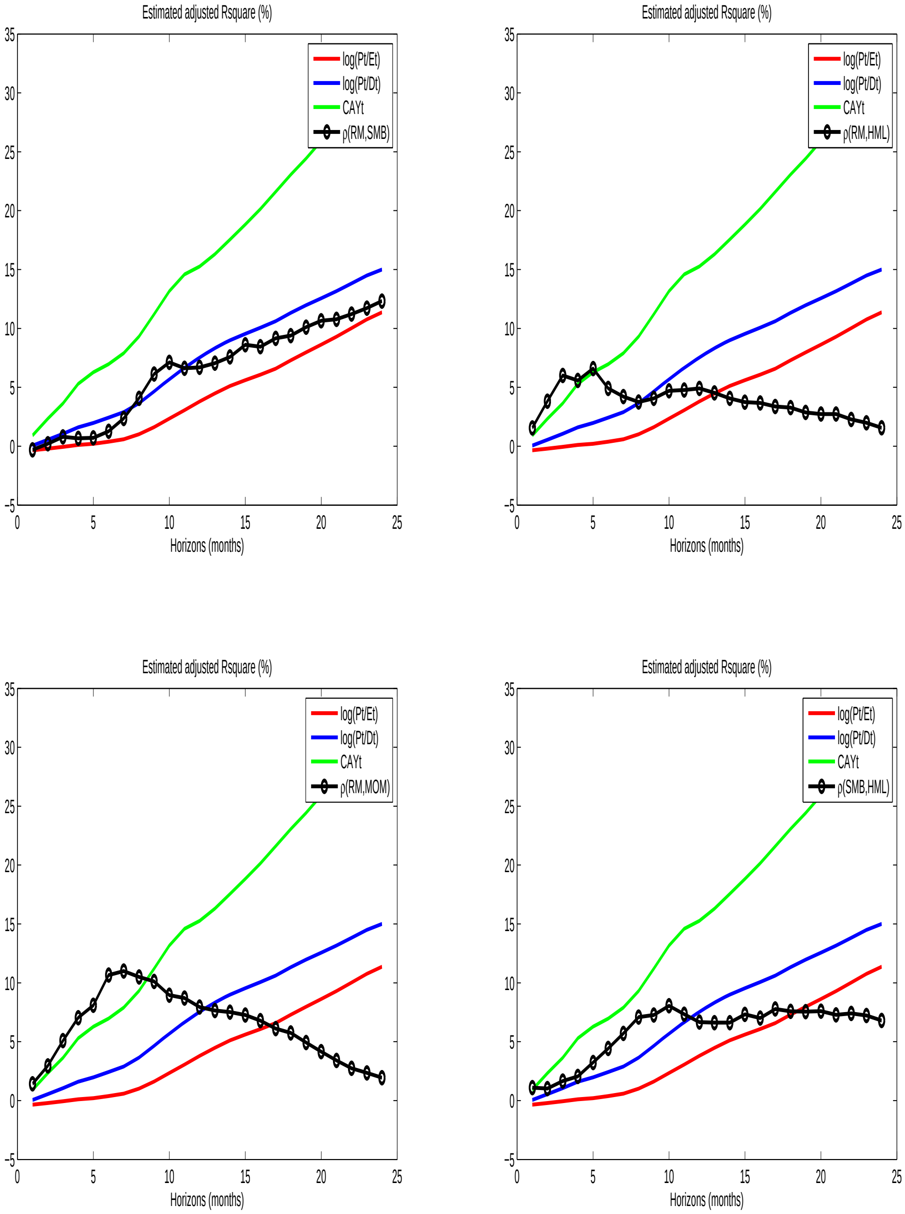

Figure 12: **Estimated** $R^2 s$

The figure shows the R^2 s from the multivariate regressions of the scaled h-period S&P 500 returns on predictor variables. All of the regressions are based on monthly observations from January 1990 to December 2008.