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Economic Significance of Predictable Variations in Stock Index Returns

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ABSTRACT

Knowledge of the one-month interest rate is useful in forecasting the sign as well as the variance of the excess return on stocks. The services of a portfolio manager who makes use of the forecasting model to shift funds between bills and stocks would be worth an annual management fee of 2% of the value of the assets managed. During 1954:4 to 1986:12, the variance of monthly returns on the managed portfolio was about 60% of the variance of the returns on the value weighted index, whereas the average return was two basis points higher.

A STATISTICALLY SIGNIFICANT NEGATIVE correlation between nominal excess returns on stocks and nominal interest rates has been noted in the financial economics literature. In this paper we examine the economic importance of the ability of nominal interest rates to forecast nominal excess returns on stocks. The qualitative conclusion of the paper is that the forecasting ability of treasury bill rates is economically significant. The evidence suggests that this is true because both the expected value and the variance of the nominal stock excess returns depend in interesting ways on the nominal interest rate.[1]

Our approach to evaluating the economic importance of the negative correlation between the nominal interest rate and stock returns is similar in spirit to Fama and Schwert (1977), who examine whether the statistically significant negative correlation between stock returns and nominal interest rates can be used to forecast times when the expected nominal risk premium on stocks is negative. They conclude that the negative slope coefficient in the regression of stock returns on treasury bill returns is not useful in predicting times when stocks do worse than bills. This is probably too stringent a measure of economic importance—we are able to show economic significance despite the inability of the model to consistently forecast periods with a negative risk premium.

Our primary assumption is that the model used to forecast stock index returns is known to sophisticated investors; i.e., the model is predicting (market) expected

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[1] Although Fama and Schwert present results which suggest that the variance of the excess return on stocks may be positively related to the level of the interest rate, they do not explicitly consider such a possibility. Our tests were motivated by Breen (1984), who demonstrates that certain simple trading rules can substantially reduce risk without sacrificing expected return.

returns rather than (market) unexpected returns. Hence, any predictability that we may find is, by assumption, the result of changing market risks as well as the changing price of those risks. At the margin, any sophisticated investor will attach zero value to portfolio excess returns since the model is assumed to be known. However, a naive investor who believes that changes in the return distribution are not related to our, or other, predictive variables may attribute value to the managed portfolio. A useful way to look at the economic significance of the ability of the nominal interest rate to forecast the excess return on stocks is to ask how much value a naive investor would attribute to a portfolio managed using the forecasts.

This value can be estimated using the Henrikkson and Merton (1981) methodology for evaluating the performance of timing portfolios. We conclude that a portfolio strategy that uses the negative relationship between stock returns and the nominal interest rate to time the market, when the value weighted index of stocks in the New York Stock Exchange (NYSE) is used as the stock index portfolio, will be worth an annual management fee of 2% of the assets managed. The portfolio strategy is valuable in part because the excess return on stocks is relatively less volatile during forecasted up markets than during forecasted down markets.

This paper follows a fairly extensive literature which investigates the relation between stock market excess returns and interest rates. There are essentially two lines of research: the first assumes that interest rates are good proxies for expected inflation and analyzes, both theoretically and empirically, the relation between stock market returns and inflation; the second is concerned with the predictability of stock excess returns.

The first line of research has tried to explain the negative relation between stock market excess returns and inflation through an analysis of money supply and/or money demand. Using a variety of models, Fama (1981), Geske and Roll (1983), and Kaul (1987) argue that the relation between excess returns and inflation is "spurious" in the sense that expected returns and inflation are both endogenous variables, simultaneously determined by exogenous state variables. That is, the relation is not structural. Still, in order to explain the relation between expected inflation and expected excess returns, the expected excess return must be allowed to change, but this line of research has not provided an indication of how important these changes in expected returns are. Theoretical investigations in this first line of research have examined whether the intuitive stories described in the empirical studies can be made rigorous. For example, Stulz (1986) shows that, in a simple representative agent model, increases in expected inflation due to worsening productivity can lead to a decrease in the return differential between stocks and nominal bills.

The second line of research examines the predictability of excess returns. For example, Keim and Stambaugh (1986) and Campbell (1987) both investigate the ability of various interest rate variables to predict stock index excess returns. There is some information about the importance of changing expected returns in these studies, but the information may be difficult to interpret. For example, Campbell (1987) reports an R^2 associated with the predictive model for stock excess returns of 11%. He further points out that the standard deviation of the forecasts is 17%. However, it is likely that the true relation between excess returns and interest rates is highly nonlinear, and hence the estimated linear projection is unlikely to be the same as the conditional expectation. However, if the relation is merely a projection and not a conditional expectation, then these numbers may not provide an indication of the economic importance of changing expected returns. Furthermore, as Campbell points out, interpretation of the t-statistics associated with the coefficient on the treasury bill rate may be complicated by the fact that treasury bill rates appear to be a random walk. This difficulty does not arise in the methodology we employ.

In our study we examine the ability of treasury bill returns to forecast the return on the equally weighted as well as the value weighted index of stocks traded on the New York Stock Exchange. Examination of the value weighted index is motivated by its use in prior empirical studies (Fama (1981) and Fama and Schwert (1987)). Furthermore, theoretical investigations in the area have focused on the temporal covariation between the interest rate and the expected return on aggregate wealth invested in productive assets. (See Stulz (1986) and Danthine and Donaldson (1986).) If all productive assets are traded, the return on this aggregate wealth portfolio is the return on the value weighted index. Since we limit our attention to stocks traded on the New York Stock Exchange, there is no a priori reason to believe that the value weighted index is a better proxy for the wealth portfolio. Indeed, most empirical studies of the static CAPM have used the equally weighted index as the proxy for the aggregate wealth portfolio. Also, empirical evidence from studies of the Arbitrage Pricing Theory suggests that the equally weighted index is a better choice for the factor in a single-factor model. (See Connor and Korajczyk (1987).)

I. The Forecasting Model

Let r_{mt} and r_{ft} be, respectively, the rate of return on the market index portfolio (the value weighted and the equally weighted indices of stocks in the NYSE, obtained from the Center for Research in Security Prices, University of Chicago) and the nominally risk-free interest rate (treasury bill returns from Ibbotson and Associates (1987)) during month t. Let $x_t = r_{mt} - r_{ft}$ denote the excess return on the market index. Define y_t to be one if x_t is positive and zero otherwise. We will consider the simplest scenario in which the portfolio manager is invested all in stocks or all in bills. Let $I_t = 1$ if the portfolio manager invests all the funds in the stock index portfolio at the beginning of period $t + 1$ (end of period t) and 0 otherwise. The portfolio manager would ideally like to have all the money in the stock index portfolio whenever y_{t+1} is 1 and in treasury bills whenever y_{t+1} is 0. We will use the period $t + 1$ nominally risk-free rate of interest which is known at the end of period t to predict x_{t+1} and hence y_{t+1}.

Consider now the following linear projection:

$$x_{t+1} = \beta_0 + \beta_1 r_{ft} + \varepsilon_{t+1}. \tag{1}$$

At the end of each month t, we estimate the parameters of the projection given in (1) using data pertaining to the immediately preceding 36 months, as in Fama and Schwert (1977). Let b_j, $j = 0, 1$ denote the estimated values of β_j, $j = 0, 1$. The predicted value $\hat{x}_{t+1}$ *of* x_{t+1} is given by $b_0 + b_1 r_{ft+1}$, where r_{ft+1}, the period $t + 1$ nominally risk-free interest rate, is known at the end of period t. The decision rule we use is as follows: if the predicted value is greater than zero, keep all the money in the stock index portfolio (i.e., $I_t = 1$); otherwise, keep all the money in treasury bills (i.e., $I_t = 0$).

Table I presents the summary statistics for the stock and bill returns used in our study. The average return during the period 1954:4 to 1986:12 on the value weighted index of stocks on the NYSE was 0.98% per month, which was 0.53 percentage points more than the average return on one-month treasury bills during the corresponding period. The corresponding figures for the equally weighted index are 1.24% per month and 0.79 percentage points, respectively. The value weighted index earned a higher return than treasury bills in 57% of the months, while the equally weighted index excess return was positive 58% of the time. The value weighted index return has a lower mean and lower risk than the equally weighted index return in each subperiod as well. Notice, also, that the distribution of equally weighted index excess returns is substantially more leptokurtic than the distribution of the value weighted index.

Table II presents summary statistics for the managed portfolio. The portfolio managed using the value weighted index earned, on average, 55 basis points more than the treasury bill. While the excess return on the managed portfolio is 2 basis points larger than the excess return on the value weighted index, its standard deviation is only 78% of that of the index. The portfolio managed using the equally weighted index earns a lower return than the index and also has lower risk. The subperiod results are similar.

Table I

Summary Statistics for Data Used

The return data for the value and equally weighted indices of all NYSE stocks were taken from the CRSP tapes. The risk-free rate is from Ibbotson and Associates (1987).

	Value Weighted Index			Equally Weighted Index		
	54:4-86:12 $N = 393$	54:4-70:7 $N = 196$	70:8-86:12 $N = 197$	54:4-86:12 $N = 393$	54:4-70:7 $N = 196$	70:8-86:12 $N = 197$
			Monthly Stock Return (%)			
Mean	0.98	0.89	1.07	1.24	1.05	1.43
Std. dev.	4.13	3.70	4.53	5.06	4.27	5.75
$\rho(1)$	0.03	0.08	0.07	0.12	0.17	0.08
			Monthly Excess Return on Stocks (%)			
Mean	0.53	0.61	0.44	0.79	0.77	0.80
Std. dev.	4.16	3.74	4.55	5.08	4.30	5.77
Kurtosis	0.77	0.17	0.90	3.07	0.99	3.17
$\rho(1)$	0.05	0.10	0.03	0.12	0.18	0.09
			Monthly Nominal Interest Rate (%)			
Mean	0.45	0.28	0.63			
Std. dev.	0.26	0.13	0.24			
$\rho(1)$	0.95	0.93	0.92			

Table II

Summary Statistics for the Return on the Managed Portfolio (%)

The managed portfolio is generated in the following way: at time t, funds are invested in the stock index portfolio (CRSP value weighted or equally weighted index of stocks on the NYSE) or in treasury bills based on the current treasury bill rate (from Ibbotson and Associates (1987)) and parameters estimated in a regression of the market index excess return on treasury bill rates over the previous 36 months.

	Value Weighted Index			Equally Weighted Index		
	54:4-86:12	54:4-70:7	70:8-86:12	54:4-86:12	54:4-70:7	70:8-86:12
	$N = 393$	$N = 196$	$N = 197$	$N = 393$	$N = 196$	$N = 197$
	Monthly Excess Return on The Managed Portfolio (%)					
Mean	0.55	0.59	0.51	0.64	0.69	0.59
Std. dev.	3.24	2.70	3.70	3.91	3.18	4.52
$\rho(1)$	0.07	0.19	0.01	0.05	0.21	0.15
	Forecasted Down Markets					
N	122	75	47	120	68	52
Correct forecasts	62	33	29	53	28	25
	Forecasted Up Markets					
N	271	121	150	273	128	145
Correct forecasts	165	81	84	161	84	77

The estimated value of the slope coefficient in the regression of the monthly excess return on stocks on the monthly treasury bill return is negative and statistically significantly different from zero at conventional levels for both the value weighted and the equally weighted index portfolios. (See Panel A of Table III.) The t-statistics were corrected for the presence of conditional heteroscedasticity using the procedures in Hansen (1982) and White (1980). The presence of conditional heteroscedasticity is verified by regressing the squared residuals on the risk-free interest rate, as given in equation (2) below.

$$\varepsilon_t^2 = \gamma_0 + \gamma_1 r_{ft} + \zeta_t. \tag{2}$$

The results are given in Panel B of Table III, and they agree with the qualitative results obtained by Campbell (1987).[2] The estimated slope coefficients in equation (2) are positive and statistically significantly different from zero when the standard errors are calculated using the procedure in White (1980), which allows for the presence of conditional heteroscedasticity for both the value and equally weighted indices. This suggests that, during the post-Treasury Accord period, excess returns on stocks were, on average, relatively low and more volatile when the nominal interest rate was relatively high. Both indices exhibit similar sub-period patterns, with the first half of the sample period exhibiting significance but the second half exhibiting none.

Since there is substantial persistence in the residuals of this regression, we also computed the standard errors using procedures in Hansen (1982), which allows for conditional heteroscedasticity and serially correlated residuals. We

[2] Shanken (1987) has independently arrived at a similar conclusion.

Table III

Linear Projections of Monthly Excess Return on Stocks (x_t) on the Monthly Nominal Risk-Free Interest Rate (r_{ft}) and Linear Projections of the Squared Errors from the First Regressions, ε_t^2, on the Monthly Interest Rate

R^2 is corrected for the degrees of freedom. Heteroskedasticity corrected t-statistics are reported in square brackets. Heteroskedasticity and serial correlation corrected t-statistics with 20 lags for the entire period and 14 lags for the subperiods are reported in parentheses. Results are reported for the CRSP value weighted and equally weighted portfolios of NYSE stocks. Nominal risk-free rates were obtained from Ibbotson and Associates (1987).

	Value Weighted Index			Equally Weighted Index		
	54:4-86:12	54:4-70:7	70:8-86:12	54:4-86:12	54:4-70:7	70:8-86:12
	$N = 393$	$N = 196$	$N = 197$	$N = 393$	$N = 196$	$N = 197$
			$x_t = \beta_0 + \beta_1 r_{ft} + \varepsilon_t$ (A)			
β_0	1.60	2.85	2.10	1.78	3.10	2.50
	(4.28)	(4.60)	(2.60)	(4.18)	(4.59)	(2.47)
β_1	−2.37	−8.05	−2.65	−2.19	−8.42	−2.72
	(−2.91)	(−3.56)	(−2.11)	(−2.31)	(−3.23)	(−1.80)
R^2	0.02	0.08	0.02	0.01	0.06	0.01
			$\varepsilon_t^2 = \gamma_0 + \gamma_1 r_{ft} + \xi_t$ (B)			
γ_0	9.15	5.39	13.77	12.17	2.14	28.80
	(3.36)	(1.51)	(1.93)	(2.12)	(0.49)	(2.02)
	[4.20]	[1.74]	[2.56]	[3.84]	[0.50]	[2.89]
γ_1	17.11	26.58	10.28	29.36	54.31	6.17
	(2.86)	(2.41)	(1.18)	(1.77)	(4.33)	(0.37)
	[3.26]	[2.37]	[1.28]	[3.47]	[3.06]	[0.50]
R^2	0.02	0.03	0.00	0.02	0.05	0.00

report the results when twenty lags were used to compute the covariance matrix. The pattern of significance is unaltered for the value weighted index, whereas the significance for the equally weighted index is considerably reduced for the sample period.

Theory does not provide operationally useful guidance regarding the number of lags to use, and hence we calculated the standard errors for all lags between zero and twenty. For the value weighted index, we found that the t-statistic dropped initially and then increased with the number of lags, reaching a minimum of 2.34 at ten lags. For the equally weighted index, the t-statistic tended to decrease with the number of lags. These results are consistent with the variance process following a low order ARMA process, which induced a high level of persistence in the variance. This would suggest that inference performed with more lags is preferred.

II. Tests of Timing Ability

A. Presence of Forecasting Ability

One way to examine the forecasting ability of the model is to test whether the expected excess return on the stock index portfolio (x_t) during forecasted up markets is different from that during forecasted down markets. This was first suggested by Cumby and Modest (1987). It is equivalent to rejecting the null hypothesis $a_1 = 0$ in the following regression:

$$x_t = a_0 + a_1 I_{t-1} + v_t, \tag{3}$$

where I_{t-1} is one if the forecasting model predicts an up market during period t and is zero otherwise. We will denote this test as the Cumby-Modest test.

Testing whether a_0 is negative is similar to testing whether the expected return on the managed portfolio, X_{st}, is greater than the expected return on the stock index portfolio, as in Fama and Schwert (1977). Since $E(X_{st})$ is given by $E[X_{st}] = E(x_t | I_{t-1} = 1]P\{I_{t-1} = 1\}$, and since $E[x_t] = E[x_t | I_{t-1} = 1]P\{I_{t-1} = 1\} + E[X_t] | I_{t-1} = 0]P\{I_{t-1} = 0\}$, testing whether $E(X_{st}) \leq E(x_t)$ is equivalent to testing $E(x_t | I_{t-1} = 0)\text{prob}(I_{t-1} = 0) \geq 0$. This latter condition is logically equivalent (as long as I_{t-1} is zero with positive probability) to the null hypothesis concerning a_0. However, the two tests are not equivalent, and in this instance the difference in means test is inefficient.[3]

Panel A of Table IV presents the estimated values of a_0 and a_1 in equation (3). The point estimate of a_1 is 0.87 ($t = 1.80$) for the value weighted index and 0.46 ($t = 0.76$) for the equally weighted index. The corresponding values for a_0 are -0.08 ($t = -0.21$) and 0.41 ($t = 0.86$), respectively. Since there is some reason (see Table III, Panel B) to suspect that the variance of the excess return on the market index portfolio is not the same during predicted up and down markets, we use the heteroscedasticity-consistent covariance matrix estimator suggested by White (1980) in computing the t-statistics.

The Cumby-Modest test is concerned with only the first moment, whereas investors will in general care about other moments as well. Therefore, we also examine the variance of the excess return on the market index during forecasted up and down markets. The results are in Panel B of Table IV. For both the value and equally weighted indices, the variance of the excess return is estimated to be larger during forecasted down markets than during forecasted up markets. The relation is significant for only the value weighted index. These results are consistent with the results in Panel B of Table III. We do not find any statistically significant correlation between variance of excess returns and the forecast when the equally weighted index is used. We report the t-statistics using the heteroskedasticity and serial correlation consistent standard error estimation procedure with zero and twenty lags but calculated the standard errors for all lags between zero and twenty. Once again, the t-statistic tends to decrease and then increase with the number of lags used.

[3] This statement can be verified by analytically calculating the t-statistics associated with the two tests. Let N be the number of times I_t is equal to zero; $N = \Sigma(1 - I_t)$. It can be verified that the estimator of a_0 is given by $\hat{a}_0 = \Sigma(1 - I_t)x_{t+1}/N$. The heteroskedastic consistent t-statistic is given by $t_{a_0} = \hat{a}_0\sqrt{N}/\sigma_u$, where $\sigma_u^2 = (1/N)\Sigma(1 - I_t)(x_{t+1} - \hat{a}_0)^2$. In contrast, the difference in means estimator is given by $-N\hat{a}_0/T$, and the associated t-statistic is approximately given by (ignoring the degrees of freedom correction in the calculation of the variance) $-t_{a_0}/\sqrt{[1 + (t_{a_0}^2)\ (N-T)/NT)]}$, which is closer to zero than t_{a_0}. Intuitively, the difference in means test ignores the fact that there are a number of zeros in the series whose mean we calculate. For an efficient test, one should ignore these zeros in the calculation of the relevant variance. Of course, there are fewer degrees of freedom associated with the test of $\hat{a}_0$, but this is of little consequence for N greater than 30.

Table IV

Performance Measures of the Treasury Bill Forecasting Model

At time t, funds are invested in the market index ($I_{t-1} = 1$) or in treasury bills ($I_{t-1} = 0$) based on the current treasury bill rate (from Ibbotson and Associates (1987) and parameters estimated in a regression of the market index (CRSP value weighted and the equally weighted index of stocks on the NYSE) excess return (x_t) on treasury bill rates (r_{ft}) over the previous 36 months. Heteroskedasticity corrected t-statistics are reported in square brackets. Heteroskedasticity and serial correlation corrected t-statistics with 20 lags for the entire period and 14 lags for the subperiods are reported in parentheses.

	Value Weighted Index			Equally Weighted Index		
	54:4-86:12 $N = 393$	54:4-70:7 $N = 196$	70:8-86:12 $N = 197$	54:4-86:12 $N = 393$	54:4-70:7 $N = 196$	70:8-86:12 $N = 197$
			$x_t = a_0 + a_1 I_{t-1} + v_t$ (A)			
a_0	−0.08	0.06	−0.30	0.41	0.22	0.78
	(−0.21)	(0.13)	(−0.39)	(0.86)	(0.37)	(0.81)
a_1	0.87	0.88	0.98	0.46	0.84	0.02
	(1.80)	(1.55)	(1.14)	(0.76)	(1.22)	(0.02)
			$v_t^2 = b_0 + b_1 I_{t-1} + \eta_t$ (B)			
b_0	21.91	17.36	29.11	35.09	24.50	48.77
	(4.98)	(5.81)	(3.11)	(3.42)	(3.54)	(3.16)
	[6.91]	[7.15]	[3.99]	[4.56]	[5.16]	[3.13]
b_1	−6.96	−5.92	−11.36	−13.46	−9.53	21.28
	(−2.01)	(−1.68)	(−1.31)	(−1.56)	(−1.42)	(−1.69)
	[−1.98]	[−1.99]	[−1.48]	[−1.70]	[−1.80]	[−1.31]
			$y_t^{a} = c_0 + c_1 I_{t-1} + w_t$ (C)			
c_0	0.49	0.56	0.38	0.56	0.59	0.52
	(10.87)	(9.77)	(5.40)	(12.32)	(0.86)	(7.49)
c_1	0.12	0.11	0.18	0.03	0.06	0.01
	(2.16)	(1.53)	(2.13)	(0.51)	(0.82)	(0.15)
			$I_{t-1} = \alpha_0 + \alpha_1 y_t + \eta_t$ (D)			
α_0	0.63	0.55	0.69	0.68	0.62	0.73
	(16.95)	(9.40)	(14.70)	(18.81)	(10.83)	(15.90)
α_1	0.10	0.11	0.13	0.02	0.06	0.01
	(2.16)	(1.53)	(2.13)	(0.51)	(0.82)	(0.15)

[a] y_t: dummy variable for excess returns (x_t); one if x_t is positive and zero otherwise.

Our inability to find the a_1's (in equation (3)) to be statistically significantly different from zero may be due in part to the fact that stock returns are extremely volatile and rather long time periods of observations are needed for precise estimates. This will be true especially if excess returns are drawn from a distribution with no finite second moments. The Cumby-Modest test can be modified to examine whether the probability of an up market varies according to the forecast. Notice that, given a positive expected excess return, the probability of an up market is a function of both the conditional mean and conditional variance. For example, if, as Table III suggests, the interest rate can be used to predict times when the market is relatively less volatile, then the interest rate can be used to predict times in which the excess return on the market index is more likely to be positive even if the conditional expected excess return is a constant. Thus, another test of the significance of the forecast is to test whether c_1 in the following regression is statistically significantly positive:

$$y_t = c_0 + c_1 I_{t-1} + w_t. \tag{4}$$

The estimated value of c_1 for the value weighted index is 0.12 ($t = 2.16$) during 1954:4 to 1986:12. That is, during the post-Treasury Accord period, it was more likely that the value weighted market would be up when predicted up than when predicted down. The estimated value of c_1, while positive, is not statistically significantly different from zero for the equally weighted index.

B. Value of the Forecasting Ability

A natural question that arises at this stage is whether the forecasting ability picked up by the above test is economically important and, if so, how important. Our definition of economic importance is the value, to a naive investor, of the portfolio returns generated by the forecasting model. To value the forecasting ability of the model, we will use the approach developed in papers by Merton (1981) and Henriksson and Merton (1981). The Henriksson-Merton approach is largely preference free and derives an estimate of "value at the margin." That is, the Henriksson-Merton estimate represents the extra value obtained from investing a small amount in the managed portfolio. They assume that p_1, the probability of a correct forecast conditional on a down market (negative realized excess return), and p_2, the probability of a correct forecast conditional on an up market (positive realized excess return), do not depend on the actual level of the realized excess return. Under these assumptions, the value of the forecasting ability of the model, per dollar invested, is equal to $p_1 + p_2 - 1$ one-period call options[4] on the stock index portfolio with a current value of one dollar and a strike price equal to one plus the risk-free rate.

We estimate $p_1 + p_2 - 1$ using the following regression:

$$I_{t-1} = \alpha_0 + \alpha_1 y_t + u_t. \tag{5}$$

Note that

$$\alpha_0 = E(I_{t-1} | x_t \leq 0) = 1 - p_1$$

and

$$\begin{aligned} \alpha_1 &= E(I_{t-1} | x_t > 0) - E(I_{t-1} | x_t \leq 0) \\ &= p_1 + p_2 - 1. \end{aligned}$$

Hence, the Henriksson-Merton nonparametric estimate of $p_1 + p_2 - 1$ is equivalent to the regression estimate of α_1 in (5). The results of the regression are given in Table IV.

[4] The analysis in Henriksson and Merton is in terms of puts. However, notice that the put-call parity theorem implies that the put and the call will have the same value.

Panel D of Table IV presents the estimates. The estimated value of α_1 is 0.10 ($t = 2.16$) for the value weighted index. It is not statistically significantly different from zero for the equally weighted index. During 1954:4 to 1986:12, the sample standard deviation of the monthly continuously compounded rate of return on the CRSP value weighted index was 4.02%. The average monthly continuously compounded risk-free rate was 0.42 percent. The Black-Scholes value of the call (as well as the put) option corresponding to these parameter estimates is \$0.0164. Hence, an estimate of the value of the forecasts is $(p_1 + p_2 - 1)$ (0.0164) per month per dollar invested. Using the value weighted index and the post-Treasury Accord period data, the value of the timing model is estimated to be $(0.10)(1.64)(12) = 1.97$ percent of the value of the portfolio being managed, per year.

C. Subperiod Results

The early part of our sample has been studied by other researchers, and to some extent our research was motivated by the results of this earlier work. It is therefore of interest to see whether our results are driven by the first half of the sample period. Also, during the second half of the sample period, nominal interest rates were substantially more variable. Since there are theoretical reasons (see Stulz (1986)) for there to be more variation in stock index expected returns during periods of greater variation in expected inflation, we may expect the forecasting model to perform better in the second half of the sample period. For these reasons we split the sample into two parts and examine the performance of the forecasting model in the two subperiods.

The level of statistical significance found in the overall period implies that the performance of the forecasting model in the two subperiods is unlikely to be statistically significantly different. However, given our strong prior that the model should perform better during the second subperiod, evidence to the contrary would suggest the possibility of ex post selection bias.

Table IV also presents the subperiod results. The absolute value of the estimated slope coefficients in all the equations for the value weighted index are greater in the second subperiod, but the differences are not statistically significant (assuming temporal independence). In particular, the point estimate of the value of the forecasting model is 1.95% of the value of the assets managed, per year, in the first subperiod and 2.79% in the second.[5] These findings are consistent with our expectations.

As with the total sample period, the forecasting model shows no significant ability to forecast the equally weighted index excess return. If anything, the evidence is for better forecasting ability in the first subperiod. We examine the performance of the model when the equally weighted index is used in the next subsection.

[5] The average interest rates are 0.28% and 0.63% in the first and second subperiods, respectively. The standard deviations of the continuously compounded value weighted index returns are 0.037 and 0.0448, respectively. These parameter values lead to call option values of 0.0148 and 0.0179, respectively.

D. Forecastability of Equally Weighted Index Returns

Given the estimated value of the portfolio managed with the value weighted index, and given the statistically significant relation between the equally weighted index return and the treasury bill return, the inability of the model to forecast the equally weighted index return is somewhat puzzling. While it is conceivable that the value weighted index is a better proxy for the wealth portfolio, the miserable performance of the equally weighted forecasting model is still a surprise, especially since the correlation coefficient between the two index excess returns is 0.92 for the overall sample period.

It is possible that the difference in performance is due to difficulties in obtaining reliable estimates of the short run relation between the equally weighted index return and the nominal interest rate. First, it is well documented in the literature that the January seasonal is particularly important in the equally weighted index return. Since we use only three years of data to estimate the forecasting function, there are only three observations of January returns, and hence it is not possible to estimate reliably the January seasonal. Second, the equally weighted excess return distribution is substantially more leptokurtic than the value weighted excess return distribution, especially during the second subperiod. (See Table I.)

In view of the statistical difficulties mentioned above, and given the high correlation of the two indices, forecasts of the value weighted index applied to the equally weighted index may be preferred to forecasts derived from the fitted relation between the equally weighted index return and the nominal interest rate. We examine this possibility in Table V. I_{t-1} is the zero-one decision variable derived from the rolling regressions using the value weighted index excess returns. The managed portfolio invests all the funds in the equally weighted index whenever I_{t-1} is one and invests in treasury bills otherwise.

The estimated value of the slope coefficient, a_1, in the Cumby-Modest regression (equation (3)) for the period 1954:4 to 1986:12 is 1.06, which is 2.3 times the corresponding number for the equally weighted index in Table IV. The estimated number of free call options, α_1, in the Henriksson-Merton market timing test (equation (5)) is 0.08, which is 4 times the corresponding number in Table IV. Since the equally weighted index excess return distribution is relatively more leptokurtic in the second subperiod, we should expect that the improvement in performance should be greater in the second subperiod. During this subperiod, the estimated value of a_1 is 0.99, which is 49 times that of the corresponding number in Table IV. The estimated number of free call options, α_1, is 0.08, which is 8 times that of the corresponding number in Table IV. Comparison of Tables III and IV suggests that at least some of the differences in predictability of the two indices are due to difficulties in estimating short-term relations between returns with leptokurtic distribution and nominal interest rates.

III. Conclusions

In this paper we address the question of the economic importance of predictable stochastic variations in stock index excess returns by further analyzing the

Table V

Performance Measures of the Treasury Bill Forecasting Model

At time t, funds are invested in the CRSP equally weighted index of stocks on the NYSE ($I_{t-1} = 1$) or in treasury bills ($I_{t-1} = 0$) based on the current treasury bill rate (from Ibbotson and Associates (1987)) and parameters estimated in a regression of the CRSP value weighted market index excess return (x_t) on treasury bill rates (r_{ft}) over the previous 36 months. Heteroskedasticity corrected t-statistics are reported in square brackets. Heteroskedasticity and serial correlation corrected t-statistics with 20 lags for the entire period and 14 lags for the subperiods are reported in parentheses.

	54:4-86:12 $N = 393$	54:4-70:7 $N = 196$	70:8-86:12 $N = 197$
	$x_t = a_0 + a_1 I_{t-1} + v_t$ (A)		
a_0	0.06	0.06	0.05
	(0.11)	(0.13)	(0.05)
a_1	1.06	1.15	0.99
	(1.77)	(1.73)	(0.90)
	$v_t^2 = b_0 + b_1 I_{t-1} + \eta_t$ (B)		
b_0	33.21	24.19	47.62
	(3.44)	(4.74)	(2.56)
	[4.41]	[5.56]	[2.63]
b_1	−11.11	−9.82	−19.29
	(−1.48)	(−1.99)	(−1.21)
	[−1.39]	[−1.98]	[−1.04]
	$y_t = c_0 + c_1 I_{t-1} + w_t$ (C)		
c_0	0.52	0.56	0.45
	(11.41)	(9.77)	(6.16)
c_1	0.09	0.11	0.11
	(1.64)	(1.53)	(1.28)
	$I_{t-1} = \alpha_0 + \alpha_1 y_t + u_t$ (D)		
α_0	0.64	0.55	0.72
	(17.35)	(9.41)	(15.48)
α_1	0.08	0.11	0.08
	(1.64)	(1.53)	(1.27)

negative correlation between stock index returns and treasury bill interest rates. We construct a forecasting model based on this relation and evaluate the forecasting ability of the model using the Cumby-Modest and Henriksson-Merton tests of market timing ability. We conclude that treasury bill returns can indeed forecast changes in the distribution of stock index excess returns when the index is the value weighted portfolio. Furthermore, the forecasts of the value weighted excess return will be worth, on an annual basis, 2% of the value of the assets managed to an investor who uses the data from 54:4 to 86:12 to assess the performance of the forecasting model. The excess returns on stocks are relatively less volatile and more likely to be positive during forecasted up markets.

Despite the significant negative correlation between treasury bills and the equally weighted index, the forecasting model did not show statistically or economically significant forecasting ability. This is possibly due to the leptokurtosis and January seasonal in the distribution of equally weighted index excess returns. The substantial leptokurtosis and January seasonal cause estimation of the short run relation between index returns and nominal bill returns to be imprecise.

While our results are qualitatively consistent with the predictions in Stulz (1986), they also suggest the need to model the conditional heteroskedasticity present in the data. We believe that our results will motivate research that will lead to a better understanding of the relationship between monetary policy, nominal interest rates, inflation, and stock returns.

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