# Market Risk Premiums and the Macroeconomy: Canadian Evidence of Stock Market Predictability

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*A simple theory for the formation of expected equity market risk premiums is presented that hypothesizes that premiums are correlated negatively with recent lags of output growth rates and correlated positively with future output growth rates. Both propositions are supported by Canadian data. The theory, by linking market premiums to the current and future health of the economy, allows for the modeling of market risk premium expectations as a function of financial state variables if the state variables can be shown to predict output growth. Five state variables are studied: dividend yield, default spread, term spread, T-bill rate, and industrial production growth. Significant forecasting power is found in* ***ex post*** *regressions of quarterly and annual market risk premiums on the financial state variables over the 38 year sample period. To test the* ***ex ante*** *predictive power and profitability of the model, a moving window regression analysis is performed. Based on a simple investment rule, the model generates a return that is 356 basis points per annum higher than the return of the Toronto Stock Exchange 300 total return index with only 73 percent of the risk.*

## INTRODUCTION

There has been much interest in the academic community regarding stock market predictability. Two broad streams of research have evolved. First, there is the stream that shows stock returns are predictable from previous returns. Fama and French (1988b), Lo and MacKinlay (1988), Poterba and Summers (1988), and Jegadeesh (1990) show that short-term stock returns exhibit significant positive serial correlation and long-term stock returns exhibit significant negative serial correlation. Brock, Lakonishok, and LeBaron (1992) and Jegadeesh and Titman (1993) examine technical trading rules and relative strength models, respectively, and demonstrate they may be implemented profitably. Second, many researchers have examined the predictability of stock returns using economic variables both endogenous and exogenous to the equity markets. For example, Campbell (1987), Fama and French (1988a, 1989), Fama (1990), Chen (1991), Harvey (1991), Campbell and Hamao (1992), and Ferson, Foerster, and Keim (1993) examine the predictability of stock returns from various economic variables.

This study follows the second stream by examining the predictability of stock market returns, or more specifically stock market risk premiums, using observable macroeconomic state variables. Risk premiums have been shown by Ferson and Harvey (1991) to account for the vast majority of the predictability of stock returns at the portfolio level and therefore are used instead of real stock market returns in this paper. The paper proceeds under the premise that if it is possible to find a set of financial state variables that predict

* The author is grateful for the helpful comments of Stephen R. Foerster, John S. Hulland, Joseph P. Kairys Jr., and Ronald G. Wirick. Useful comments also were received from Angela Downey and Robert Giberson, seminar participants at a Western Business School colloquium and the 1993 Northern Finance Association Meetings held in Halifax, Nova Scotia.


0747-5535/96/1600-0087 $02.50

real Gross Domestic Product (GDP) growth, then it may be possible to use these same financial state variables to predict stock market premiums. The study is unique in that few investigations have focused on the predictability of the Canadian stock market. Furthermore, few Canadian or U.S. studies have examined the profitability of such predictability.

This research is motivated by Chen's (1991) examination of the relationships between U.S. real output growth, equity market risk premiums, and five macroeconomic state variables. Chen shows that a set of information variables commonly used to determine conditional expected stock returns is related to U.S. output growth in a manner that is consistent with general intertemporal asset pricing models. As Fama (1991, p. 1610) notes, establishing a link between expected returns and business conditions remains one of finance's more important areas of future research. This paper attempts to add another small piece to the puzzle. The analysis presented here is similar to Chen's in that it examines the same relationships and state variables, but it uses Canadian data over a longer sample period and thus endeavors to provide valuable out-of-sample support for his work.

The study extends Chen's (1991) analysis by examining the *ex ante* profitability of implementing the market premium prediction model with an operational trading strategy. This helps determine if stock market predictability may be used to generate statistically significant returns above a buy-and-hold market portfolio. If it can be shown that economic agents can earn higher risk-adjusted returns than the market portfolio by using publicly available information variables, then the market efficiency debate becomes more than an academic exercise. If higher returns can be generated from these information variables, then the market is either inefficient *or* economic agents rationally give up this potential return. Investors may give up this return because the loss of expected utility from a less smooth consumption path is higher than the utility gained from capturing the return. Thus, if the world is assumed rational and efficient, this potential excess return is a measure of the return that is foregone by rational economic agents to meet their objective of smoother consumption.

## LINKING THE MACROECONOMY TO MARKET PREMIUMS

Although most papers examining the predictability of stock returns are empirical studies with little theoretical foundation, several asset pricing models relate expected stock returns to economic variables. For example Ross (1976), Lucas (1978), and Cox, Ingersoll, and Ross (1985) propose equilibrium models that relate individual stocks to various economic variables. This paper is concerned with how market risk premiums, however, not individual stock returns, relate to macroeconomic variables. The market risk premium is a true macroeconomic variable and, as Ferson and Harvey (1991) have shown, accounts for much of the predictable variance in individual stock returns.

The Sharpe (1964)-Lintner (1965) capital asset pricing model (CAPM) is a single period model in which the expected market premium is assumed constant. Intertemporal asset pricing models such as Merton's (1973) intertemporal CAPM, Lucas' (1978) asset pricing model, and Breeden's (1979) consumption CAPM allow for stochastic investment opportunity sets. Although these models do not address how the market risk premium will evolve over time with respect to specific economic variables, they do assume the market risk premium is a positive function of the economy's aggregate risk aversion or some representative agent's relative risk aversion parameter.

Following Chen (1991), a Lucas (1978) and Breeden (1979) type economy is assumed. Thus, if the utility of consumption is given by a common hyperbolic absolute risk aversion (HARA) class utility function:

$$(1)\ U(C) = \frac{\alpha}{(1-\alpha)}(C - C_0)^{1-\alpha}$$

where:

| | | |
|---|---|---|
| $\alpha \geq 0$ | = | A constant; |
| $C$ | = | Aggregate consumption; and |
| $C_0$ | = | Subsistence level of consumption, |

then the relative risk aversion (RRA) coefficient is given by:

$$(2)\ RRA = -C\,\frac{U''(C)}{U'(C)} = \left(\frac{C}{C - C_0}\right)$$

where:

| | | |
|---|---|---|
| $U'(C)$ | = | The first derivative of the utility of consumption with respect to consumption; and |
| $U''(C)$ | = | The second derivative of the utility of consumption with respect to consumption. |

Equation (2) implies that as $C$ approaches $C_0$, relative risk aversion approaches infinity. That is, when aggregate consumption is low, relative risk aversion is high. Thus, the market's risk premium, which is a reflection of society's risk aversion, also will tend to be high. Therefore, the current health of the economy, which can be proxied by recent GDP growth, is related negatively to the market risk premium. As a result, a negative correlation between recent lags of GDP growth and market premiums should be observed.

This extremely simple model, however, does not explicitly take into account that individuals will form expectations of future consumption or output. As initially suggested by Modigliani and Brumberg (1954) and Friedman (1957), economic agents will attempt to smooth their consumption paths over time. If agents expect good economic times and high consumption in the future, they will bid up interest rates by borrowing in an attempt to equalize present consumption with future consumption. Therefore, higher expected future economic growth also will be associated with higher expected returns on bonds and stocks. Unfortunately, the effect on market risk premiums using only this framework is ambiguous.

Abel (1988) develops an intertemporal general equilibrium model based on an infinitely-lived representative consumer. Abel begins with the following well-known first-order utility maximization condition:

(3) $P_t U'(C_t) = \beta E_t\{(P_{t+1} + Y_{t+1})U'(C_{t+1})\}$

where:

$P_t$ = The price of a share of stock in units of consumption at time t;
$U'(C_t)$ = The marginal utility of consumption in period t;
$\beta$ = A time preference parameter;
$E_t$ = The expectations operator conditioned on information available at time t;
$P_{t+1}$ = The price of a share of stock at time t+1;
$Y_{t+1}$ = Next period's dividends; and
$U'(C_{t+1})$ = The marginal utility of next period's consumption.

The left side of equation (3) represents the loss (gain) in utility from reducing (increasing) consumption in period t by $P_t$ units to buy (sell) an additional share of stock. The right side of the equation represents the discounted expected gain (loss) in utility associated with the increase (decrease) in period t + 1 consumption due to the purchase (sale) of the share in the prior period. Optimality requires that the decrease (increase) in period t utility be equal to the discounted expected increase (decrease) in period t + 1 utility. By rearranging equation (3), it easily can be shown that the representative investor will set his or her discounted expected marginal rate of substitution of future consumption for present consumption equal to the inverse of his or her expected return on a marginal share of stock.

Abel (1988) proceeds to show that the expected stock market risk premium is given by:

(4) $E_t\left\{R_{t+1} - R^F_{t+1}\right\} = f(\mu_t, \upsilon_t) \bullet y_t^{-\alpha}$

where:

$R_{t+1}$ = The market return at time t + 1;
$R^F_{t+1}$ = The risk-free rate at time t + 1;
$f(\mu_t, \upsilon_t)$ = Some function of expected future output $\mu_t$ and the volatility of future output $\upsilon_t$; and
$y_t$ = The most recent level of output.[1]

Abel shows that in the simple case where the utility function is given by lnC, the expected market risk premium is given by:

(5) $E_t\left\{R_{t+1} - R^F_{t+1}\right\} = \beta^{-1}\left(\frac{\mu_t}{y_t}\right)\left(\frac{\upsilon_t}{(1 + \upsilon_t)^2}\right)$.

[1] Abel (1988) assumes that the only good in the economy is nonstorable dividends, all shares pay identical dividends, and the number of shares of stock is normalized to equal the number of consumers. Thus, equilibrium in the goods market requires that aggregate consumption equals aggregate dividends, which also must equal aggregate output.

Thus, the conditional expected equity market risk premium is correlated negatively with the most recent level of output and correlated positively with expected future output. Abel's model also implies a positive correlation between future output volatility and the next period's expected market premium. For this paper, it is assumed that output volatility is constant.[2]

Therefore, the model contains two testable propositions. First, present market premiums should be correlated negatively with recent lagged output growth rates. Second, present market premiums should be correlated positively with future output growth rates. Therefore, if it is possible to find a set of macroeconomic state variables that predict current and future real output growth in advance and if it can be shown that stock market premiums are correlated with current and future GDP growth, then it may be possible to use these macroeconomic state variables to predict stock market premiums.

## DATA SET AND VARIABLES

The data used for this study are from Statistic Canada's CANSIM database, the International Monetary Fund's international financial statistics (IFS) database, and the Canadian Financial Markets Research Centre's (CFMRC) database. In particular, GDP, the Toronto Stock Exchange (TSE) dividend yield, long-term government bond yield, long-term corporate bond yield, and T-bill rate are from the CANSIM database. The industrial production data are from the IFS database, and the TSE stock market total return data are from the CFMRC database. The GDP data set frequency is quarterly and hence limits the study of how real activity varies with respect to the financial state variables and stock returns to this frequency. The state variables and stock data are available, nevertheless, in a monthly frequency. The time horizon for the study is determined by the availability of several variables that are only available back to 1956. As a result, the data set for the study begins in the first quarter of 1956 and ends in the fourth quarter of 1993, resulting in a 38 year sample of 152 quarterly observations.

The remainder of this section defines and describes the motivation for selecting each of the variables used in this study. The two endogenous variables are real GDP growth and the stock market risk premium. The exogenous state variables are dividend yield, default spread, term spread, T-bill rate, and industrial production growth.

### *REAL GDP GROWTH*

Real GDP growth in quarter t, $GDP_t$, is derived as follows:

$$(6)\quad GDP_t = \frac{\text{Real GDP}_t - \text{Real GDP}_{t-1}}{\text{Real GDP}_{t-1}}$$

Stock returns long have been known to be correlated with future economic activity (e.g., Burns, 1930). More recently, Fama (1981, 1989), Geske and Roll (1983), Fischer and Merton (1984), and Schwert (1990) show that real stock returns predict future real output

[2] Chen (1991) finds no significant correlation between output volatility and expected market risk premiums in the U.S. data.

growth in U.S. data, and Chen (1991) demonstrates that the U.S. market risk premium predicts future real output growth. Using Canadian data, Cozier and Rahman (1988) show that real stock returns are correlated with future real activity, and Foerster and Turnbull (1993) show that nominal stock returns predict future real GDP growth.

### *MARKET RISK PREMIUM*

The market premium is the price of market risk. It is a premium to compensate investors for taking more risk than the economy's risk-free asset. Accordingly, the market premium for quarter t, $PREM_t$, is defined as:

$$(7)\ PREM_t = \left(\frac{TSEI_t - TSEI_{t-1}}{TSEI_{t-1}}\right) - AVETBILL_t$$

where:

$TSEI_t$ = The TSE 300 total return index (which includes dividends); and
$AVETBILL_t$ = The average 90 day Government of Canada T-bill rate during quarter t.

As suggested previously, if it is possible to find a set of financial state variables that predict real GDP growth far enough in advance and if it can be shown that stock market premiums are correlated with current and future GDP growth, then it may be possible to use the financial state variables to predict stock market premiums.

The exogenous financial state variables used in this study to predict current and future output now are defined. They are observable at the beginning of quarter t and, as a result, will carry the subscript t - 1.

### *DIVIDEND YIELD*

The first state variable is the 12 month trailing TSE dividend yield, $DIV_{t-1}$. It is measured in the month immediately prior to quarter t and therefore can be observed at the beginning of quarter t. Dividend yields have been used to predict stock returns in many recent studies. For example, Rozeff (1984), Campbell and Shiller (1988), Fama and French (1988a, 1989), Fama (1990), Schwert (1990), and Chen (1991) find significant relationships between stock returns and dividend yields. Dividend yields are a within-the-equity-market measure of economic health. High dividends relative to equity prices suggest that the public does not view economic growth as probable. That is, economic agents perceive present and future economic prospects as poor and bid down equity prices relative to current dividends. Conversely, low dividend yields generally occur when the economy is booming and equity prices have been bid up relative to current dividends. Therefore, $DIV_{t-1}$ should be correlated negatively to GDP.

### *DEFAULT SPREAD*

The default spread is defined as the difference between the yield on a portfolio of long-term corporate bonds and the yield on a portfolio of long-term government bonds. The default spread for the last month of quarter t - 1, $DEF_{t-1}$, is defined as:

(8) $DEF_{t-1}$ = Long-Term Corporate Bond $Yield_{t-1}$ - $GOV_{t-1}$

where:

$GOV_{t-1}$ = The long-term Government of Canada bond yield at the end of quarter t - 1.

The default spread has been used by Chen, Roll, and Ross (1986), Keim and Stambaugh (1986), Fama and French (1989), Fama (1990), Schwert (1990), and Chen (1991) to predict stock returns. Chen, Roll, and Ross (1986) argue that the default spread captures current business conditions. They contend that the default spread represents the degree of risk aversion in the economy. When the economy is unhealthy, economic agents will bid up the premium on risky debt relative to less risky debt to compensate for the uncertainty and riskiness of future economic growth. Thus, $DEF_{t-1}$ should be correlated negatively with recent GDP growth.

### *TERM SPREAD*

The term spread is the slope of the yield curve. Thus, the term spread in the month immediately preceding quarter t, $TERM_{t-1}$, is defined as:

(9) $TERM_{t-1} = GOV_{t-1} - TBILL_{t-1}$

where:

$TBILL_{t-1}$ = The Government of Canada T-bill rate at the end of quarter t - 1.

The term spread is another commonly used variable for predicting stock returns. Chen, Roll, and Ross (1986), Campbell (1987), Fama and French (1989), Fama (1990), Schwert (1990), and Chen (1991) use term spread as a variable to predict stock market returns. It is expected that $TERM_{t-1}$ will be correlated positively with future GDP growth. If future output is expected to be high, individuals will want to smooth their consumption paths by attempting to borrow against expected future output, thereby bidding up long interest rates.

### *T-BILL RATE*

The 90 day Government of Canada T-bill rate, $TBILL_{t-1}$, is the implied monthly yield for the last month of quarter t - 1. Fama and Schwert (1977), Chen, Roll, and Ross (1986), Shanken (1990), Chen (1991), and Fama and French (1989) have used the T-bill rate to predict stock returns. The T-bill rate is a proxy for expected future inflation. Fama (1981) shows that the rate of inflation is correlated negatively with GDP growth in the U.S., and Cozier and Rahman (1988) find similar results for Canada. Because the T-bill rate is a proxy for expected future inflation and future inflation is correlated negatively with future GDP growth, $TBILL_{t-1}$ is expected to be correlated negatively with future GDP growth.

*INDUSTRIAL PRODUCTION GROWTH*

The final state variable is the 12 month growth in industrial production. The growth in industrial production, $IP_{t-1}$, up to and including the final month of quarter t - 1 is defined as:

$$(10)\ IP_{t-1} = \frac{\text{Industrial Production}_{t-1} - \text{Industrial Production}_{t-4}}{\text{Industrial Production}_{t-4}}$$

where industrial production is measured at the end of any given quarter t. Industrial production growth is probably the least used of the five state variables in this paper for predicting stock returns. Nevertheless, Chen, Roll, and Ross (1986), Fama (1990), and Chen (1991) examine the relationship between industrial production and stock returns. Industrial production is chosen for this study because it is assumed to be highly correlated with current GDP growth.

Summary statistics for the variables over the period 1956:1 to 1993:4 are given in Table 1. As standard financial theory would predict, the average annualized quarterly TSE return of 10.7 percent is higher than the average annualized T-bill return of 7.2 percent and thus possesses much more risk as measured by standard deviation. The mean of the first endogenous variable, real GDP growth, over the 38 year sample period is 0.93 percent per quarter, with a standard deviation of 1.1 percent. The mean of the second endogenous variable, the market risk premium, is 0.76 percent per quarter with a large standard deviation of 7.9 percent. Those familiar with the United States stock markets will recognize that the Canadian market risk premium is lower than its U.S. counterpart. This is presumably due to a combination of the TSE 300 index's poor performance relative to the U.S. stock markets in the latter part of the sample period and the propensity of the Canadian T-bill rate to exceed its U.S. counterpart.

Autocorrelations also are given in Table 1. As expected, the five macroeconomic state variables possess high positive autocorrelations, all equal to or greater than 0.80 for the first lagged quarter. Real GDP growth, on the other hand, shows surprisingly low autocorrelations, with a first lag autocorrelation of only 0.17 and a fourth lag autocorrela-

**Table 1—Summary Statistics of Non-Overlapping Quarterly Observations, 1956:1 to 1993:4**[1]

| Variable | Symbol | Mean | Standard Deviation | Autocorrelations 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|
| Dividend Yield | $DIV_t$ | 3.550 | 0.679 | 0.865 | 0.696 | 0.554 | 0.424 |
| Default Spread | $DEF_t$ | 0.926 | 0.368 | 0.868 | 0.758 | 0.721 | 0.639 |
| Term Spread | $TERM_t$ | 1.018 | 1.514 | 0.799 | 0.618 | 0.492 | 0.389 |
| T-bill Rate | $TBILL_t$ | 7.237 | 3.708 | 0.938 | 0.871 | 0.828 | 0.767 |
| Industrial Production Growth | $IP_t$ | 3.718 | 5.480 | 0.806 | 0.592 | 0.325 | 0.036 |
| Real GDP Growth | $GDP_t$ | 0.933 | 1.114 | 0.174 | 0.104 | 0.157 | -0.018 |
| TSE Total Return | $TSE_t$ | 2.574 | 7.801 | 0.171 | -0.083 | -0.114 | -0.130 |
| Market Risk Premium | $PREM_t$ | 0.762 | 7.919 | 0.188 | -0.067 | -0.108 | -0.135 |

[1] The variables DIV, DEF, TERM, TBILL, and IP are given in annualized percent and are monthly observations taken from the last month of any given quarter. The variables GDP, TSE, and PREM are given in quarterly percent

tion that turns negative. The market risk premium possesses a first lag autocorrelation of 0.18, with the remaining autocorrelations being small and negative.

The cross correlations between the variables are given in Table 2. The signs of all correlations between GDP growth and the financial state variables are as hypothesized. GDP growth is correlated positively with the TSE market premium. The correlation coefficients also reflect the extent to which multicollinearity between the exogenous state variables may be a problem in the multivariate regressions performed in subsequent sections. Table 2 shows that most of the correlations between the state variables are fairly low, with those between the measures of current economic health—dividend yield, default spread and industrial production growth—and those between the measures of future economic health—term spread and T-bill rate—being the greatest in absolute magnitude. They range from 0.46 to 0.67. Thus, while the threat of multicollinearity is low, it may be prudent to be careful when adding more than one measure of current or future economic health into a single regression equation. In the next section, the relationships between the endogenous and exogenous state variables are examined further.

**Table 2—Correlations for Non-Overlapping Quarterly Observations, 1956:1 to 1993:4**

| | $DIV_t$ | $DEF_t$ | $TERM_t$ | $TBILL_t$ | $IP_t$ | $GDP_t$ | $PREM_t$ |
|---|---|---|---|---|---|---|---|
| $DIV_t$ | 1.00 | | | | | | |
| $DEF_t$ | 0.46 | 1.00 | | | | | |
| $TERM_t$ | -0.29 | 0.00 | 1.00 | | | | |
| $TBILL_t$ | 0.41 | 0.23 | -0.67 | 1.00 | | | |
| $IP_t$ | -0.51 | -0.49 | 0.21 | -0.32 | 1.00 | | |
| $GDP_t$ | -0.29 | -0.24 | 0.23 | -0.27 | 0.57 | 1.00 | |
| $PREM_t$ | -0.29 | -0.17 | 0.23 | -0.22 | 0.01 | 0.16 | 1.00 |

## REAL ACTIVITY, RISK PREMIUMS AND THE MACROECONOMIC STATE VARIABLES

Two propositions are established in the second section. First, recent lags of real GDP growth should be correlated negatively with the present equity market risk premium. Second, future real GDP growth should be correlated positively with the present market risk premium. To test these propositions, period t's market premiums, $PREM_t$, are regressed on future real GDP growth, $GDP_{t+i}$, at leads of i quarters.

The results shown in Table 3 support both propositions. The coefficient t-test probability values, in parentheses, and the regression $R^2$s are listed below each estimate. The regression coefficients of $GDP_{t+i}$ show that, as the first proposition states, GDP lags are correlated negatively with market risk premiums. Only the GDP growth coefficient at a lag of three quarters, $GDP_{t-3}$, is significant at the 5 percent level, although all the coefficients of lagged GDP growth, including the most recent quarter, are negative. Thus, the first proposition holds: current market risk premiums are related negatively to recent lags of GDP growth. Furthermore, the coefficients of $GDP_{t+i}$ are positive for GDP leads of zero to five quarters and significant at least at the 1 percent level for leads of one, two, and three quarters. Among these three quarters, the greatest level significance, 0.001, and $R^2$, 0.07, is observed at $GDP_{t+2}$, followed by $GDP_{t+1}$ and $GDP_{t+3}$, respectively. Therefore, the

**Table 3—Univariate Regressions of Quarterly Market Risk Premium on Various Leads of Real GDP Growth Rates Using Quarterly Observations, 1956:1 to 1993:4[1]**

$$PREM_t = \alpha + \beta GDP_{t-i} + \varepsilon_t \quad i = -4, -3, \ldots, +7$$

| GDP Lag or Lead Regression Coefficient | | | |
|---|---|---|---|
| $GDP_{t-4}$ | $GDP_{t-3}$ | $GDP_{t-2}$ | $GDP_{t-1}$ |
| -0.646 | -1.521 | -0.447 | -0.284 |
| (0.266) | (0.022) | (0.506) | (0.645) |
| 0.01 | 0.04 | 0.00 | 0.00 |
| GDP Lag or Lead Regression Coefficient | | | |
| $GDP_t$ | $GDP_{t+1}$ | $GDP_{t+2}$ | $GDP_{t+3}$ |
| 1.097 | 1.718 | 1.998 | 1.454 |
| (0.121) | (0.007) | (0.001) | (0.009) |
| 0.02 | 0.06 | 0.07 | 0.04 |
| GDP Lag or Lead Regression Coefficient | | | |
| $GDP_{t+4}$ | $GDP_{t+5}$ | $GDP_{t+6}$ | $GDP_{t+7}$ |
| 0.829 | 0.327 | -0.694 | -0.503 |
| (0.158) | (0.572) | (0.184) | (0.376) |
| 0.01 | 0.00 | 0.01 | 0.00 |

[1] Each cell represents one univariate ordinary least squares regression. Within each cell, the first value is the regression coefficient point estimate, the value in parentheses is the t-test p-value for the estimate, and the third value is the regression $R^2$. The standard errors used in the t-tests are calculated to be consistent in the presence on unknown heteroscedasticity in a manner similar to White (1980). The regressions use non-overlapping, quarterly frequency, equity risk premiums as the dependent variable and various lags or leads of quarterly growth in real GDP as the independent variable. $PREM_t$ is the market risk premium during quarter t in percent and $GDP_{t+i}$ is real GDP growth during quarter t + i in percent

second proposition also is satisfied; current market risk premiums are related positively to future GDP growth. Equity market risk premiums tend to lead GDP growth by one to three quarters.

Given that both propositions are satisfied, a set of economic state variables may be established that are correlated with both recent and future economic growth. In particular, given the objective ultimately is to predict next period's market risk premium, it is important to find economic state variables that are correlated with next period's GDP growth (i.e., proposition one) and next period's expected future GDP growth (i.e., proposition two).

Table 4 shows the univariate regression statistics of real GDP growth at lead i, $GDP_{t+i}$, on each of the five time t observable macroeconomic state variables. The results illustrate that the state variables may be grouped approximately into current measures of economic health and future measures of economic health. The current measures of economic health appear to be dividend yield, default spread, and industrial production growth. First, lagged dividend yields are highly significant predictors of GDP growth from a GDP lag of three quarters to a GDP lead of one quarter. All the significant coefficients are of the hypothesized negative sign. It is most significant, as measured by probability value and $R^2$, at a GDP growth lag of one quarter. Second, lagged default spreads are highly significant predictors of GDP growth from a lag of three quarters to a lead of zero quarters.

**Table 4—Univariate Regressions of Various Leads of the Real GDP Growth Rate on the Financial State Variables Using Quarterly Observations, 1956:1 to 1993:4**[1]

$$GDP_{t+i} = \alpha + \beta_k(\text{State Variable } k)_{t-1} + \varepsilon_t \quad i = -4, -3, \ldots, +7$$

| State Variable | State Variable Regression Coefficient for Given GDP Lag or Lead | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $GDP_{t-4}$ | $GDP_{t-3}$ | $GDP_{t-2}$ | $GDP_{t-1}$ | $GDP_{t}$ | $GDP_{t+1}$ | $GDP_{t+2}$ | $GDP_{t+3}$ | $GDP_{t+4}$ | $GDP_{t+5}$ | $GDP_{t+6}$ | $GDP_{t+7}$ |
| $DIV_{t-1}$ | -0.091 | -0.330 | -0.461 | -0.529 | -0.441 | -0.299 | -0.072 | 0.059 | 0.083 | 0.095 | 0.029 | 0.007 |
| | (0.528) | (0.009) | (0.000) | (0.000) | (0.000) | (0.018) | (0.565) | (0.610) | (0.441) | (0.340) | (0.777) | (0.951) |
| | 0.00 | 0.04 | 0.07 | 0.10 | 0.07 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $DEF_{t-1}$ | -0.428 | -0.614 | -0.603 | -0.695 | -0.610 | -0.316 | -0.199 | -0.198 | 0.170 | 0.185 | -0.059 | 0.157 |
| | (0.065) | (0.014) | (0.016) | (0.004) | (0.015) | (0.256) | (0.435) | (0.419) | (0.525) | (0.417) | (0.778) | (0.525) |
| | 0.02 | 0.04 | 0.04 | 0.05 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $TERM_{t-1}$ | 0.033 | 0.051 | 0.054 | 0.179 | 0.246 | 0.312 | 0.362 | 0.286 | 0.280 | 0.222 | 0.176 | 0.131 |
| | (0.552) | (0.371) | (0.384) | (0.007) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.002) | (0.016) | (0.073) |
| | 0.00 | 0.00 | 0.01 | 0.06 | 0.11 | 0.18 | 0.24 | 0.15 | 0.14 | 0.09 | 0.05 | 0.03 |
| $TBILL_{t-1}$ | -0.044 | -0.047 | -0.056 | -0.082 | -0.097 | -0.114 | -0.114 | -0.100 | -0.099 | -0.086 | -0.068 | -0.062 |
| | (0.074) | (0.073) | (0.044) | (0.003) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.021) | (0.040) |
| | 0.02 | 0.02 | 0.03 | 0.08 | 0.11 | 0.15 | 0.15 | 0.11 | 0.11 | 0.08 | 0.05 | 0.04 |
| $IP_{t-1}$ | 0.080 | 0.095 | 0.112 | 0.116 | 0.062 | 0.034 | 0.019 | 0.001 | 0.004 | 0.016 | 0.020 | 0.024 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.060) | (0.271) | (0.972) | (0.779) | (0.311) | (0.208) | (0.138) |
| | 0.16 | 0.22 | 0.31 | 0.33 | 0.10 | 0.03 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 |

[1] Each cell represents one univariate ordinary least squares regression. Within each cell, the first value is the regression coefficient point estimate, the value in parentheses is the t-test p-value for the estimate, and the third value is the regression $R^2$. The standard errors used in the t-tests are calculated to be consistent in the presence on unknown heteroscedasticity in a manner similar to White (1980). The regressions use various lags or leads of non-overlapping, quarterly frequency, quarterly growth in real GDP as the dependent variable and one lagged state variable as the independent variable. $GDP_{t+i}$ is real GDP growth during quarter t + i in percent, $DIV_{t-1}$ is the TSE 12 month trailing dividend yield measured in the last month of quarter t - 1 in percent, $DEF_{t-1}$ is the spread between long-term corporate and long-term government bond yields in the last month of quarter t - 1 in annualized percent, $TERM_{t-1}$ is the spread between long-term government bond and T-bill yields in the last month of quarter t - 1 in annualized percent, $TBILL_{t-1}$ is the T-bill rate in the last month of quarter t - 1 in annualized percent, and $IP_{t-1}$ is the 12 month growth in industrial production up to and including the last month of quarter t - 1 in percent

The significant default spread coefficients are all negative, and the variable is most powerful in predicting GDP growth at lag of one quarter. Third, lagged 12 month growth in industrial production is highly significant for predicting GDP growth from a lag of four quarters to a lead of zero quarters. Lagged industrial production is also most significant at a GDP lag of one quarter. Thus, the three state variables that measure current economic health are of the hypothesized sign and are significant for predicting at least next quarter's GDP growth rate, although all three are correlated most significantly with GDP growth in the quarter in which the state variables are measured.

The measures of future economic health appear to be the term spread of interest rates and the T-bill rate. First, the term spread is significant in predicting GDP growth from a GDP lag of one quarter to a lead of six quarters, and all its coefficients are of the hypothesized positive sign. It is most significant for predicting GDP growth three quarters from the beginning of period t. Second, the T-bill rate is a significant predictor of GDP growth from a GDP lag of one quarter to a lead of at least seven quarters. All the coefficients are of the hypothesized positive sign. The T-bill rate is most powerful in predicting GDP growth three to four quarters from the beginning of quarter t. Thus, the two state variables chosen to predict future economic activity, the term spread and T-bill rate, are of the hypothesized sign, significant in predicting GDP growth at least six quarters from the current quarter, and most powerful three quarters from when the variables are measured.

Therefore, next period's market risk premium is related negatively to recent GDP growth and related positively to future GDP growth, as postulated in the two propositions derived from the model presented above. Furthermore, three state variables have been identified that predict economic activity up to one quarter ahead, and two state variables have been identified that predict economic activity up to seven quarters ahead. Consequently, next period's market risk premium should be predictable from combinations of the measures of the then current and future economic health.

## MARKET RISK PREMIUM PREDICTABILITY

This section presents evidence that *ex post* market risk premiums are predictable from the macroeconomic states variables. First, it is shown univariately that several state variables possess predictive power, especially when the risk premium horizon is extended from one quarter to one year. Second, it is shown that in multivariate regressions 10 percent of quarterly and 41 percent of yearly market premium variance are predicted by the five state variables.

A brief discussion regarding the expected signs of the regression coefficients is in order. The theory presented in the second section allows for simple and concise predictions of the expected signs. For example, because the dividend yield, default spread, and industrial production growth are our measures of next period's current economic health, the theory presented previously would predict that they should possess the opposite regression coefficient sign that they did in predicting GDP growth due to the first of the two propositions. That is, the theory would predict that the dividend yield and default spread will be correlated positively with next period's risk premium, while industrial production growth should be correlated negatively with the next period's risk premium. Similarly, because the term spread and T-bill rate are our measures of next period's expected future GDP growth, the theory predicts that they should possess the same regression coefficient sign that they did in predicting future GDP growth due to the second proposition. Thus, the theory would predict that the term spread and T-bill rate will be correlated positively and negatively with next period's risk premium, respectively.

Univariate regressions of quarterly and yearly market premiums on the financial state variables using quarterly observations are shown in Table 5. The regression statistics for the univariate quarterly market premiums over the whole sample period are not strong. Over the full sample period, only the term spread is significant in predicting next quarter's risk premium, and it possesses an $R^2$ of only 0.03. Dividend yield shows some promise as a predictor of risk premiums; however, it is only significant at the 10 percent level. All the coefficient signs are as expected, except the default spread which possesses an insignificant negative coefficient. The subperiod analysis shows only marginally more encouraging results. The dividend yield coefficient is just barely insignificant in the first subperiod with an $R^2$ of 0.08 and significant in the second subperiod with an $R^2$ of 0.06. In the third subperiod, the term spread is significant with an $R^2$ of 0.08 and the T-bill rate is significant at the 10 percent level with an $R^2$ of 0.09. In addition, the subperiod analysis illustrates that the signs on the state variable coefficients are not perfectly stable for some variables, although any unexpectedly signed coefficients are insignificant. For example, the term spread possesses an insignificant negative sign and the T-bill an insignificant positive sign in the second subperiod. In addition, the default spread's coefficient sign turns to the expected positive sign in the latest subperiod, resulting in all state variables possessing the expected coefficient sign during this most recent period.

The univariate regressions of next year's market risk premium on the macroeconomic state variables are much more encouraging than those of the quarterly risk premium. Three of the five state variables are highly significant, with $R^2$s ranging from 0.05 for the term spread variable to 0.19 for the dividend yield variable. All the state variables except the default spread possess the expected coefficient signs. The subperiod analysis illustrates that the dividend yield is by far the best predictor of next year's market risk premium. The dividend yield coefficient is highly significant in each of the subperiods with $R^2$s ranging between 0.17 in the second subperiod and 0.39 in the first subperiod. The default spread is insignificant and possesses an unexpected negative coefficient in the first and second subperiods, but is significant at the 10 percent significance level and possesses the expected positive coefficient in the third subperiod. The term spread and industrial production growth variables are significant in at least one subperiod with all coefficients in each subperiod possessing the expected signs. The T-bill rate, however, does not appear to possess any significant power for forecasting next year's equity risk premium. The most recent subperiod generally shows the greatest predictability.

Tables 6 and 7 display multivariate regressions of quarterly and yearly horizon market premiums on various combinations of the financial state variables. The first six regressions of both tables include only one measure of current and future economic health to avoid possible multicollinearity problems. As noted previously, correlations between the measures of current economic health—dividend yield, default spread, and industrial production growth—and between the measures of future economic health—term spread and T-bill rate—range between 0.46 and 0.67.

**Table 5—Univariate Regressions of Quarterly and Annual Equity Risk Premiums on the Financial State Variables Using Quarterly Observations, 1956:1 to 1993:4[1]**

$$PREM_{t,t-i} = \alpha + \beta_k(\text{State Variable k})_{t-i} + \varepsilon_t \quad i = 0, 3$$

| | $DIV_{t-1}$ | $DEF_{t-1}$ | $TERM_{t-1}$ | $TBILL_{t-1}$ | $IP_{t-1}$ |
|---|---|---|---|---|---|
| Panel A: Quarterly Equity Risk Premiums, $PREM_t$ | | | | | |
| 1956:2 to 1993:4 | 1.995 | -0.601 | 0.884 | -0.283 | -0.179 |
| | (0.096) | (0.762) | (0.047) | (0.197) | (0.200) |
| | 0.03 | 0.00 | 0.03 | 0.02 | 0.02 |
| 1956:2 to 1968:3 | 5.623 | -2.241 | 1.951 | -0.517 | -0.373 |
| | (0.056) | (0.424) | (0.122) | (0.605) | (0.137) |
| | 0.08 | 0.01 | 0.05 | 0.01 | 0.05 |
| 1968:4 to 1981:1 | 2.619 | -0.602 | -0.118 | 0.154 | -0.092 |
| | (0.045) | (0.863) | (0.804) | (0.605) | (0.693) |
| | 0.06 | 0.01 | 0.01 | 0.00 | 0.00 |
| 1981:2 to 1993:4 | 0.852 | 2.513 | 1.385 | -0.827 | -0.206 |
| | (0.751) | (0.709) | (0.044) | (0.093) | (0.344) |
| | 0.00 | 0.01 | 0.08 | 0.09 | 0.02 |
| Panel B: Annual Equity Risk Premiums, $PREM_{t,t+3}$ | | | | | |
| 1956:2 to 1993:1 | 11.38 | -0.618 | 2.719 | -0.632 | -0.755 |
| | (0.000) | (0.888) | (0.013) | (0.271) | (0.015) |
| | 0.19 | 0.00 | 0.05 | 0.02 | 0.06 |
| 1956:2 to 1968:3 | 27.64 | -6.171 | 4.501 | -0.159 | -1.227 |
| | (0.000) | (0.297) | (0.172) | (0.936) | (0.004) |
| | 0.39 | 0.02 | 0.05 | 0.00 | 0.12 |
| 1968:4 to 1981:1 | 9.262 | -6.773 | 0.017 | 0.002 | -0.299 |
| | (0.000) | (0.256) | (0.991) | (0.998) | (0.481) |
| | 0.17 | 0.02 | 0.00 | 0.00 | 0.02 |
| 1981:2 to 1993:1 | 13.27 | 25.14 | 4.425 | -1.379 | -1.074 |
| | (0.010) | (0.074) | (0.005) | (0.366) | (0.040) |
| | 0.21 | 0.11 | 0.14 | 0.04 | 0.13 |

[1] Each cell represents one univariate ordinary least squares regression. Within each cell, the first value is the regression coefficient point estimate, the value in parentheses is the coefficient's t-test p-value, and the third value is the regression $R^2$. The standard errors used in the t-tests are calculated to be consistent in the presence of unknown heteroscedasticity in a manner similar to White (1980). Panel A regressions use non-overlapping, quarterly frequency, quarterly equity risk premiums as the dependent variable and one lagged state variable as the independent variable. Panel B regressions use overlapping quarterly frequency annual excess returns as the dependent variable and one lagged state variable as the independent variable. $PREM_t$ is the market risk premium during quarter t in percent, $PREM_{t,t+3}$ is the market risk premium from quarter t through quarter t + 3 in percent, $DIV_{t-1}$ is the TSE 12 month trailing dividend yield measured in the last month of quarter t- 1 in percent, $DEF_{t-1}$ is the spread between long-term corporate and long-term government bond yields in the last month of quarter t - 1 in annualized percent, $TERM_{t-1}$ is the spread between long-term government bond and T-bill yields in the last month of quarter t - 1 in annualized percent, $TBILL_{t-1}$ is the T-bill rate in the last month of quarter t - 1 in annualized percent, and $IP_{t-1}$ is the 12 month growth in industrial production up to and including the last month of quarter t - 1 in percent

Table 6 shows that, as the model predicts, explained variance more than doubles when both a measure of next quarter's current economic health and expected future economic health are included in the same regression. For example, dividend yield and term spread in regression equation (Q1) are both highly significant in predicting next quarter's market risk premium, and the regression's adjusted $R^2$ exceeds the sum of the $R^2$s of the each variable's univariate regression. Furthermore, the level of statistical significance for

**Table 6—Multivariate Regressions of Quarterly Equity Risk Premiums on Financial State Variables Using Non-Overlapping Quarterly Observations, 1956:1 to 1993:4**[1]

$$PREM_t = \alpha + \sum_k \beta_k(\text{State Variable k})_{t-j} + \varepsilon_t$$

| No. | Constant | $DIV_{t-1}$ | $DEF_{t-1}$ | $TERM_{t-1}$ | $TBILL_{t-1}$ | $IP_{t-1}$ | $R^2_{adj}$ |
|---|---|---|---|---|---|---|---|
| | | | State Variables | | | | |
| Q1 | -10.179 | 2.732 | | 1.215 | | | 0.07 |
| | (0.023) | (0.028) | | (0.006) | | | |
| Q2 | -6.718 | 3.156 | | | -0.517 | | 0.07 |
| | (0.099) | (0.008) | | | (0.013) | | |
| Q3 | 0.448 | | -0.620 | 0.885 | | | 0.02 |
| | (0.804 | | (0.752) | (0.046) | | | |
| Q4 | 2.775 | | 0.053 | | -0.284 | | 0.00 |
| | (0.191) | | (0.978) | | (0.196) | | |
| Q5 | 0.579 | | | 1.061 | | -0.238 | 0.04 |
| | (0.554) | | | (0.019) | | (0.097) | |
| Q6 | 4.740 | | | | -0.411 | -0.268 | 0.04 |
| | (0.007) | | | | (0.056) | (0.061) | |
| Q7 | -10.542 | 3.804 | -3.872 | 1.350 | | | 0.08 |
| | (0.018) | (0.003) | (0.035) | (0.002) | | | |
| Q8 | -6.757 | 3.227 | -4.968 | 1.444 | | -0.219 | 0.09 |
| | (0.139) | (0.011) | (0.009) | (0.001) | | (0.097) | |
| Q9 | -5.552 | 3.440 | -4.620 | 1.058 | -0.256 | -0.229 | 0.10 |
| | (0.245) | (0.006) | (0.016) | (0.068) | (0.337) | (0.078) | |

[1] Each row represents one multivariate ordinary least squares regression. The value in parentheses below each regression coefficient is the coefficient's t-test p-value. The standard errors used in the t-tests are calculated to be consistent in the presence of unknown heteroscedasticity in a manner similar to White (1980). The right column lists the regression $R^2$s adjusted for degrees of freedom. The regressions use non-overlapping, quarterly frequency, quarterly equity risk premiums as the dependent variable and two or more lagged state variables as the independent variables. $PREM_t$ is the market risk premium during quarter t in percent, $DIV_{t-1}$ is the TSE 12 month trailing dividend yield measured in the last month of quarter t - 1 in percent, $DEF_{t-1}$ is the spread between long-term corporate and long-term government bond yields in the last month of quarter t - 1 in annualized percent, $TERM_{t-1}$ is the spread between long-term government bond and T-bill yields in the last month of quarter t - 1 in annualized percent, $TBILL_{t-1}$ is the T-bill rate in the last month of quarter t - 1 in annualized percent, and $IP_{t-1}$ is the 12 month growth in industrial production up to and including the last month of quarter t - 1 in percent

each variable appears to have increased dramatically. For instance, the significance of the dividend yield in the univariate regression is only 0.096, while the lowest level of significance in the five multivariate regressions in which it is included, along with at least one proxy for future economic health, is 0.028. These observations appear consistent for all the macroeconomic state variables.

The dividend yield and term spread variables appear the most significant of the five state variables. This is not surprising because they are the most significant in the univariate regressions. Dividend yield is highly significant in all its regressions and term spread is also significant in all its regressions, but only at the 10 percent level in equation (Q9). Without dividend yield in the regression, the default spread is insignificant with both measures of future economic activity. But when dividend yield is in the regression, it becomes highly significant. The T-bill rate shows little predictive power. It is only significant with dividend yields and also when it is the only proxy for future economic activity. Industrial production is not significant at the 5 percent level in any regression, but is significant at the 10 percent level in all regressions. Regression adjusted $R^2$s vary between 0.00 for equation (Q4) and 0.10 for equation (Q9) in which all state variables are present. $R^2$s equal or exceed 0.07 whenever the dividend yield variable is present.

Equation (Q9) is plotted in Figure 1. The plot shows that while the variability of the market premium variable is not fully predicted by the financial state variables, its sign and relative magnitude are predicted. The fact that excess returns are far more volatile than forecasted excess returns is not terribly surprising. A large body of literature demonstrates that stock returns are more volatile than explained by strictly fundamental factors.[3]

**Figure 1—Actual Versus Estimated Quarterly Equity Risk Premiums, 1956:2 to 1993:4**

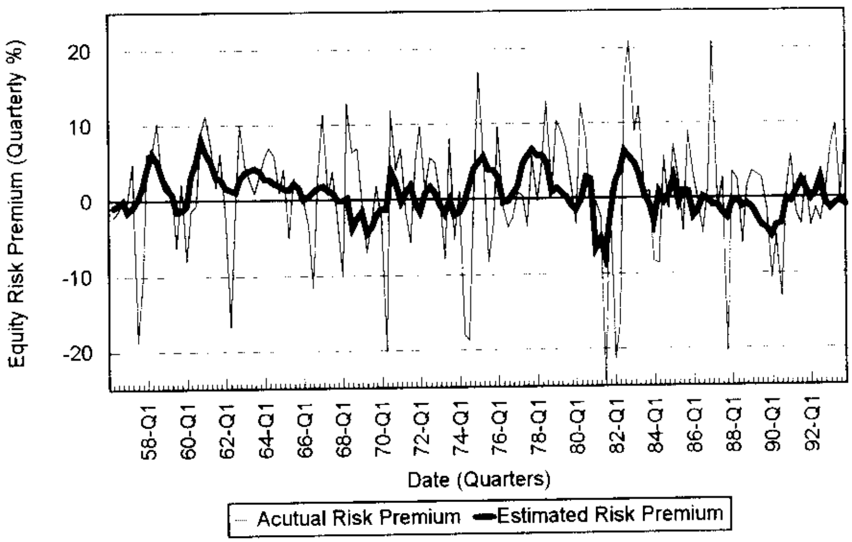



Table 7 shows multivariate regressions of yearly market premiums on the financial state variables using quarterly observations. The results demonstrate that the predictability characteristics of yearly market premiums are similar to those of the quarterly market premiums, with only several qualifications. First, the term spread variable becomes almost as statistically significant as the dividend yield variable. The $R^2$s of any regression that possesses the dividend yield variable, however, far exceed those regressions that do not. Second, the T-bill rate variable becomes more significant in the yearly market premium regressions than it is in the quarterly market premium regressions, although its

[3] Most notably, see LeRoy and Porter (1981), Shiller (1981), and De Bondt and Thaler (1985).

predictive power remains limited. Third, the industrial production variable is much more significant in the yearly regressions than it is in the quarterly regressions. Finally, the adjusted $R^2$s of the regressions have increased substantially such that the highest $R^2$ of 0.41 is obtained in equation (A9) which contains all five of the macroeconomic state variables.

The yearly market premium regression with all the macroeconomic state variables, equation (A9), is plotted against the market premiums in Figure 2. As expected, it shows that the variability of the market risk premium is reduced substantially from that of the quarterly market premium plotted in Figure 1.

Therefore, market risk premiums are predictable using the previously defined macroeconomic state variables. The predictive powers of the state variables individually are not nearly as great as in the multivariate regressions that include at least one proxy for next period's current economic health and at least one proxy for future economic health. This

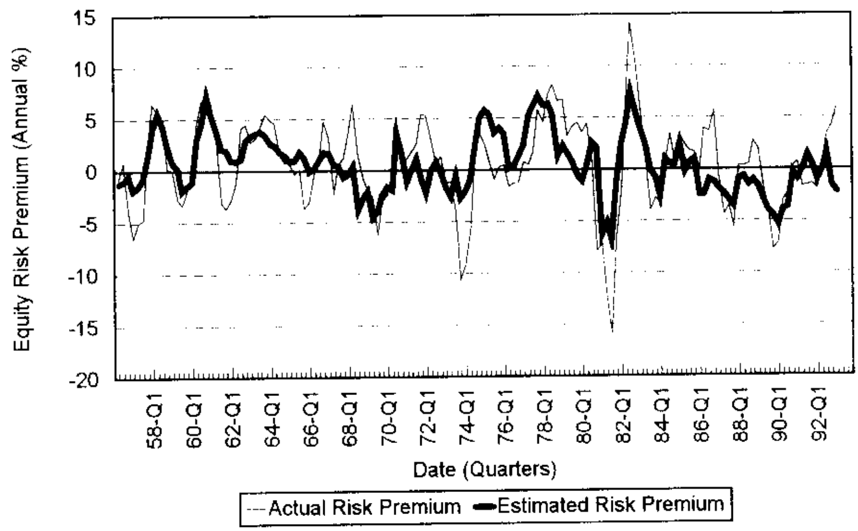
**Table 7—Multivariate Regressions of Yearly Equity Risk Premiums on Financial State Variables Using Quarterly Observations, 1956:1 to 1993:1[1]**

$$PREM_{t,t+3} = \alpha + \sum_k \beta_k(\text{State Variable } k)_{t-1} + \varepsilon_t$$

| No. | Constant | State Variables<br>$DIV_{t-1}$ | $DEF_{t-1}$ | $TERM_{t-1}$ | $TBILL_{t-1}$ | $IP_{t-1}$ | $R^2_{adj}$ |
|---|---|---|---|---|---|---|---|
| A1 | -49.52<br>(0.000) | 13.61<br>(0.000) | | 4.167<br>(0.000) | | | 0.29 |
| A2 | -38.73<br>(0.000) | 15.21<br>(0.000) | | | -1.712<br>(0.000) | | 0.29 |
| A3 | 1.152<br>(0.773) | | -0.614<br>(0.890) | 2.719<br>(0.013) | | | 0.04 |
| A4 | 7.130<br>(0.202) | | 0.903<br>(0.827) | | -0.653<br>(0.235) | | 0.00 |
| A5 | 3.333<br>(0.133) | | | 3.379<br>(0.002) | | -0.929<br>(0.003) | 0.12 |
| A6 | 14.82<br>(0.000) | | | | -1.097<br>(0.029) | -0.990<br>(0.002) | 0.09 |
| A7 | -51.66<br>(0.000) | 18.32<br>(0.000) | -16.42<br>(0.000) | 4.667<br>(0.000) | | | 0.38 |
| A8 | -40.52<br>(0.000) | 16.62<br>(0.000) | -19.64<br>(0.000) | 4.943<br>(0.000) | | -0.644<br>(0.014) | 0.40 |
| A9 | -37.26<br>(0.000) | 17.29<br>(0.000) | -18.72<br>(0.000) | 3.824<br>(0.000) | -0.730<br>(0.092) | -0.672<br>(0.009) | 0.41 |

[1] Each row represents one multivariate ordinary least squares regression. The value in parentheses below each regression coefficient is the coefficient's t-test p-value. The standard errors used in the t-tests are calculated to be consistent in the presence of unknown heteroscedasticity in a manner similar to White (1980). The right column lists the regression $R^2$s adjusted for degrees of freedom. The regressions use overlapping, quarterly frequency, annual equity risk premiums as the dependent variable and two or more lagged state variables as the independent variables. $PREM_{t,t+3}$ is the market risk premium during quarters t through t + 3 in percent, $DIV_{t-1}$ is the TSE 12 month trailing dividend yield measured in the last month of quarter t - 1 in percent, $DEF_{t-1}$ is the spread between long-term corporate and long-term government bond yields in the last month of quarter t - 1 in annualized percent, $TERM_{t-1}$ is the spread between long-term government bond and T-bill yields in the last month of quarter t - 1 in annualized percent, $TBILL_{t-1}$ is the T-bill rate in the last month of quarter t - 1 in annualized percent, and $IP_{t-1}$ is the 12 month growth in industrial production up to and including the last month of quarter t - 1 in percent

**Figure 2—Actual Versus Estimated Annual Equity Risk Premiums, 1956:2 to 1993:1**




is what the model presented earlier implies. Although the state variables are often highly significant, the best adjusted $R^2$ for the quarterly horizon regressions is only 0.10, although for the yearly horizon regressions adjusted $R^2$ peaks at 0.41. Furthermore, Figures 1 and 2 illustrate that the multivariate estimations predict much of the movement in the market risk premiums. While the forecasting model does not predict the volatility of the excess returns, it does perform well at predicting the sign of the market premium.

The models analyzed in this section are *ex post* best fit regressions, despite the fact that theoretically they use realized state variables to predict next period's market premium. Although the results do show that market premiums have been predictable from realized state variables, any test of the profitability of this model must be done using an *ex ante* model on out-of-sample data. This is the approach taken in the next section.

## PROFITABILITY FROM MARKET RISK PREMIUM PREDICTABILITY

If it can be shown that market risk premiums can be predicted reliably in period t with only data available from previous periods, then it may be stated that market risk premiums are *ex ante* predictable. It is argued by some, however, that no empirical test can show *ex ante* predictability because all empirical tests by definition are based on data already realized.[4] Nevertheless, showing that the model developed here would have been

[4] For further discussion of this issue, see Merton (1985).

profitable in a simulated *ex ante* manner is still valuable in building a stronger case for the predictability of market risk premiums.[5]

In addition, if the model can be shown to produce a higher risk-adjusted return than the market, it would illustrate the magnitude of the return that is foregone by the representative agent in the risk premium model presented earlier in the agent's bid to smooth consumption. That is, in the rational efficient market proposed in the model, risk premiums will be bid up or down as the representative economic agent attempts to smooth consumption based on his or her forecasts of current and future economic activity. In this theoretical world, the representative agent may forego higher risk-adjusted returns in order to try and obtain a smoother consumption path with no loss of utility. The agent is happy to forego the higher return, to the point where the marginal rate of substitution of expected consumption equals that of returns, because the loss of utility from a less smooth consumption path exceeds that of the utility lost from capturing lower stock returns.

To use the model for investment purposes, a trading strategy must be operationalized. The trading strategy analyzed here is a simple rule that states:

- If the expected market risk premium for period t is positive, invest in the TSE 300 index;
- If the expected market risk premium for period t is less than or equal to zero, invest in T-bills.

Given that on average TSE 300 stocks will earn a higher return than T-bills, to be successful the model must predict negative market premiums. If the model never predicts negative market premiums, then the market always would be predicted to have a higher return than T-bills and the market portfolio always would be held. Therefore, the model's return will be compared with a market buy-and-hold strategy. That is, the model is deemed profitable if it can obtain a higher return than a passive strategy of buying-and-holding the TSE 300 portfolio.

To implement the model in an *ex ante* manner, the investment decision in each period t must be based on the model generated from data known prior to period t. Therefore, a moving window regression methodology is used. Specifically, for every time period t, a regression of the form:

$$(11)\ PREM_t = \alpha + \beta_1 DIV_{t-1} + \beta_2 DEF_{t-1} + \beta_3 TERM_{t-1} + \beta_4 TBILL_{t-1} + \beta_5 IP_{t-1} + \varepsilon_t$$

is run for the four years immediately before period t. The period t observable state variables are substituted into the estimated regression equation to obtain the prediction for the market premium, $PREM_t$, in the quarter that is just beginning. If the predicted market premium is positive, invest in the TSE 300 index. If it is less than or equal to zero,

[5] Note that this test is performed over the same sample period as the previous *ex post* regressions; thus, a stronger case for the profitable predictability of risk premiums could be built if a hold-out sample from the *ex post* regressions were used in the tests. Given that the largest data set available is only 38 years, however, any hold-out sample would be too small to provide the power required in the statistical tests to differentiate the model performance from the market buy-and-hold performance.

invest in T-bills. This procedure is repeated such that quarterly market risk premium predictions are made at the beginning of each month until the end of the sample, 1993:4. Overlapping quarterly predictions are used to increase the power of the statistical tests. Because this methodology requires a four year estimation window, the first prediction period is 1960:2.[6]

Table 8 presents the results of the analysis for the full sample period and two equal subperiods. For the full sample period the average quarterly T-bill and TSE returns are 1.86 percent and 2.84 percent, respectively. The risk premium prediction model, however, generates a quarterly return of 3.65 percent, 356 basis points per annum above the TSE buy-and-hold return. The difference in mean returns generated from the risk premium model and the TSE portfolios is statistically significant at a confidence level of 99.9 percent. Moreover, the 356 basis points above market return is obtained with less risk as measured by standard deviation. The risk of the model portfolio at 5.92 percent is 27 percent lower than the risk of market portfolio at 8.06 percent. An F-test confirms that the model's risk is significantly lower than the TSE's risk with a confidence level greater than 99.9 percent. The model's higher return and lower risk is illustrated further with Sharpe's (1975) reward-to-variability index.[7] The Sharpe ratio shows that the model portfolio generates 0.303 percent return above the T-bill rate per unit of risk, and the TSE 300 portfolio generates a 0.122 percent return above the T-bill rate per unit of risk. Thus, on a risk-adjusted basis, the model portfolio generates returns above the T-bill rate that are 2.5 times those that the TSE 300 portfolio generates. The difference in Sharpe ratios is shown to be highly significant using Jobson and Korkie's (1981) difference in Sharpe ratios test statistic.

Table 8 also shows that the portfolio performance results over the whole sample are consistent in each of the two equal subperiods. The two subperiods differ markedly in the mean T-bill rate and TSE return. The T-bill rate from the first subperiod to the second subperiod almost doubles, and the TSE return increases commensurably. Nevertheless, the

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[6] Five, six, and seven year windows also are analyzed. The model performance in all of these cases is qualitatively similar to those of the four year window. In addition, regression coefficient stability is examined using the four year estimation windows. Only 26.9 percent of the dividend yield coefficients, 36.8 percent of the default spread coefficients, and 20.0 percent of the term spread coefficients are of the hypothesized positive sign, while 83.7 percent of the T-bill coefficients and 71.9 percent of the industrial production growth coefficients are of the hypothesized negative sign. Furthermore, 38.0 percent of dividend yield coefficients, 38.0 percent of the default spread coefficients, 33.6 percent of the term spread coefficients, 55.1 percent of the T-bill coefficients, and 27.4 percent of the industrial production growth coefficients are statistically significant at the 5 percent significance level.

[7] Sharpe's (1975) reward-to-variability index is given by:

$$S_P = \frac{(R^P_{ave} - R^F_{ave})}{\sigma_P}$$

where:

$R^P_{ave}$ = The average portfolio return;

$R^F_{ave}$ = The average T-bill rate; and

$\sigma_P$ = The standard deviation of the portfolio.

It measures the risk premium that a portfolio achieves per unit of risk.

**Table 8—Profitability Analysis of a Simple Investment Strategy Using Quarterly Equity Risk Premium Forecasts Obtained From Four Year Regression Windows on Previously Available Data, April 1960 to December 1993[1]**

| | | Full Period 1960:4 to 1993:12 | Subperiod #1 1960:4 to 1977:2 | Subperiod #2 1977:3 to 1993:12 |
|---|---|---|---|---|
| Mean Returns (Quarterly %) | T-bill Portfolio | 1.858% | 1.259% | 2.457% |
| | TSE Portfolio | 2.843% | 2.173% | 3.515% |
| | Model Portfolio | 3.651% | 2.910% | 4.394% |
| | (p-value)[2] | (0.001) | (0.027) | (0.011) |
| Standard Deviations (Quarterly %) | T-bill Portfolio | 0.848% | 0.451% | 0.719% |
| | TSE Portfolio | 8.055% | 7.398% | 8.632% |
| | Model Portfolio | 5.917% | 4.890% | 6.725% |
| | (p-value) | (0.000) | (0.000) | (0.000) |
| Sharpe Ratios | TSE Portfolio | 0.122 | 0.124 | 0.122 |
| | Model Portfolio | 0.303 | 0.338 | 0.287 |
| | (p-value)[4] | (0.000) | (0.000) | (0.000) |
| Model Portfolio Trading Statistics | No. of Predictions | 405 | 203 | 202 |
| | No. of Trades | 63 | 38 | 25 |
| | % of Time in Market | 56.79% | 52.22% | 61.39% |
| | Transaction Cost to Nullify Model's Risk-Adjusted Excess Return | 6.885% | 5.582% | 9.008% |
| Bear Market Statistics | No. of Actual Bears | 162 | 78 | 84 |
| | No. of Successful Predictions | 94 | 52 | 42 |
| | Conditional Probability $p_1$ | 0.580 | 0.667 | 0.500 |
| | (p-value)[5] | (0.010) | (0.001) | (0.250) |
| Bull Market Statistics | No. of Actual Bulls | 243 | 125 | 118 |
| | No. of Successful Predictions | 162 | 80 | 82 |
| | Conditional Probability $p_2$ | 0.667 | 0.640 | 0.695 |
| | (p-value)[5] | (0.000) | (0.000) | (0.000) |
| Henriksson and Merton Test of Market Timing $H_0$: $p = p_1 + p_2 = 1$ | Total Conditional Probability $p = p_1 + p_2$ (p-value)[6] | 1.247 (0.000) | 1.307 (0.000) | 1.195 (0.001) |

[1] Results are based on overlapping monthly predictions of next quarter's risk premium. Risk premium forecasts for subsequent quarters are made on a monthly basis using monthly frequency lagged information variables ($DIV_{t-1}$, $DEF_{t-1}$, $TERM_{t-1}$, $TBILL_{t-1}$, and $IP_{t-1}$) with overlapping quarterly market risk premiums as the dependent variable. The regression windows use the prior four years of monthly data. The model returns are based on investing in the TSE whenever the forecasted risk premiums are positive and in T-bills whenever the forecasted risk premiums are negative

[2] The p-values are for one-tailed paired t-tests. The null hypothesis is that the model's mean quarterly return is less than or equal to the TSE's total mean quarterly return

[3] The p-values are for difference in variance F-tests with the null hypothesis that the variances of the model returns and the TSE returns are equal

[4] The Sharpe ratio test statistic is derived and discussed in Jobson and Korkie (1981). The p-values are for one-tailed tests of Sharpe ratio equality where the null hypothesis is that the Sharpe ratio of the TSE portfolio is greater than or equal to the Sharpe ratio of the model portfolio

[5] The p-values are for one-tailed binomial tests of the null hypothesis that the conditional probability of successful bear (or bull) market predictions is less than or equal to 0.50, which would be obtained by random chance if the model had no predictive capability. It is assumed that the sample size is large enough to use a normal approximation for the binomial distribution

[6] The market timing test is the Henriksson and Merton (1981) nonparametric market timing test. The p-value of rejecting the null hypothesis of no market timing ability (i.e., p = 1) is based on a normal approximation to a hypergeometric distribution

model portfolio outperforms the TSE buy-and-hold by 74 basis points per quarter in the first subperiod and by 88 basis points per quarter in the second quarter. T-tests confirm that the model outperforms the TSE in raw returns in both the subperiods. Furthermore, the model return is generated with 34 percent and 22 percent less risk than the TSE return in each of the respective subperiods. These differences in risk are also highly statistically significant. Combining risk and return into the Sharpe ratio shows that the model portfolio generates 2.73 and 2.35 times the risk-adjusted returns of the TSE buy-and-hold portfolio in the first and second subperiods, respectively. The Jobson and Korkie (1981) Sharpe ratio test confirms that the Sharpe ratios of the model are statistically higher than those of the TSE portfolio in both subperiods, with greater than 99.9 percent confidence.

The above analysis assumes that trading transaction costs are zero. If transaction costs are high enough to cancel the model gain over the TSE buy-and-hold return, then the market may be considered efficient in the Grossman and Stiglitz (1980) sense. The trading statistics shown in Table 8 illustrate that trades occur in only 15.6 percent of all the prediction periods, in only 18.7 percent of the first subperiod predictions, and in only 12.4 percent of the second subperiod predictions. Using these trading statistics, it is possible to calculate the transaction costs required to nullify the model portfolio's excess risk-adjusted returns relative to the TSE buy-and-hold portfolio. The round-trip transaction cost per trade required to nullify the model's excess risk-adjusted return is 6.9 percent over the whole sample period, 5.6 percent in the first subperiod, and 9.0 percent in the second subperiod. These transaction costs are likely much higher than actual transaction costs, especially in the last subperiod, even if the bid-ask spread cost is included.[8]

The Henriksson and Merton (1981) nonparametric test of market timing is employed to quantify the significance of the market timing ability provided by the model. The test is based on the idea that the conditional probability of predicting a bear market given that a bear market occurs, $p_1$, is 50 percent if no market timing ability is present.[9] Similarly, with no market timing ability, the conditional probability of predicting a bull market given that a bull market occurs, $p_2$, is 50 percent. Thus, the null hypothesis of no market timing ability is that the sum of these two conditional probabilities, p, is unity.

The Henriksson and Merton (1981) market timing test is developed in the lower half of Table 8. First, the conditional probability of predicting a bear market given that a bear market occurs, $p_1$, is 58.0 percent over the whole sample period. A binomial test confirms that this conditional probability of successful bear market predictions is greater than 50 percent at the 99 percent confidence level. The conditional probability of predicting a bear market in each of the subperiods is 66.7 percent and 50.0 percent, respectively, indicating that the model appears to have been better at predicting bear markets in the first half of the sample. Second, the conditional probability of predicting a bull market given

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[8] Transaction costs in Canada have been falling steadily since April 1983, when the TSE adopted negotiated commission rates. In recent years individual investors face discount transaction costs of approximately 0.20 percent on a \$20 share (*Globe and Mail*, 1993). The TSE estimates that the average transaction cost on transactions valued at more than \$500,000 between 1977 and 1980 is 0.36 percent. On transactions prior to 1977 the transactions costs are marginally higher.

[9] A bear market is defined as any time period that the TSE 300 total return is less than or equal to the T-bill rate. Similarly, a bull market is defined as any time period that the TSE 300 total return is greater than the T-bill rate.

that a bull market occurs is 66.7 percent for the whole sample period, 64.0 percent in the first subperiod, and 69.5 percent in the second subperiod. Each one of these conditional probabilities is significantly greater than 50 percent at high confidence levels. Finally, the sum of the conditional probabilities for the whole sample period of 1.25 (or 1.31 and 1.20 for each of the respective subperiods) is tested against the null hypothesis that the sum equals unity. The no market timing null hypothesis is rejected with at least 99.9 percent confidence for the whole sample and each of the subsamples. Accordingly, the model appears to possess market timing ability such that the conditional probability of successful bear market predictions, the conditional probability of successful bull market predictions, and the total conditional probability of successful bear and bull market predictions statistically exceeds random chance.

Therefore, by using the market premium prediction model together with a simple trading rule in an *ex ante* manner, an investor could have earned an abnormally high risk-adjusted return relative to a buy-and-hold strategy. Do these findings contradict market efficiency? The question is not answerable. Any test of market efficiency is a joint test of market efficiency and the model used to test for efficiency.[10] Because the model presented earlier permits time-varying market risk premiums, the fact that the regression equations can be used to predict market premiums does not violate market efficiency. Economic agents rationally expect the market risk premium to vary with the current and future health of the economy. If current and future economic health is measurable by the state variables suggested in this paper, then it is rational for economic agents to form expectations of the market risk premium based on these state variables. Rational expectations dictate that the market risk premium should be predictable both *ex ante* and *ex post*.

Most asset pricing models do not allow for negative expected risk premiums [for example, Sharpe's (1964) CAPM and Merton's (1973) ICAPM]. If these models were the true models of the economy, then market rationality and efficiency would be violated if one consistently could predict negative market risk premiums. On the other hand, some models of asset pricing do allow rational economic agents to form expectations of negative market risk premiums. The simple model presented earlier, which is based on a Lucas (1978) and Breeden (1979) consumption economy, is one of these. Therefore, if the model presented in this paper is the true model of the economy, then none of the results obtained here violate market efficiency. This does not mean that the model presented here is the true model. Models of bounded rationality [for example, those proposed by De Bondt and Thaler (1985) and Summers (1986)] are also consistent with the empirical results of this paper.

## CONCLUSIONS

A theory for the formation of expected market risk premiums is presented that is based on a representative consumer economy. It hypothesizes that market risk premiums are correlated negatively with recent output growth and correlated positively with future output growth. Both hypotheses are supported empirically by 38 years of Canadian data. The theory, by linking market premiums to the health of the economy, allows for the modeling of market risk premium expectations as a function of macroeconomic state vari-

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[10] See Fama (1970, 1991) for excellent expositions on market efficiency.

ables if the state variables can be shown to predict output growth. Five state variables are studied: dividend yield, default spread, term spread, T-bill rate, and industrial production growth. All the state variables significantly predict GDP growth. In particular, the dividend yield, default spread, and industrial production growth state variables are shown to predict next quarter's current output growth. The term spread and T-bill rate are shown to predict next quarter's expected future output growth. Thus, the state variables show that they are possible candidates for predicting next period's market risk premium as well.

In *ex post* regressions of quarterly and annual market risk premiums on the macroeconomic state variables, significant forecasting power is found. First, in quarterly horizon expected market premium regressions, the dividend yield proves to be the most powerful of the proxies of current economic health, and the term spread proves to be the most powerful of the proxies for future economic health. Together they explain 7 percent of the variance of quarterly equity premiums, while all five macroeconomic state variables explain 10 percent of the variance. In the annual horizon regressions, the dividend yield and default spread are equally powerful proxies for current economic health, and term spread remains the most powerful proxy of future economic health. These three variables explain 38 percent of yearly horizon risk premiums, while all five state variables explain 41 percent of the variance.

In general, the Canadian results correspond with Chen's (1991) study of the relationship between U.S. market risk premiums and the macroeconomy. Nevertheless, three differences should be highlighted. First, while Chen and this study find that the dividend yield is the most important of the proxies of current economic health for predicting equity risk premiums, Chen finds that the T-bill rate is the more important of the two proxies for future economic health. It appears that the term spread, not the T-bill rate, is the more important proxy of future economic health for predicting equity premiums in Canada. Second, although Chen finds that the default spread is not as significant for predicting equity premiums as dividends, he does find that it possesses the hypothesized positive coefficient. In Canada the default spread appears a little more significant than it is in the U.S., but it consistently possesses a negative coefficient. Finally, despite using identical macroeconomic state variables, Chen finds that U.S. equity risk premiums are much more predictable than Canadian risk premiums, especially for the shorter horizon premiums. Chen finds that the five state variables predict 17 percent of the variance of quarterly horizon risk premiums and 48 percent of the variance of yearly horizon risk premiums, which compares with only 10 percent and 41 percent, respectively, for Canadian risk premiums. This may imply that the much smaller and more inefficient Canadian stock market may become more predictable as it grows and becomes more efficient. In the subperiod analysis it is shown that Canadian equity risk premiums in the most recent subperiod possess the greatest degree of predictability. This tends to support the argument that predictability is a rational outcome of economic agents smoothing their consumption paths in an efficient market.

A moving window regression analysis is performed to test the predictive power and potential profitability of the model. Based on a simple investment rule, the model generates a return that is 356 basis points per annum above the return of TSE 300 total return index, with only 73 percent of the risk, over a 34 year test period. Several statistical tests confirm that the model generates higher risk-adjusted returns, usually at greater than the

99.9 percent confidence level. In addition, market timing tests confirm that the model possesses significant market timing ability. This significantly profitable predictability adds much importance to the market efficiency debate. Assuming that the simple model presented in this paper is the true model of the economy, profitable predictability of market risk premiums does not violate market efficiency. Nevertheless, the empirical results obtained in the paper also may be consistent with inefficiency or bounded rationality models.

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