The Predictive Ability of the Bond-Stock Earnings Yield Differential Model

KLAUS BERGE, GIORGIO CONSIGLI, AND WILLIAM T. ZIEMBA

KLAUS BERGE
is a financial controller for Allianz SE in Munich, Germany.
klaus.berge@allianz.com

GIORGIO CONSIGLI
is an associate professor in the Department of Mathematics, Statistics, and Computer Science at the University of Bergamo in Bergamo, Italy.
giorgio.consigli@unibg.it

WILLIAM T. ZIEMBA
is Alumni Professor of Financial Modeling and Stochastic Optimization, Emeritus at the University of British Columbia in Vancouver, BC, Canada., and Visiting Professor at the Mathematical Institute, Oxford University and the ICMA Centre, University of Reading.
ziemba@interchange.ubc.ca

The Federal Reserve (Fed) model provides a framework for discussing stock market over- and undervaluation. It was introduced by market practitioners after Alan Greenspan's speech on the market's irrational exuberance in November 1996 as an attempt to understand and predict variations in the equity risk premium (ERP). The model relates the yield on stocks (measured by the ratio of earnings to stock prices) to the yield on nominal Treasury bonds. The theory behind the Fed model is that an optimal asset allocation between stocks and bonds is related to their relative yields and when the bond yield is too high, a market adjustment is needed resulting in a shift out of stocks into bonds. If the adjustment is large, it causes an equity market correction (a decline of 10% within one year); hence, there is a short-term negative ERP. The model predicted the 1987 U.S., 1990 Japan, 2000 U.S., and 2002 U.S. corrections.

A similar valuation model using the 30-year long bond rate and the equity yield difference as the underlying measure of relative equity market valuation was suggested by Ziemba and Schwartz [1991] (see also Ziemba [2003], and Koivu, Pennanen, and Ziemba [2005]). The partial predictability of stock returns has been analyzed and confirmed by Fama and French [1988b], and Poterba and Summers [1988]. The ability of financial and accounting variables to predict individual stock prices and stock indices has been studied by Campbell [1987, 1990, 1993]; Campbell and Shiller [1988]; Campbell and Yogo [2006]; Fama and French [1988a, 1989]; Goetzmann and Ibbotson [2006]; Jacobs and Levy [1988]; Lakonishok, Schleifer, and Vishny [1994]; Polk, Thompson, and Vuolteenaho [2006], and Ziemba and Schwartz [1991, 2000].

The Fed model has been successful in predicting market turns, but in spite of its empirical success and simplicity, the model has been criticized. First, it does not consider the role played by time-varying risk premiums in the portfolio selection process, yet it does consider a risk-free government interest rate as the discount factor of future earnings. More seriously, the inflation illusion (the possible impact of inflation expectations on the stock market) as suggested by Modigliani and Cohn [1979] is not taken into consideration. Second, the model assumes the comparability of an earnings-to-price ratio (EP), a real quantity, to a nominal, bond-induced interest rate (Campbell and Vuolteenaho [2004]). Asness [2000, 2003], and Ritter and Warr [2002] discussed these issues. Consigli, MacLean, Zhao and Ziemba [2006] propose a stochastic model of equity returns based on an extension of the Fed model inclusive of a risk premium in which market corrections are endogenously generated by the bond–stock yield difference. The model accommodates both cases of prolonged yield deviations leading to a long series of small declines in the equity market and the case, which is peculiar to recent speculative bubbles, of a series of corrections over limited time periods. The inclusion of the yield differential as a key driver of the market correction process is tested and the model is validated with market data.

The next, or second, section discusses the bond–stock valuation model and shows its original application to the October 1987 correction. Hence, the ERP is not constant and thus is partially predictable. The third section discusses overvaluation and possible forthcoming corrections. The fourth section discusses empirical evidence from the U.S., U.K., Japan, Germany, and Canada. The fifth section analyzes endogenous instability, risk premiums, and the nominal-versus-real variable issue. The last section concludes.

VALUATION MODEL, EQUITY YIELD, AND 10-YEAR INTEREST RATE

The Fed model in its original 1996 form states the dependence of a fair stock price level, $\tilde{p}(t)$, at time t to the expected earnings, $E(t)$, and the 10-year Treasury rate, $r(t)$. Earnings expectations are fully incorporated in prices and discounted at the current 10-year risk-free rate for $t = 1, 2, \ldots,$

$$\tilde{p}(t) = \frac{E(t)}{r(t)} \tag{1}$$

Earnings per share, $y(t)$, are computed by equity investors as the expected earnings for a given unit investment in the stock market with equity shares, $S(t)$,

$$y(t) = \frac{E(t)}{S(t)} \tag{2}$$

then $S(t) = \frac{E(t)}{Y(t)}$. There is a direct relationship between the equity yield in Equation (2) and the risk-free rate in Equation (1). The ratio of the current market value to the theoretical value is the bond–stock yield ratio, $BSYR(t)$,

$$\frac{S(t)}{\tilde{p}(t)} = \left[\frac{E(t)}{y(t)} \Big/ \frac{E(t)}{r(t)} \right] = \frac{r(t)}{y(t)} = BSYR(t) \tag{3}$$

The bond–stock earnings yield differential, $BSEYD(t) = r(t) - y(t)$, is related to the (random) valuation measure and the equity yield,

$$\frac{S(t)}{\tilde{p}(t)} - 1 = \frac{BSEYD(t)}{y(t)} \tag{4a}$$

$$BSEYD(t) = \left[BSYR(t) - 1 \right] y(t) \tag{4b}$$

The differential reflects the difference between the current market value and its theoretical value. A more theoretically sound motivation for the predictive ability of the BSEYD is the basic Gordon formula, where EP is the forward earnings yield (which Schwartz and Ziemba [2000] show is the best predictor of at least individual Japanese stock prices),

EP – nominal yield = equity risk premium – real growth – inflation, so the BSEYD can be used as a proxy for the unobservable right-side economic variables.

For a given equity yield, the BSEYD and the BSYR can be used to identify zones of under- and overvaluation and to forecast possible forthcoming market adjustments. Under the Fed model assumptions, we expect the market, even with prolonged deviations, to fluctuate around its theoretical value and, thus from time to time, the BSYR should converge to one and the BSEYD to zero. Alternatively, a market risk premium should be accounted for and future earnings accordingly discounted by an interest rate above the prevailing risk-free rate (10-year maturity rates in the canonical Fed model assumption).

A classic example of the use of this model is the stock market correction in October 1987 illustrated in Exhibit 1. It is from this application that Ziemba's Yamaichi Research Institute study group in 1988 formulated the BSEYD measure described in Ziemba and Schwartz [1991], and Ziemba [2003]. The danger zone was entered in May 1987 and the correction occurred in October, four months later. During June, July, and August, investors kept rebalancing their portfolios from the bond to the equity market (MSCI TRI + 13.87% over the quarter). The equity market then fell –31.80% in the following quarter (September to November 1987) with the majority of the decline occurring in October. In order to validate the approach, Berge and Ziemba [2006] used eight different strategies to test the predictive ability of the BSEYD or, equivalently, the BSYR (see Exhibit 2). The strategies

EXHIBIT 1
Behavior of BSEYD in U.S. Around October 1987 Stock Market Correction

Date	10Y T-Bond Yield	EP Ratio	BSEYD	MSCI TRI Return in %
Sep-86	7.45	7.19	0.26	-8.50
Oct-86	7.43	6.81	0.62	5.68
Nov-86	7.25	6.78	0.47	2.35
Dec-86	7.11	7.07	0.04	-2.52
Jan-87	7.08	6.26	0.82	13.28
Feb-87	7.25	5.96	1.29	3.59
Mar-87	7.25	5.76	1.49	2.70
Apr-87	8.02	5.8	2.22	-0.90
May-87	8.61	5.85	**2.76**	0.56
Jun-87	8.40	5.59	**2.81**	5.18
Jul-87	8.45	5.36	**3.09**	4.75
Aug-87	8.76	4.88	**3.88**	3.94
Sep-87	9.42	5.03	**4.39**	-2.13
Oct-87	9.52	6.35	3.17	**-21.22**
Nov-87	8.86	7.38	1.48	-8.45
Dec-87	8.99	6.87	2.12	7.04
Jan-88	8.67	6.66	2.01	4.28
Feb-88	8.21	6.86	1.35	4.19
Mar-88	8.37	7.14	1.23	-3.35
Apr-88	8.72	7.08	1.64	0.92
May-88	9.09	7.51	1.58	0.86
Jun-88	8.92	7.29	1.63	4.65
Jul-88	9.06	7.32	1.74	-0.31
Aug-88	9.26	8.77	0.49	-3.35

Source: Berge and Ziemba [2006].

are defined over either 5- or 10-year time-data intervals, under normal or historical return distribution assumptions, and different fractile levels on such distributions for exiting and entering the equity market. The threshold levels were specified for the BSEYD measure.

These 60 or 120 observations, respectively, including the value of the current month, define the threshold levels for the end of that month. As time evolves, the most recent monthly value is added and the oldest value is omitted. Moving intervals diminish the impact of changes in the regulatory framework of the economy on EP ratios over time, since high past values of the BSEYD are eventually excluded. For the historical values of the BSEYD, two different distributional concepts are used to define the predetermined exit and entry threshold levels: normal and historical. In the case of normality, the mean and standard deviation of the historical range of BSEYD*s* are

$$\overline{BSEYD_{t,d}} = \frac{1}{d} \sum_{j=t-d+1}^{t} BSEYD_j \tag{5}$$

and

$$s_{BSEYD_{t,d}} = \sqrt{\frac{1}{d-1} \sum_{j=t-d+1}^{t} (BSEYD_j - \overline{BSEYD_{t,d}})^2} \tag{6}$$

respectively, where d is the length of the interval considered. The exit threshold level is

$$TL_{t,d,\alpha_1}^{Out,ND} = \overline{BSEYD_{t,d}} + z_{\alpha_1} \cdot s_{BSEYD_{t,d}} \tag{7}$$

and the entry threshold level is

$$TL_{t,d,\alpha_2}^{In,ND} = \overline{BSEYD_{t,d}} + z_{\alpha_2} \cdot s_{BSEYD_{t,d}} \tag{8}$$

EXHIBIT 2
Strategies Used to Evaluate the Robustness (Predictive Ability) of BSEYD-based Strategies

Strategy	Length of Determining Interval (Years)	Distribution Type	Fractile for Exit Threshold Level (α_1)	Fractile for Entry Threshold Level (α_2)
1	5	Historical	90%	80%
2	5	Historical	90%	70%
3	5	Normal	95%	85%
4	5	Normal	95%	75%
5	10	Historical	95%	85%
6	10	Historical	95%	75%
7	10	Normal	90%	85%
8	10	Normal	90%	80%

Source: Berge and Ziemba [2006].

where $Z_{\alpha 1}$ and $Z_{\alpha 2}$ are the α_1- and α_2-fractiles, respectively, of the standard normal probability distribution. The second concept calculates the α_1- and α_2 fractiles of the historical distribution. The α-fractile of d observations is

$$\tilde{x}_{\alpha} = x_{(k)} + (x_{(k+1)} - x_{(k)}) \cdot (1-\alpha) \qquad (9)$$

where $k = d \cdot \alpha$ and $x_{(k)}$ is the k- smallest value of the d observations starting at the end of month $(t - d + 1)$ and ending at the end of month t.

The strategies are evaluated over the 1979–2005 period in five equity markets—the U.S., U.K., Germany, Canada, and Japan. The stock market index data are from Morgan Stanley Capital International (MSCI) and utilize a uniform methodology across all markets. The total return indices (TRI) are calculated with gross dividends (before taxes) reinvested to estimate the total return on the market that would be achieved by reinvesting one-twelfth of the annual dividend reported at every month-end. The price-to-earnings (PE) ratios provided by MSCI refer to the companies in the respective MSCI TRI. They are the sum of the weighted latest share prices in local currency divided by the sum of the weighted most recent trailing 12-month earnings (losses) per share. MSCI does not estimate future earnings, so only past earnings are included in their data. Actual earnings are entered in the database as soon as they are reported at an adequately detailed level. The advantage of the MSCI indices over other indices is that even when the overall market experiences losses, PE ratios, in this case negative, can be calculated. For cash equivalents, the yield on 3-month T-bills is used. Data for 3-month T-bills are from Global Financial Data (GFD) and Thomson Financial Datastream.

Data on 10-year government bond yields come from various sources. The U.S. data are from the Federal Reserve. Yields are of constant maturity interpolated from the daily yield curve. Data for Germany were supplied by the Deutsche Börse AG and are calculated similarly as for U.S. data. Data for the U.K. and Japan come from GFD. These yields refer to government bonds with maturities closest to 10 years. Data for Japan are available beginning in May 1980. Japanese T bill data were not updated monthly until December 1981. Canadian government bond yields were obtained from the Bank of Canada.

For the first strategy, five years of monthly observations are used prior to 1979 to estimate the historical (or frequency) distribution of the 90% and 80% fractiles. Every month the data includes the realized monthly return and discards the oldest observation to keep the five-year window constant. Every strategy has well-defined equity market entry and exit values—once in, the strategy suggests 100% in equities, once out 0% (i.e., a 0–1 stock–bond strategy). The appendix contains results for the five markets for the 35-year period 1970–2005. Every fractile pair defines the market *danger zone* used in defining optimal investment strategies and portfolio rebalancing.

Strategy 6 was preferable in terms of total return over the 25-year period 1980–2005 in the U.S. market. Exhibit 3 shows exiting and entering months according

EXHIBIT 3

Required Exit and Re-Entry Fractiles for Strategy 6 for Optimal Performance

Correction Number	Start Date	Value of BSEYD (Previous Month)/ Corresponding Required Exit Fractile	End Date	Value of BSEYD/ Corresponding Required Re-Entry Fractile
3	April 1981	1.74 / 97.5%	September 1981	2.04 / 96.5%
4	December 1981	1.26 / 87.5%	July 1982	0.00 / 65.0%
5	September 1987	3.88 / 99.0%	November 1987	1.48 / 55.0%
6	June 1990	2.31 / 77.0%	October 1990	1.40 / 41.0%
7	July 1998	1.83 / 62.0%	August 1998	0.96 / 25.0%
8	April 2000	2.99 / 94.0%	September 2001	1.11 / 18.5%
9	April 2002	2.39 / 84.0%	September 2002	-0.32 / 0.0%

Note: Corrections 1 and 2 predate April 1981. See Exhibit A1 in the appendix.

to these thresholds and the BSEYD signal in the previous month.

Exhibits A1–A10 in the appendix show the following for each of the five countries: stock market corrections (declines of more than 10%) and their durations, as well as the results of the strategies in terms of percent of time in the stock market, mean log return, standard deviation, Sharpe ratio, mean excess return, and terminal value. All criteria are compared to actual stock market total returns from 1975–2005 for Strategies 1 to 4 and from 1980–2005 for Strategies 5 to 8. Dimson, Marsh, and Staunton [2006, 2007] presented returns over more than 100 years, but did not discuss partially predictive investment strategies as did Berge and Ziemba [2006].

The U.S. had 9 corrections from 1975 to 2005. The terminal values, Sharpe ratios, and so forth all suggest that the strategies added considerable value. The main test is, are you better off being out of the stock market when the BSEYD measure suggests you should be? For example, \$100 grew to \$4,650 in the stock market and from \$8,480 to \$10,635 with Strategies 1 to 4 for the period 1975–2005. In addition, the portfolio variance was less because about 15% to 20% of the time one is out of the stock market. The period 1980–2005 had similar positive results for the various strategies.

Japan had 7 corrections including the 31-month 56.2% decline starting in January 1990. Ziemba [2003], and Ziemba and Schwartz [1991] provided calculations showing that this correction was the most in the danger zone of any of the measures in the 42-year period 1948–1990. Ziemba and Schwartz found that every time the BSEYD measure was in the danger zone during the period 1948–1988, there was a correction of at least 10% from the current stock index level. The BSEYD measure produced no misses (12/12), but only 12 of the 20 corrections from 1948 to 1988 resulted from its predictive ability. The other 8 corrections were instigated by other causes. The results for Japan, as for the U.S., are good for the measure: ¥100 grows to ¥213.88 with the market index from 1985 to 2005, but to ¥455.72 to ¥498.62 with Strategies 1 to 4. Strategies 5 to 8 also had good predictive results for the period 1990–2005.

The results for the other three countries were not as good in terms of final wealth levels over the period 1975–2005. All the strategies, however, were superior to a buy and hold strategy in terms of Sharpe ratios and in the final wealth levels during the period 1980–2005. For the U.K., most of the strategies outperformed the stock market return of the buy and hold strategy, but some strategies did underperform and the outperformance of the winning strategies was minimal.

The U.K. had 15 corrections, mostly of short duration, but the 17.9% decline of September 2000 lasted 13 months and the April 2002 decline of 31.6% lasted 10 months.

The results in Canada were similar to those of the U.S. with 5 of its 12 corrections having declines of over 20%, including a 41.2% decline in September 2000 over 13 months. With 13 corrections, Germany also had similar results with the March 2000 decline of –44% lasting 19 months and the April 2002 decline of –53.9% spread over 12 months.

The basic conclusion is that the bond–stock model has had positive predictive ability, working as well as it has in these five countries, especially in the 1980–2005 period, with the results in the U.S. and Japan the best. Portfolio strategies based on the bond–stock relative valuation measure have produced superior returns relative to a buy and hold strategy.

OVERVALUATION AND FORTHCOMING CORRECTIONS

The evidence shows that the effectiveness of the bond–stock yield difference measure varies from market to market and additional indicators may be required to generate robust strategies across markets and times. We focus on the properties of the yield ratio as a signal of forthcoming market corrections, thus suggesting an immediate exit from the equity market, but investors will follow different strategies.

A critical view on the role of the bond–stock yield differential as a predictive variable of future market adjustments depends on the market evidence. Consider the following alternative scenarios from which an indirect economic validation of the approach can be derived:

1. The stock market is overvalued according to the bond–stock yield differential and a subsequent market correction is observed; this evidence supports the suggested approach.
2. Market corrections are observed even if the yield differential is within the no-danger zone.
3. Even if the yield differential remains for an extended period in the danger zone, no market corrections occur.
4. Market corrections do not occur for an extended period of time and the yield differential is around zero.

The first and fourth market conditions support the BSEYD model and suggest that a large difference between the earnings per share at an aggregate level in the economy and the 10-year bond rate is a sufficient condition for a subsequent correction.

The second and third conditions suggest that investors act independently and do not rely on the bond–equity yield differentials to determine their portfolio strategies and the strategic bond–equity portfolio composition. If corrections are observed when the yield differential is relatively low, this implies that the yield differential may very well provide a sufficient, but not necessary, condition for corrections. In this case, other variables are determining the adjustment. Finally the absence of corrections in the presence of persistently high differentials would contradict the sufficient condition.

We directly test the short-term predictive power of the yield spread with respect to market returns, verifying the market response to diverging bond and stock yields observed in previous periods. A BSEYD in the upper tail of the frequency distribution should, in general, anticipate a market correction of varying intensity. To document short-term predictability we use a simple predictive regression model based on monthly returns in the equity market and one-, two-, and three-month lagged yield spreads. The bivariate prediction equation for each market k (U.S., U.K., Japan, Germany, and Canada) is

$$\rho_k(t) = a_k + b_k\left[\gamma_k(t-h) \geq z_{k,90\%}^{t-h}\right] + e_k(t)h \\ = 1,2,3 \quad k = 1,\ldots,5 \tag{10}$$

where

ρ_k(t) is the month-to-month log equity return for market k, over $(t-1, t)$, namely $\ln\left(\frac{s_k(t)}{s_k(t-1)}\right)$, $\gamma_k(t-h)$ is the BSEYD or *yield spread* at time $t-h$ one, two, and three months earlier, and $z_{k,90\%}^{t-h}$ is the 90th percentile of the yield spread historical distribution estimated at time $t-h$ over the market history $(t-h-H, t-h)$, where H defines a 15-year data history.

For every t, starting with the period January 1970 to December 1984, we estimate the frequency distribution on this window, first identifying the 90% percentile and then moving forward one month, then identifying the associated 90% percentile, and repeating with a constant time window.

Once such a series of critical values has been identified, we test for t = Jan1985,…, Dec2004, to determine if the current yield spread falls above the current critical value, namely, $\gamma_k(t-h) \geq z_{k,90\%}^{t-h}$. Then, conditional on the yield spread excess, we determine the market return one, two, and three months ahead, and identify the residuals for each month and market. In this way, we estimate directly from the tail of the distribution the market-specific coefficients a_k, b_k over the 20-year period.

This procedure tests the market return dependence on the one-, two-, and three-month lagged yield spread, conditional on such spread being above the 90th yield percentile. A statistically significant relationship between ρ_k(t)and $\gamma_k(t-h)$, h = 1, 2, 3 for market k is not sufficient to assess the predictive power of the yield spread with respect to the equity return. A negative coefficient b_k is needed with residuals normally distributed with mean 0 and variance $e_k(t) \in N(0, \sigma_k^2)$. Exhibit 4 reports the results. (See also Exhibit 5 for the one-month predictive regressions in the U.S.) The second and third columns of Exhibit 4 give the means and standard deviations of monthly returns conditional on the yield spread being inside the time varying 10% upper tail. The regression results and mean and variance of the computed residuals are given for the selected subsamples, and depend on market volatility.

The yield spread has some short-term predictive power in the U.S. and U.K. markets, but very little in the Japan market and none in the German market. We are not testing the effectiveness of the yield spread as the driving variable of a strategic portfolio allocation, but only the dependence of short-term market corrections (not beyond three months) on previously observed bond–stock yield excesses.

High Yield Difference with Corrections

The BSEYD model relies on the evidence that, at current market values, improved expectations of company earnings drive up price yields making equity investments more attractive than fixed-income investments. This change in yields pushes up the demand for stocks and triggers a portfolio rebalancing from bonds to stocks. In turn, this shift pushes stock yields down toward their long-term equilibrium value which is typically inclusive of a small ERP over the risk-free rate. If, however, earnings expectations keep rising, stock prices may keep rising as well. This drives the market dynamics in such a way

Exhibit 4

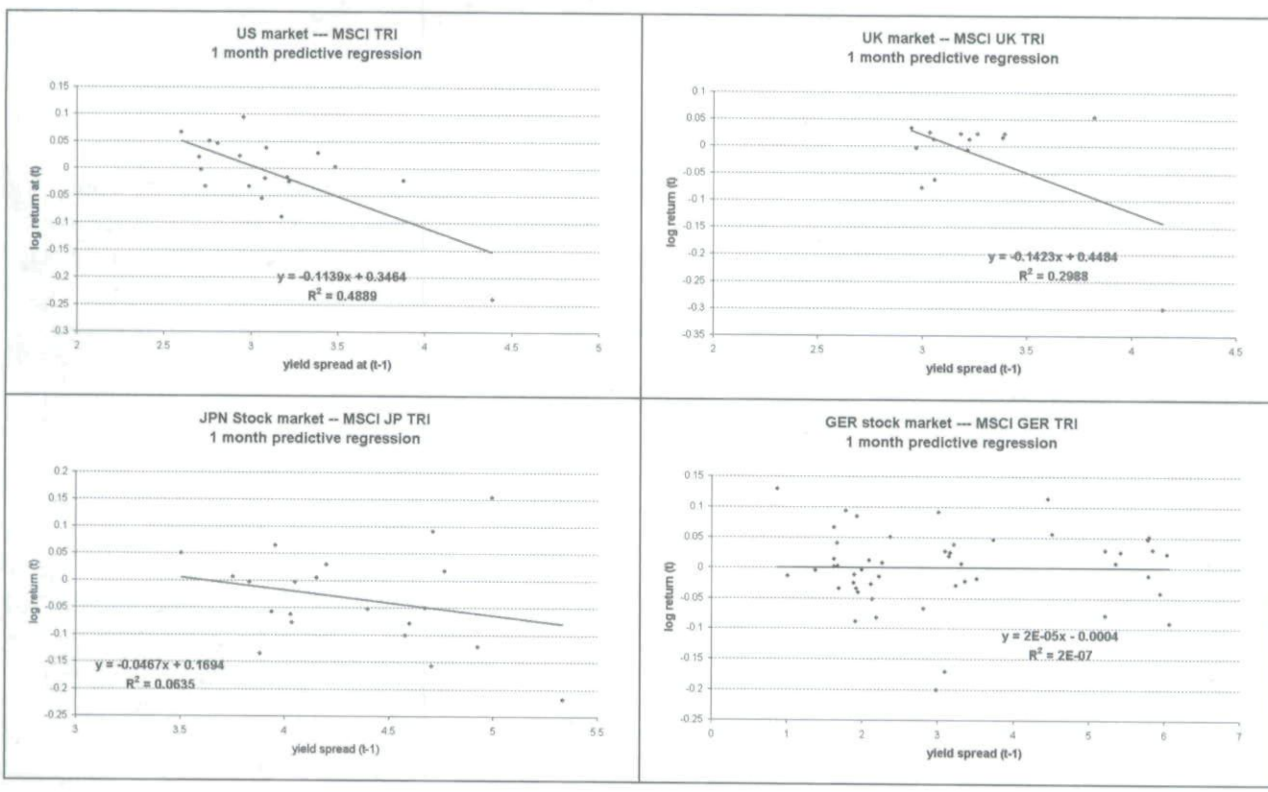
One-, Two-, and Three-Month Predictive Power of BSEYD for Various Equity Markets, 1985–2005

Jan 1985 -- Dec 2005 MSCI monthly data							
	conditional	conditional	y(t)=a+b z(t-j) + e(t) ; j=1,2,3			residuals	
US Equity	mean	std dev	a	b	R^2	variance	mean
lag 1	-0.008059506	0.071475813	0.346	-0.1139	0.4889	0.002961	0.000466996
lag 2	-0.004050033	0.074122486	0.2817	-0.918	0.2955		
lag 3	-0.009414431	0.071723591	-0.0575	0.0152	0		
UK Equity							
lag 1	-0.01566462	0.089364691	0.4484	-0.1423	0.299		
lag 2	-0.028584323	0.089782349	0.4671	-0.152	0.337	0.005599	4.08603E-05
lag 3	-0.008372955	0.051777963	-0.1527	0.0442	0.08		
JPN Equity							
lag 1	-0.032871424	0.08874209	0.1694	-0.0467	0.0635	0.007375	9.60305E-05
lag 2	-0.02053557	0.091968716	0.0608	-0.0188	0.0095		
lag 3	-0.023069067	0.092978531	-0.1301	0.0247	0.0162		
GER Equity							
lag 1	-0.003929792	0.060827994	-0.0019	-0.0006	0.0002	0.003623	-0.000123067
lag 2	-0.004137307	0.060351908	0.0022	-0.002	0.0028		
lag 3	-0.000313041	0.061393217	-0.0004	0.00005	0		

Note: No results are reported for Canada because no yield excesses were reported over the 20-year period from January 1985 to December 2005.

Exhibit 5

One-Month Predictive Regressions of BSEYD for Various Equity Markets, January 1985–December 2005



that the market price yield does not stabilize around a consensus long-term level.

A condition of instability may emerge in this setting if the 10-year interest rate also increases. Several factors explain this possibility:

1. The selling of 10-year T-notes to finance stock market investments.
2. A shift of the yield curve induced by Fed policy in order to offset the inflationary impact on consumption from the stock market wealth effect.
3. The possible overheating of the economy associated with improved earnings expectations, partly due to the persistence of market increases.
4. An increased demand for long-term funding to finance equity investments.

This last scenario, in spite of an assumed improvement in earnings expectations, generally induces a modest increase in the theoretical equilibrium stock market value, thus supporting a growing deviation of the actual market capitalization from the long-term theoretical value.

Such a deviation will persist and fuel increasing forward instability until interest rate tightening is no longer perceived by the market as being sufficient to reduce the expected improvement in companies' earnings. From a different viewpoint, investors initially begin rebalancing from bonds to equity then, relying on the positive market outlook, begin borrowing to move further up on the efficient frontier in order to maximize expected return. The subsequent market adjustment will largely be due to the sudden and substantial inversion of relative values. Under these circumstances, foreign investors will play a specific role; that is, in the presence of an increasing foreign–domestic interest rate gap, foreign investors will be attracted to foreign equity markets to attempt to obtain superior returns and to gain from the exchange rate differential. Inflows from foreign markets will further hasten the departure of the market from its theoretical value. In this sequence of events, the 10-year Treasury rate will correspondingly deviate from the stock market yield. The 1987 crisis and the comparatively smaller 1997 crisis are consistent with this observation. On October 17, 1987, the 10-year rate was 10.22%, increasing from 7.5% in March 1987. As shown in Exhibit 1, the BSEYD moved over the same period from 1.49 to 4.32 in September. A prolonged decrease of equity yields and increase of interest rates in a rapidly expanding economy may lead to a market overvaluation and a subsequent market collapse when the BSEYD reaches a level unsustainable by the market.

High Yield Difference without Corrections

Can the BSEYD remain high on historical terms (above 2.03 which was the average between January 1, 1985, and December 31, 2004) for an extended period of time when the market is relatively stable? Or, is it possible to have a scenario in which the yield ratio is increasing and high, the ratio between actual and theoretical prices is increasing, and the equity market is increasing, without having a speculative bubble?

Thus, in the case of stable earnings expectations and price yields, a reduction in market interest rates—due perhaps to a loose monetary policy by the Federal Reserve motivated by exogenous factors—to below the equity yield decrease will drive up the ratio, but without causing a bubble. Low interest rates will also limit the inflows from foreign equity markets and from currency revaluation. This was the situation in the U.S. market from 1991 to 1992 and in 1999. Consider the 1999 period in which no corrections occurred; the BSEYD ratio remained above 3.0 for a long period. The reason appears to be related to the fact that the market had a correction during the fall of 1998, was already regaining its pace, and a few months elapsed before the realization was made that the theoretical market value was stable and interest rates were low and, indeed, slightly decreasing. The bond–stock ratio increased during a period of low interest rates (below 6%) in the U.S. and increasing corporate earnings. If the equity yield is decreasing because of a sharply rising equity market and interest rates remain low or decreasing, a relatively high BSEYD can be associated with stable market expectations. Then, a BSEYD in the danger zone is not sufficient to lead to a market correction. Inflation expectations play an additional role in market sentiment with decreasing interest rates conveying a positive sentiment on the market.

Low Yield Difference with Corrections

Finally, is a high BSEYD necessary to observe a correction? Not always. Market corrections have been observed even when the bond–stock differential was low and stable; see Exhibit 4. Also, events like September 11, 2001, can cause market corrections. In that case, the S&P 500 fell by –14% in the week following the reopening of U.S. markets after they had been closed for one week.

The case of market instability and a low BSEYD is crucial in assessing the validity of the indicators as valuation measures. One such example begins in the third quarter of 2002. After a smooth decrease of the BSEYD during July and August 2002, a sequence of large declines followed: –5.98% in the second week of September, –12.75% in the third week of September, and –6.49% in the first week of October. During this period, the BSEYD never reached the danger zone, remaining below the 2.85 level. The 10-year rate was stable, but began to decrease, falling below 5% in October 2002. A common explanation is that the ratio had dramatically decreased from a May 2002 maximum of 3.5 and the equity yield was on a positive trend at the time, anticipating the following market recovery. No market corrections have been recorded with a low BSEYD and an increasing equity market.

In summary, the following aspects appear key to the ongoing debate regarding the robustness of the BSEYD as a tool for anticipating signals and their economic implications:

1. The relative nature of the valuation measure implies that diverging bond and stock yields may lead to market corrections if the equity market has increased rapidly over the preceding months due to bond–equity rebalancing and equity investments are funded through borrowing and incoming foreign capital, even with high and increasing interest rates. In this case, the degree of market internationalization may become relevant. A high BSEYD alone, however, is neither sufficient nor necessary to anticipate a market crisis.
2. The stock market phase appears crucial. A high yield differential is consistent with either an increasing or decreasing equity market; in both cases, the market adjustment will depend on the relative dynamics of the 10-year rate and price yield, conditional on recent market performance.
3. Finally, interest rates and inflationary expectations are relevant. Increasing, but relatively low, interest rates have a positive effect on market expectations and usually accompany a smooth convergence of equity prices to theoretical values, avoiding market corrections.

Also a period of instability may be induced by an exogenous correction or crisis in a different market (i.e., independently of the local current yield ratio).

U.S. AND WORLDWIDE RESULTS

We review the evidence in Berge and Ziemba [2006] from five equity markets. The second section and appendix show that being out of the market when the BSEYD measure indicates an investor should be out dominates buy and hold strategies in the U.S., U.K., Japan, Germany, and Canada during the period 1975–2005. Periods in the danger zone are identified by entry and exit signals; the associated time periods can vary and the lack of correction occurrence is identified once the market is in the danger zone. Exhibit 6 shows that 34 corrections occurred while the yield differential was not in the danger zone; only 13 corrections were accurately called by the BSYED danger zone.

Consider the first row of Exhibit 6. In the first column is a sequence of market corrections correctly anticipated by the yield differential. The second column shows the corrections that occurred when the BSEYD was not in the danger zone. During the 25-year history studied in the U.K., of 11 market corrections, only 1 was anticipated by the BSEYD measure. Some of the recent corrections started in a foreign market and took on a domino effect as discussed further in the appendix. Exhibits 7 and 8 report the series of corrections observed in the U.S. and U.K. markets between 1980 and 2005. The overlapping corrections sequence, noted in bold in the exhibits, is only marginally due to internal bond–stock yield differentials. Before most of these corrections, the BSEYD was not in a danger zone. After the corrections, however, monetary authorities intervened, injecting liquidity into the markets or lowering interest rates in an attempt to limit the market's fall and its systemic consequences. As a result, the BSEYD was also reduced.

EXHIBIT 6

Evaluation of Forecasting Signals for Best-Performing BSEYD Strategy 6 in U.S., Germany, Canada, U.K., and Japan, 1980–2005

	BSEYD in Danger Zone (U.S., GER, CAN, U.K., JPN)	BSEYD Not in Danger Zone (U.S., GER, CAN, U.K., JPN)
Correction Occurred	3, 4, 3, 1, 2 = 13	4, 8, 7, 10, 5 = 34
Correction Did Not Occur	2, 3, 1, 3, 0 = 9	3, 5, 2, 1, 1 = 12

Source: Berge and Ziemba [2006].

EXHIBIT 7

Forecasting Signals and Corrections in the U.S. 1980–2005

Correction Number	Start Date	Duration (Months)	Decline (%)
1	April 1981	6	-11.6
2	December 1981	8	-11.1
3	**September 1987**	3	-29.4
4	**June 1990**	5	-14.1
5	July 1998	2	-14.7
6	**April 2000**	18	-31.2
7	**April 2002**	6	-29.1

Although the duration of the correction starting in April 2000 is longer than one year, it is considered a correction since the stock market dropped 23.9% within the following 12 months.

EXHIBIT 8

Forecasting Signals and Corrections in the U.K. 1980–2005

Correction Number	Start Date	Duration (Months)	Decline (%)
1	September 1981	1	-16.1
2	**October 1987**	2	-33.4
3	September 1989	2	-10.4
4	January 1990	4	-12.3
5	**July 1990**	3	-16.0
6	June 1992	3	-14.9
7	February 1994	5	-15.1
8	May 1998	5	-14.3
9	January 2000	2	-10.2
10	**September 2000**	13	-17.9
11	**April 2002**	10	-31.6

Although the duration of the correction starting in September 2000 is longer than one year, it is considered a correction since the stock market dropped 14.7% within 12 months between September 2000 and August 2001.

The evidence on the predictive power of the BSEYD in the U.K. market is partially attributable to a global adjustment of international portfolios which started outside the U.K. Specifically, 4 of 11 market crises were *imported* from the U.S. market as part of a systemic adjustment. The June 1992 crisis was a by-product of the European currency crisis and was imported from a different financial market. The results of the out-of-sample test of the strategies based on the BSEYD are variable across the five countries. Almost all strategies performed better than the stock market, as is shown in the second section of this article and the appendix. The results in the U.S. and Japan were the best. All five countries experienced the situation in which not all corrections were predicted.

The co-movement of the BSEYD and the respective stock market demonstrates that some corrections are not detectable. The methodology of the strategies recommends moving out of the stock market when the current value of the BSEYD is extremely high compared to its past values. Hence, a rise of the BSEYD prior to the occurrence of corrections is necessary to yield a successful prediction of these corrections. This behavior was observable for some of the corrections in the various countries. The stock market did not always fall after a sharp rise in the indicator, however, and other corrections occurred when the indicator was not at historically excessive levels. These corrections were not caused by disequilibrium in the yield on long-term government bonds and the EP ratio of the stock market. Only one of the corrections which occurred during 1995–2005 was predicted by the strategies. Two strategies for the U.K. gave correct signals for the correction starting in January 2000.

The results demonstrate a relationship between the yield on long-term government bonds and the EP ratio of the stock market, at least for the extreme values of the spread between these variables. This relationship was proven to be exploitable for outperforming the stock market. Because the pattern is observable over a long period of time in several countries and is valid for most strategies, it is generally applicable and not data mining.

If the strategies detect a negative return on the stock market for certain periods over a long time, this leads to the conclusion that, on average, a negative return on the stock market could be expected whenever the indicator moves into the danger zone.

The assertion that trading profits suggest a semi-strong efficient markets hypothesis violation is true for all countries. Although the net mean returns on the strategies were not always clearly higher than those of the stock market, the standard deviation of the returns was always much below that of the stock market. So, risk-adjusted profits net of transaction costs were always positive with higher Sharpe ratios. The assertion that negative expected returns suggest even stronger market inefficiency cannot be generally supported. Negative stock market returns for out-of-the-market periods are observable for the U.S. and Japan, and only partly for Germany and the U.K. These returns are not significantly negative due to the high volatility of returns in these periods.

ENDOGENOUS INSTABILITY, RISK PREMIUMS, AND THE NOMINAL- VERSUS REAL-VARIABLE ISSUE

Bond–stock yield differentials provide reliable forecasting signals in conjunction with other financial variables such as the level of interest rates, interest rate differentials, and equity market cycles. Campbell and Vuolteenaho [2004] criticized the Fed model, but admit that it has been "remarkably successful as a behavioural description of stock prices, and its descriptions of equity market equilibrium is superficially attractive." Their criticism is inflation-based since the major factor determining the bond yield is the expected long-term inflation rate. Declining inflation raises bond prices causing yields to fall because the fixed nominal-value coupons are worth less. They then argue, correctly, that there is no reason stocks should have lower yields because stocks are claims on corporate profits which are not fixed in nominal terms. Therefore, profits can move in line with inflation.

Campbell and Vuolteenaho rejected the two following potential explanations:

1. Inflation is bad for the real economy and corporate profits so that rising inflation lowers expected future profits and stock prices.
2. Inflation increases uncertainty and, therefore, stock prices decline.

Econometric studies since the 1920s have shown, however, that corporate dividends are not inversely related to inflation and bond yields. Also, the evidence does not support either of the two preceding explanations.

But Campbell and Vuolteenaho are swayed by the Modigliani and Cohn [1979] argument that inflation confuses investors who use nominal-based yields to discount real corporate profits. During high-inflation periods, stocks are underpriced, but declining inflation eliminates this confusion. Campbell and Vuolteenaho observed that measures of the equity risk premium, based on the cross-sectional pricing of riskier stocks relative to safer stocks or on the relative volatility of stocks and bonds, are essentially unrelated to past inflation and bond yields. We agree with the Campbell and Vuolteenaho criticism and their attempt to argue why the bond–stock measures might work. Supporting this is the observation that investors are easily confused, relying on few, and sometimes changing, key factors and ignoring other relevant economic factors.

At the heart of the Fed model, Campbell and Vuolteenaho [2004] criticize the comparability of the Treasury rate with the S&P 500 earnings yield, the first being a nominal return strictly related to the expected rate of inflation and the second an aggregate claim to corporate profits. Bond investors are aware that bond prices vary in order to compensate for inflation expectations, which leads to nominal yields moving into line with the prevailing term structure of interest rates. In contrast, corporate earnings are not expected to be constant in nominal terms. The idea that investors compare the 10-year nominal Treasury rate with the S&P 500 real price yield is thus ill-founded and unsustainable according to this explanation.

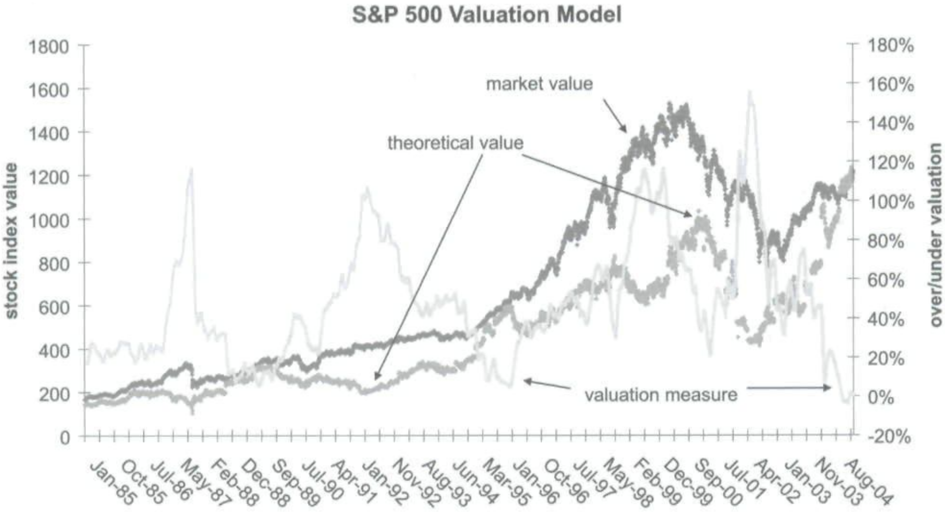
Consigli et al. [2006] tested the hypothesis that over the 1970–2005 period corrections in the U.S. market were consistent with the postulated Fed model. They found evidence of a structural positive risk premium, thus rejecting the claimed convergence of equity and bond returns after a sequence of corrections. This suggests the inclusion of the premium in a stochastic model of equity returns. The inclusion of a risk premium indirectly addresses the inflation expectations issue and focuses on the possible deviation of the equity yield from a theoretically sound market yield that, ceteris paribus, should determine current stock market values. The comparison is thus only on the appropriate discount factor of future earnings, for the current risk-free rate. The presence of a risk premium in the market can in this framework be directly implied from market data. Over the 1985–2005 period, the S&P 500 Index and its theoretical value, as given in Equation (1), performed as shown in Exhibit 9.

The departure of the 10-year rate from the equity yield is captured by the valuation measure which quantifies the percentage difference between the actual and theoretical benchmark values as illustrated in the right y-axis in Exhibit 9. Consider the correction periods in Exhibit 6. The 1987 crisis, the 1997 limited correction, and the 2000 and 2002 market corrections were associated with rising stock market prices and a decreasing theoretical S&P 500 fair value as anticipated by the BSEYD. Other corrections, such as the July 1998 and the May–June 2006 crises, occurred while the indicator was not in the danger zone.

Following this statistical evidence, the amplitude and frequency of the corrections generated by the market can be studied as a function of the yield differential and other variables driving the misvaluation process. Consigli

EXHIBIT 9

Actual and Theoretical S&P 500 and BSYR Process Minus 1

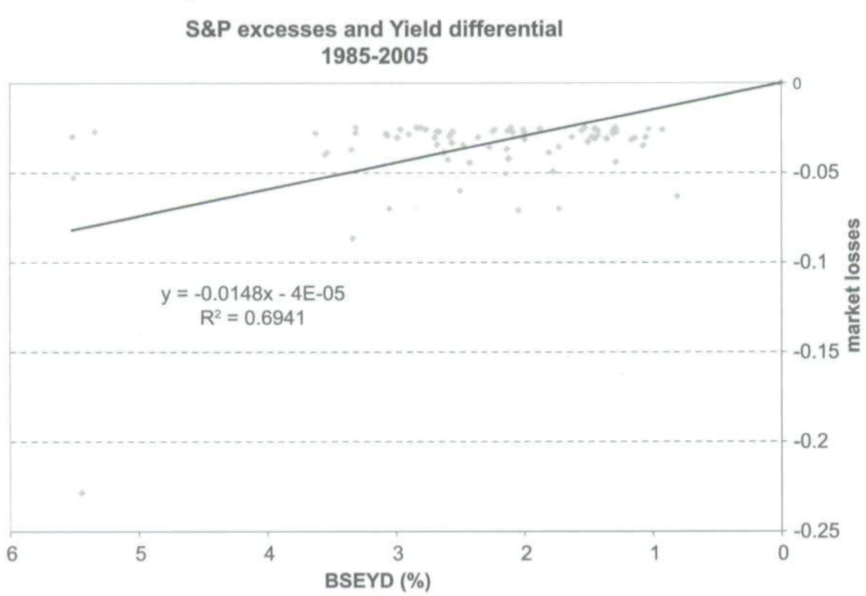


Source: Consigli et al. [2006]

et al. [2006] suggested a model extension of the basic Fed model assumptions in order to accommodate the various exceptions we have discussed. They proposed an asset pricing model for equity returns in which market instability phenomena are modeled as a Cox process whose intensity and market impact depend endogenously on the BSYR and a market-specific risk premium. The economic rationale of this approach is that even if the BSYR cannot alone be taken as a statistically robust leading indicator of prolonged market instability, the ratio provides an appropriate over- or undervaluation measure as an endogenous state variable of an asset pricing model with discontinuous returns. The random dependence of the correction process from the yield differential is also supported by the evidence in Exhibit 9. This displays the estimated linear relationship between the BSEYD and the set of market corrections—adjustments beyond a predefined –2.5% threshold— in the U.S. during the 1985–2005 period. The relationship is negative and statistically significant. The definition of an endogenous source of instability in the asset return model generalizes previous attempts to model equity returns as a Gaussian-Poisson process with constant jump intensity (Consigli et al. [2002]). This yields a model whose parameters can be estimated via maximum likelihood and fitted to market data as shown in Exhibits 9 and 10.

EXHIBIT 10

Bond-Stock Earnings Yield Differentials and Market Corrections (<–2.5%) in the U.S. Market, 1985–2005



The theoretical market price is generated by a discount rate that depends on the risk-free rate and a risk premium. The risk premium depends on factors unaccounted for in the original Fed model and, jointly with the BSEYD, determines the amplitude of forthcoming market adjustments. Investors modify their strategic portfolio allocation from bonds to equity, and vice versa, analyzing the sustainability of the current deviation of equity prices from their theoretical value and then choosing how much to invest in bonds and equities. Expectations are updated depending on the joint movements of the 10-year rate plus a risk premium and aggregate earnings, assumed to be fully incorporated in prices. The bond/stock/cash strategic portfolio selection problem can then be formulated and solved as a stochastic control problem. Once an excessive deviation of the current stock market value from its theoretical value is observed, the ratio between actual and theoretical stock price will depart from 1.0 and the ensuing adjustment can be assumed to be a random function of the BSYR. The suggested approach is consistent with the dynamic version of the Fed model proposed by Koivu, Pennanen, and Ziemba [2005] and extends the evidence of a co-integration relationship between bond and equity yields in the U.S., Japan, and Germany. See also Durré and Giot [2005] for more on the co-integration of the Fed model in various countries.

CONCLUSION

The bond–stock model has been shown to add value to a buy and hold strategy in various U.S. and foreign markets and to have the ability to predict corrections to some extent. Thus, the model provides evidence that the equity risk premium is not constant and partially predictable. Predictive ability is the best in the U.S. and in Japan, and in earlier time periods. Nevertheless, the model provided good results in the period 1980–2005. Campbell and Thompson [2005] investigated whether certain strategies out-predict the historical average of the equity risk premium. The evidence offered by Berge and Ziemba [2006] is that bond–stock measures are better predictors than historical buy and hold averages. The Consigli et al. [2006] model incorporates the bond–stock measure in a stochastic asset-pricing model valuation. This allows direct market back testing in a simulation framework and leads to a stochastic control problem for portfolio selection (i.e., tilting using the bond–stock measure adds value). High current PE ratios relative to historical PE ratios have been shown to predict corrections. See Aron [1981]; Bleiberg [1989]; Campbell and Ammer [1993]; Campbell and Shiller [1998, 2005]; Fama [1970, 1991, 1998]; French and Poterba [1991]; Polk, Thompson, and Vuolteenaho [2006]; Shiller [2000]; Siegel [2002], and Ziemba and Schwartz [1991]. However, the bond–stock model that compares PE ratios to interest rates seems to have better predictive ability (Ziemba and Schwartz [1991]; Rolph and Shen [1999]; Wong and Chew [1999]; Yardeni [2003]; Ziemba [2003], and Berge and Ziemba [2006]). The criticisms of the model by Campbell and Vuolteenaho [2004] and others are valid. The Modigliani and Cohn [1979] inflation confusion argument is one way to theoretically justify the model.

The research on the bond–stock model surveyed in this article contributes to the research on the role the model plays in portfolio strategies and clarifies the model's potential as a market crisis signal. The analysis also confirms the partial predictability of equity returns and the need to take agents' risk aversion into account when assessing market mean-reverting behavior. Furthermore, the analysis provides a basis to statistical models of equity returns which have an endogenous source of instability, thus leading to an approach to strategic asset allocation over time.

APPENDIX

All exhibits are from Berge and Ziemba [2006].

EXHIBIT A1

Stock Market Corrections (>10%) in the U.S., 1975–2005

Although the duration of the correction starting in January 1977 is longer than one year, it is considered a correction because the stock market dropped 11% within 10 months between January and October 1977. The same is true for the correction starting in April 2000; the stock market dropped 23.9% within the following 12 months.

Correction Number	Start Date	Duration (Months)	Decline (%)
1	July 1975	3	-11.8
2	January 1977	14	-15.2
3	April 1981	6	-11.6
4	December 1981	8	-11.1
5	September 1987	3	-29.4
6	June 1990	5	-14.1
7	July 1998	2	-14.7
8	April 2000	18	-31.2
9	April 2002	6	-29.1

EXHIBIT A2

Evaluation of the Performance of the Strategies for the U.S.

The mean excess return is the average monthly excess return of the strategy over the stock market. Terminal values refer to the gross performance of U.S.$100 invested using the strategy signals.

		Overall Performance of the Strategies/Stock Market				
Strategy	Number of Months in the Stock Market	Mean Log Return	Standard Deviation	Sharpe Ratio	Mean Excess Return	Terminal Value (US$)
1	319 (85.75%)	0.01194	0.03933	0.17814	0.00162	8,480.41
2	300 (80.65%)	0.01255	0.03737	0.20378	0.00222	10,635.11
3	325 (87.37%)	0.01222	0.03936	0.18517	0.00190	9,420.42
4	314 (84.41%)	0.01246	0.03835	0.19632	0.00214	10,299.03
Stock Market (1975–2005)	372 (100%)	0.01032	0.04347	0.12401		4,649.75
5	273 (87.5%)	0.01254	0.03887	0.19773	0.00224	5,009.00
6	266 (85.26%)	0.01300	0.03835	0.21236	0.00270	5,781.16
7	260 (83.33%)	0.01215	0.03831	0.19039	0.00185	4,432.10
8	254 (81.41%)	0.01225	0.03785	0.19529	0.00195	4,569.44
Stock Market (1980–2005)	312 (100%)	0.01030	0.04389	0.12405		2,490.17

EXHIBIT A3

Stock Market Corrections (>10%) in Germany, 1975–2005

Although the duration of the correction starting in October 1978 is longer than one year, it is considered a correction because the stock market dropped 12.5% within 9 months between October 1978 and June 1979. The same is true for the correction starting in March 2000; the stock market dropped 20.7% within the following 12 months.

Correction Number	Start Date	Duration (Months)	Decline (%)
1	April 1976	7	-13.7
2	October 1978	18	-15.9
3	February 1984	6	-11.2
4	May 1986	3	-16.1
5	December 1986	3	-17.9
6	September 1987	5	-40.7
7	August 1990	2	-31.0
8	June 1992	4	-18.7
9	May 1994	11	-13.6
10	August 1997	3	-15.4
11	August 1998	2	-22.4
12	March 2000	19	-44.0
13	April 2002	12	-53.9

EXHIBIT A4

Evaluation of the Overall Performance of the Strategies for Germany

The mean excess return is the average monthly excess return of the strategy over the stock market. Terminal values refer to the gross performance of €100 invested using the strategy signals.

		Overall Performance of the Strategies/Stock Market				
Strategy	Number of Months in the Stock Market	Mean Log Return	Standard Deviation	Sharpe Ratio	Mean Excess Return	Terminal Value (€)
1	302 (81.18%)	0.00881	0.05150	0.09157	0.00068	2,652.80
2	265 (71.24%)	0.00789	0.04986	0.07613	-0.00024	1,884.15
3	322 (86.56%)	0.00934	0.05455	0.09614	0.00121	3,228.95
4	312 (83.87%)	0.00922	0.05425	0.09446	0.00109	3,088.99
Stock Market (1975–2005)	372 (100%)	0.00813	0.05864	0.06886		2,061.27
5	279 (89.42%)	0.00963	0.05836	0.09405	0.00123	2,014.62
6	241 (77.24%)	0.00910	0.05651	0.08787	0.00071	1,711.54
7	259 (83.01%)	0.01032	0.05736	0.10785	0.00193	2,504.27
8	253 (81.09%)	0.01010	0.05719	0.10431	0.00170	2,337.64
Stock Market (1980–2005)	312 (100%)	0.00840	0.06201	0.06870		1,373.26

EXHIBIT A5

Stock Market Corrections (>10%) in Canada, 1975–2005

Although the duration of the correction starting in September 2000 is longer than one year, it is considered a correction because the stock market dropped 36.4% within 12 months between September 2000 and August 2001.

Correction Number	Start Date	Duration (Months)	Decline (%)
1	July 1975	4	-11.0
2	June 1976	6	-14.6
3	March 1980	1	-18.7
4	July 1981	12	-39.4
5	December 1983	8	-13.8
6	September 1987	3	-25.6
7	January 1990	4	-14.5
8	August 1990	3	-10.9
9	February 1994	5	-11.1
10	June 1998	3	-25.0
11	September 2000	13	-41.2
12	April 2002	6	-21.3

EXHIBIT A6

Evaluation of the Overall Performance of the Strategies for Canada

The mean excess return is the average monthly excess return of the strategy over the stock market. Terminal values refer to the gross performance of C$100 invested using the strategy signals.

		Overall Performance of the Strategies/Stock Market				
Strategy	Number of Months in the Stock Market	Mean Log Return	Standard Deviation	Sharpe Ratio	Mean Excess Return	Terminal Value (C$)
1	295 (79.3%)	0.00954	0.04243	0.08053	-0.00020	3,479.37
2	276 (74.19%)	0.00937	0.04110	0.07906	-0.00036	3,269.07
3	313 (84.14%)	0.00963	0.04384	0.07986	-0.00011	3,590.86
4	304 (81.72%)	0.00997	0.04301	0.08933	0.00023	4,075.27
Stock Market (1975–2005)	372 (100%)	0.00974	0.04925	0.07337		3,743.49
5	273 (87.5%)	0.00937	0.04336	0.07839	0.00094	1,859.80
6	256 (82.05%)	0.00951	0.04146	0.08535	0.00108	1,942.95
7	265 (84.94%)	0.00900	0.04235	0.07149	0.00057	1,656.33
8	254 (81.41%)	0.00890	0.04188	0.06997	0.00047	1,607.12
Stock Market (1980–2005)	312 (100%)	0.00843	0.04941	0.04977		1,387.23

EXHIBIT A7

Stock Market Corrections (>10%) in the U.K., 1975–2005

Although the duration of the correction starting in September 2000 is longer than one year, it is considered a correction because the stock market dropped 14.7% within 12 months between September 2000 and August 2001.

Correction Number	Start Date	Duration (Months)	Decline (%)
1	June 1975	2	-13.0
2	February 1976	9	-25.6
3	October 1977	5	-14.0
4	May 1979	3	-14.6
5	September 1981	1	-16.1
6	October 1987	2	-33.4
7	September 1989	2	-10.4
8	January 1990	4	-12.3
9	July 1990	3	-16.0
10	June 1992	3	-14.9
11	February 1994	5	-15.1
12	May 1998	5	-14.3
13	January 2000	2	-10.2
14	September 2000	13	-17.9
15	April 2002	10	-31.6

EXHIBIT A8

Evaluation of the Overall Performance of the Strategies for the U.K.

The mean excess return is the average monthly excess return of the strategy over the stock market. Terminal values refer to the gross performance of £100 invested using the strategy signals.

		Overall Performance of the Strategies/Stock Market				
Strategy	Number of Months in the Stock Market	Mean Log Return	Standard Deviation	Sharpe Ratio	Mean Excess Return	Terminal Value (£)
1	329 (88.44%)	0.01426	0.05020	0.14825	0.00102	20,163.11
2	314 (84.41%)	0.01363	0.04947	0.13757	0.00039	15,911.90
3	362 (97.31%)	0.01346	0.05309	0.12504	0.00022	14,948.86
4	354 (95.16%)	0.01323	0.05279	0.12136	-0.00001	13,714.36
Stock Market (1975–2005)	372 (100%)	0.01324	0.05598	0.11470		13,787.40
5	297 (95.19%)	0.01204	0.04420	0.12277	0.00101	4,275.28
6	289 (92.63%)	0.01163	0.04363	0.11495	0.00060	3,760.35
7	300 (96.15%)	0.01218	0.04419	0.12616	0.00116	4,477.37
8	293 (93.91%)	0.01196	0.04358	0.12266	0.00093	4,168.13
Stock Market (1980–2005)	312 (100%)	0.01103	0.04814	0.09179		3,121.47

EXHIBIT A9

Stock Market Corrections (>10%) in Japan, May 1985–December 2005

Although the duration of the correction starting in January 1990 is longer than one year, it is considered a correction because the stock market dropped 40% within 12 months between January and December 1990. The same is true for Corrections 4 (23.5% decline between June 1994 and May 1995), 6 (15.3% decline between August 1997 and July 1998), and 7 (20.1% decline between April 2000 and March 2001).

Correction Number	Start Date	Duration (Months)	Decline (%)
1	June 1987	7	-20.3
2	January 1990	31	-56.2
3	September 1993	3	-17.6
4	June 1994	13	-27.0
5	July 1996	7	-17.5
6	August 1997	15	-31.1
7	April 2000	37	-51.8

EXHIBIT A10

Evaluation of the Overall Performance of the Strategies for Japan

The mean excess return is the average monthly excess return of the strategy over the stock market. Terminal values refer to the gross performance of ¥100 invested using the strategy signals.

		Overall Performance of the Strategies/Stock Market				
Strategy	Number of Months in the Stock Market	Mean Log Return	Standard Deviation	Sharpe Ratio	Mean Excess Return	Terminal Value (¥)
1	222 (89.52%)	0.00612	0.05049	0.08427	0.00305	455.72
2	214 (86.29%)	0.00627	0.04942	0.08921	0.00320	473.45
3	229 (92.34%)	0.00648	0.05097	0.09059	0.00341	498.62
4	226 (91.13%)	0.00640	0.05077	0.08942	0.00334	489.16
Stock Market (5/85–12/05)	248 (100%)	0.00307	0.05778	0.02085		213.88
5	172 (91.49%)	0.00120	0.05050	-0.00157	0.00168	125.35
6	169 (89.89%)	0.00128	0.04994	-0.00008	0.00176	127.13
7	174 (92.55%)	0.00177	0.05130	0.00960	0.00225	139.56
8	172 (91.49%)	0.00120	0.05050	-0.00157	0.00168	125.35
Stock Market (5/90–12/05)	188 (100%)	-0.00048	0.05745	-0.03062		91.39

ENDNOTE

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