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Stock market "prediction" models

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Abstract

This study compares the equity allocation model relative to the more popular PE, Shiller CAPE, yield spread, Fed Model, and Buffet's Ratio (Market Cap/GDP) to predict long-term stock market returns. Although all the variables are related to long-run stock returns, only equity allocation and yield spread have root mean square errors consistently lower than a simple moving average. A simple trading rule transferring wealth between equity and 10-year T-bonds demonstrates equity allocation performs best with a 1.3% annual outperformance relative to buy-and-hold from 1990 to 2018. However, the predictive ability of the ratio was not identified until 2013 and since then, the trading strategy has underperformed by 1.5% annually. Thus, despite equity allocation's initial glamour, its long-term predictive ability does not appear to be easily transformed into profitable trading.

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1. Introduction

The financial world is inundated with newsletters, books, soothsayers, con-artists, and financial experts all touting their abilities or models that supposedly predict stock returns. This completely contradicts the Efficient Markets Hypothesis put forth by Fama (1965) who was awarded the 2013 Nobel Prize in Economics for showing stock prices appear to follow a simple random walk. Jack Bogle of Vanguard fame and creator of the first index fund in 1976 sums it up this way, "After nearly 50 years in this business, I do not know of anybody who has done market timing successfully and consistently. I don't even know anybody who knows anybody who has done it successfully and consistently."

Although most finance professionals agree with the sentiment, especially regarding short-term stock returns, the consensus for predicting longer-term (5 to 10-year) returns is less clear. This study examines the relatively new equity allocation model compared to the more common PE models, yield spread, and GDP often showcased in the popular press for predicting long-term returns.

Equity allocation has been recently identified as an excellent forecasting tool with one study by an anonymous author in Philosophical Economics (2013) dubbing it as the "single greatest predictor." Equity allocation is measured as the percentage of equity held divided by total value of equities, bonds, and cash.

The premise is that with a short-term fixed supply of investable shares, if equity demand increases, i.e. investors want to allocate more to stock, the allocation increases. Given a fixed supply, this can occur only if asset prices increase. A high allocation to equities equates to high prices and low returns in the future. The correlation to future stock returns appears high; however, the equity allocation metric published by the Federal Reserve Bank of St. Louis has a 6-month publication lag.

At a fundamental level, PE ratios and by extension the Shiller PE, which is price divided by the cyclically adjusted earnings during the preceding 10 years (referred to as CAPE) are used to explain and/or predict long-term returns based on the concept of mean reversion, Campbell & Shiller (1998, 2001). High PE ratios theoretically signal overvalued securities and vice versa with several studies suggesting predictive power, (Aydogan & Güney, 1997; Aydogan & Gursoy, 2000; Keimling, 2016; Siegel 2016) while others dispute their usefulness, (Lewellen, 2004; Welch & Goyal, 2008; Davis, Aliaga-Diaz, & Thomas, 2012; Tilley, 2018).

The Fed Model extends the PE idea to suggest the difference between the stock market's earnings yield and the 10-year Treasury yield can predict long-term returns. This idea has been used to explain the historically high PE ratios post financial crisis during the Federal Reserve's near zero interest rate policy. The term TINA (there is no alternative) rationalizes ever increasing equity values. With historically low interest rates, high PE ratios are supposedly justified but research on the usefulness of this idea has been mixed. Studies from Yardeni, (1997), Shen (2003), Jansen & Wang (2004), Koivu, Pennanen, & Ziemba (2005), and Bekaert & Engstrom (2010) have provided some support while Aseness (2003), Salomons (2006), and Estrada (2009) have been critical of the model's validity.

Closely related is the yield spread, defined in this study as the 10-year T-bond yield minus the 90-day T-bill rate. A greater spread suggests investors require greater return for taking on risk implying future equity returns should also be greater. Campbell (1987), Zhou (1996), and Campbell & Viceira (2005) find this spread predicts excess stock returns.

The Buffet indicator came about from an interview with Warren Buffet in Fortune Magazine back in 2001. Buffet suggests total market cap divided by GDP is an excellent measure of stock market valuation. A high level suggests the market is overpriced and vice versa. Jones (2015) and Frankel (2018) give credence to this model although Mackintosh (2018) points out, "Armed with perfect hindsight, GDP is one of the best investment tools there is, as a better economy means higher share prices, and vice versa." The problem is Mackintosh finds no link between past GDP and what the economy will do in the future, thus breaking the link between GDP and future returns.

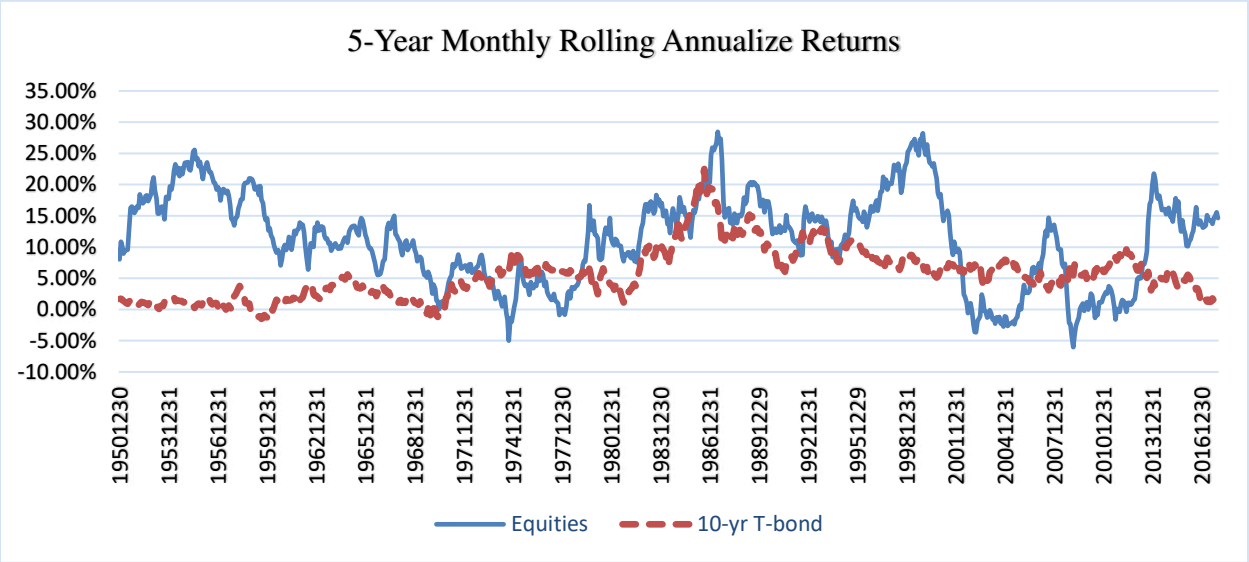
This study finds the models listed above tend to be correlated with long-run market returns but none appear to have consistent, actionable predictive value. Data lag and ex ante model creation to predict future returns results in limited tradeable value. To the extent long-run equity returns are predictable, a simple trading rule using equity allocation to predict five-year returns results in higher returns of 1.3% annually since 1990. However, the model was not identified until 2013 and since then, has underperformed by 1.5% annually. Thus, equity allocation may simply be the latest incantation of dubious forecasting based on historical data mining. In its defense, an investor would have avoiding the 2020 Covid-19 crash.

2. Data and Methodology

To provide a general overview of exactly what these models are trying to predict, Figure 1 shows the monthly rolling 5-year annual returns for The Center for Research in Security Prices (CRSP) Value Weighted Market 500 Index and 10-year Treasury bonds ending January 1951 to December 2017. Both assets show diverse returns over 5-year periods ranging from an annualized -6.97% to 26.64% for equities and -1.55% to 22.51% for 10-year T-bonds. Given this volatility, even moderately reliable long-term prediction models might be useful for asset allocation decisions, even if only partially adjusted at the margin based on the probability of below average future returns.

Models predicting returns over 10-year periods may be more accurate but are less useful. Welch & Goyal (2008) suggest model forecasts do not outperform using historical average returns. Their findings become increasingly relevant as the forecast period increases. In the last 70 years, equities have outperformed 10-year T-bonds 84.3% of the time over 10-year periods and 74.5% over 5 years. Reducing or eliminating equity exposure when there is a small probability equity will underperform is a tough hurdle for any predictive model to overcome.

Figure 1: 5-year rolling annualized returns for equities and 10-yr T-bonds from 1951 to 2017.



To examine the predictive ability of each model, excess returns are estimated using linear regression. Each regression is estimated with 5, 7, and 10-year excess returns as the dependent variable and the potential predictors as the explanatory variable as described in Equation 1:

$$ER_t = \beta_0 + \beta_1 Predictor_t + \epsilon_t \quad (1)$$

where ER_t is the 5, 7, or 10-year excess return over the upcoming 5, 7, or 10 years at a given time t, $Predictor_t$ is the value of the predictor at time t, the betas are coefficients, and ϵ_t is the innovation (shock) to excess returns. The model is used to evaluate predictive ability by comparing the fitted values from these regressions as written below in Equation 2:

$$Fitted\ ER_t = \hat{\beta}_0 + \hat{\beta}_1 Predictor_t \quad (2)$$

where $\hat{\beta}_0$ is an estimated constant, and $\hat{\beta}_1$ is the estimated change in 10-year excess returns for a unit change in the predictor.

To reduce ex post data mining and model identification, only predictions after 1990 are tested. Three of the models were known by this date, PE (Basu, 1977), Shiller CAPE (Campbell & Shiller, 1988), and yield spread, (Campbell, 1987). However, the Fed Model was not officially identified until Yardeni (1997), the Buffet Ratio in 2001 (Fortune Magazine), and the equity allocation metric in 2013 in Philosophical Economics. Theoretically, predictions using these models should not occur until after identified, but there is not enough data to test long-term returns for these models otherwise. Thus, this study will test them as if they were known in 1990 with a cautionary disclaimer about the reliability of their results.

To attain predictions, an initial regression is estimated using 1951 to 1990 data, and then new estimates are calculated each quarter as new data becomes available. Lags of the potential predictor variables are used to assure the data is known at each decision point. PE, Shiller CAPE, yield spread, and the Fed Model are all lagged one month. Both the equity allocation and market cap/GDP ratios are lagged 6-months as this data is reported with a 6-month lag at the Federal Reserve Bank of St. Louis Economic Research site. Quarterly time periods are used for

all variables to remain consistent across factors as both the equity allocation and GDP values are only reported quarterly. Predictions are generated and compared based on root mean squared error (RMSE) for regression models with each variable and multiple combinations.

To determine if the information is profitably tradeable, the following decision rule is employed: If the model indicates the subsequent 5, 7, or 10-year excess return will be less than the excess return of the 10-year T-bond minus the 90-day T-bill, the investor exits the market and purchases a 10-year Treasury. Otherwise, the investor remains in the market. This strategy is compared to a buy-and-hold strategy from 1990 forward. Transaction costs are assumed to be 0.02% per trade for the switching strategies based on a $100,000 account

3. Results

To identify which models are most useful, Table I shows the root mean square errors for each indicator and subsequent 5, 7, or 10-year excess returns.

Table I: Root Mean Square Error of Predicted Returns, 1990-2017

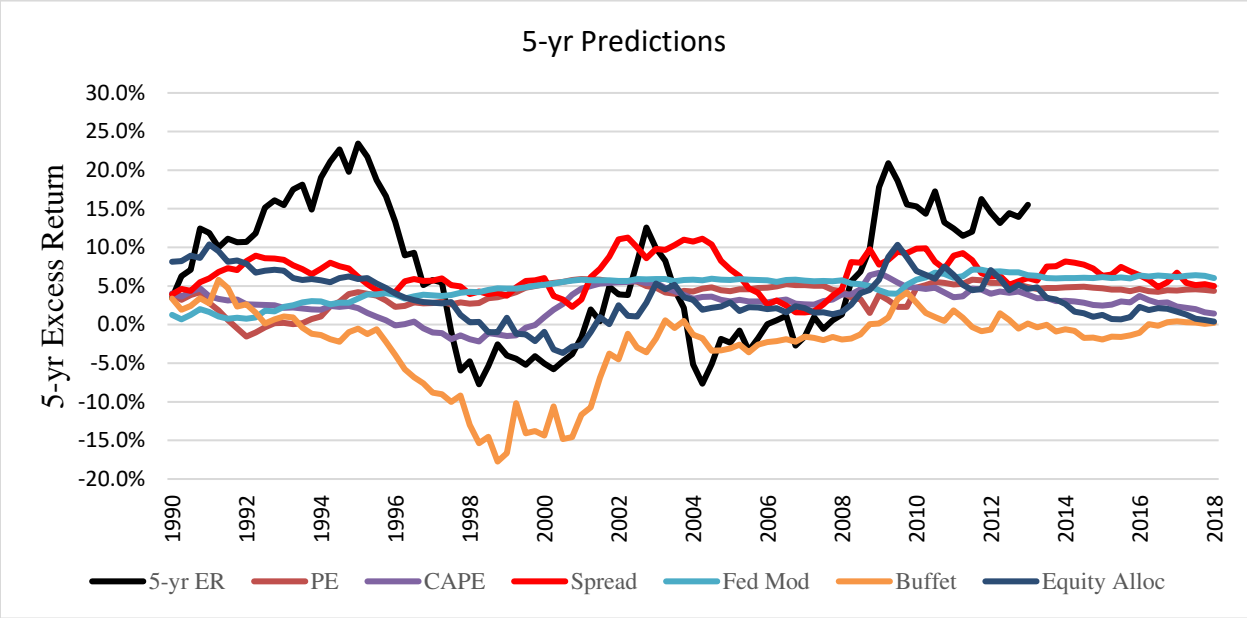
MODEL	5-YR ER	7-YR ER	10-YR ER
Naïve (constant only)	10.33%	6.54%	4.68%
Equity Allocation	7.25%	4.81%	3.45%
PE	9.95%	8.30%	6.60%
Shiller CAPE	9.20%	7.39%	6.94%
Yield Spread	8.13%	6.37%	4.54%
Fed Model	9.60%	8.05%	6.83%
Market Cap/GDP	12.00%	12.92%	15.59%
Equity All. & CAPE	8.24%	4.75%	3.14%
All models	8.18%	7.90%	8.52%

As might be expected, all the models have declining errors with longer prediction periods except Market Cap/GDP, which also does worse than even a naïve model using a simple average. The top two indicators regardless of prediction horizon are equity allocation and the yield spread. These are also the only two metrics with lower RMSE relative to the naïve model for every horizon. Combining equity allocation with any other single variable leads to worse results except with the Shiller CAPE where the RMSE declines marginally for 7 and 10-year predictions. Combining all the models leads to poorer results than using equity allocation only. All the models appear to work to some degree but at 7 and 10-year prediction horizons, only the yield spread and equity allocation outperform relative to just using a simple average. Even for these two models, it is not clear whether the predictions can be converted into an effective trading strategy that will increase return, reduce risk, or both.

Figure 2 shows the predicted and subsequent 5-year market returns from 1990 to 2017 using the various models. The Shiller CAPE, yield spread, Market Cap/GPD, and equity allocation all appear to have some predictive power based on the “eye ball” test. It is less clear whether the PE or Fed Model can be effectively used to predict 5-year subsequent returns as their predictions remain relatively flat compared to actual 5-year excess returns. Although not shown, all the models tend to look better for longer forecast horizons. Interpreting the graphs going forward, by the end of 2017, the PE, yield spread, and Fed Model all predict future 5-year excess

returns of approximately 5%. The CAPE, Market Cap/GDP and equity allocation are less optimistic predicting 0% to 2.5% annualized excess returns over the next 5 years.

Figure 2: Relationship between PE, Shiller CAPE, Fed Model, yield spread, Market Cap/GDP, and equity allocation, with subsequent 5-year S&P 500 returns, 1990-2017.



To ascertain whether the predictions can be used for trading purposes, a simple trading rule for each quarter is applied to each variable's prediction. The trading rule is: If predicted N length equity excess return exceeds 10-year T-bond minus 90-day T-bill yield, invest in equites, otherwise, invest in the 10-year T-bond. Results are compared to a simple buy-and-hold strategy represented by the S&P 500. Table 2 shows the results based on each variable from Jan. 1990 to Dec. 2017. It should be noted regression coefficients to make predictions could not be updated past 2007, 2010, and 2012 respectively for the 5, 7, and 10-year predictions as those period returns have not yet occurred. The percentage of time the model correctly predicts the right decision is reported along with the percentage of time the model has investors in equites.

Table II: 1/1990-12/2017 quarterly returns based on whether 5, 7, or 10-year predicted excess returns exceed 10-year T-bond excess yield.

Panel A: Using 5-year predicted returns

	S&P 500	Equity Allocation	PE	CAPE	Yield Spread	Fed Mod	MC/GDP
Quart. Avg.	2.69%	2.90%	2.76%	1.89%	2.69%	2.54%	1.68%
Geo. Ann	9.95%	11.26%	10.40%	6.71%	9.95%	9.33%	6.52%
St. Dev.	7.63%	6.31%	7.26%	7.04%	7.63%	7.55%	4.24%
Min	-21.90%	-21.92%	-16.93%	-21.92%	-21.92%	-21.92%	-13.94%
Max	21.57%	17.48%	21.55%	15.67%	21.55%	21.55%	14.69%
5% Var	-12.74%	-8.56%	-11.83%	-12.76%	-12.76%	-12.76%	-4.47%
Sharpe	0.21	0.28	0.23	0.11	0.20	0.19	0.13
%Correct	58.93%	56.25%	59.82%	51.79%	58.93%	59.82%	41.07%
Equity Time	100%	70.54%	84.82%	73.21%	100.00%	88.39%	7.14%

Panel B: Using 7-year predicted returns

	S&P 500	Equity Allocation	PE	CAPE	Yield Spread	Fed Mod	MC/GDP
Average	2.69%	2.58%	2.31%	2.13%	2.69%	2.65%	1.68%
Geo. Ann.	9.95%	9.88%	8.68%	7.89%	9.95%	9.85%	6.52%
St. Dev.	7.63%	6.24%	6.39%	6.41%	7.63%	7.39%	4.24%
Min	-21.90%	-21.92%	-16.93%	-21.92%	-21.92%	-21.92%	-13.94%
Max	21.57%	17.48%	15.48%	15.67%	21.55%	21.55%	14.69%
5% Var	-12.74%	-8.56%	-11.02%	-9.93%	-12.76%	-11.83%	-4.47%
Sharpe	0.21	0.24	0.19	0.16	0.20	0.21	0.13
% Correct	58.93%	55.36%	53.57%	51.79%	58.93%	61.61%	41.07%
Equity Time	100%	66.07%	69.64%	58.93%	100.00%	83.04%	7.14%

Panel C: Using 10-year predicted returns

	S&P 500	Equity Allocation	PE	CAPE	Yield Spread	Fed Mod	MC/GDP
Average	2.69%	2.81%	2.23%	1.99%	2.69%	2.59%	1.61%
Geo. Ann	9.95%	10.93%	8.66%	7.45%	9.95%	9.60%	6.21%
St. Dev.	7.63%	6.13%	5.13%	5.96%	7.63%	7.37%	4.24%
Min	-21.90%	-21.92%	-13.94%	-21.92%	-21.92%	-21.92%	-13.94%
Max	21.57%	17.48%	12.61%	15.67%	21.55%	21.55%	14.69%
5% Var	-12.74%	-6.07%	-5.05%	-8.56%	-12.76%	-11.83%	-4.47%
Sharpe	0.21	0.28	0.22	0.15	0.20	0.20	0.12
% Correct	58.93%	57.14%	53.57%	47.32%	58.93%	59.82%	40.18%
Equity Time	100%	62.50%	48.21%	40.18%	100.00%	81.25%	6.25%

*Significantly better than the S&P 500 at the 10% level, **5% level. VaR test uses Annert, Osselaer, & Verstraete (2009) method.

Table II Panel A shows if an investor follows a simple trading rule based on 5-year predicted excess returns relative to 10-year T-bond excess yields, only the equity allocation model results in higher quarterly returns relative to a buy-and-hold strategy although PE and yield spread also match or slightly improve geometric annualized returns. The yield curve never signals an exit as shown by the Equity Time row which is the percentage of time equity is held.

In terms of Sharpe ratios that measure return relative to risk, only equity allocation performs better than a buy-and-hold strategy regardless of the prediction horizon. Value at Risk (VaR) is also reduced using equity allocation relative to buy-and-hold. Note VaR shows the value at which 5% of the returns are below. Although not shown, equity allocation also works when examining the 1990 – 2001 or 2002 to 2012 time periods. In terms of excess performance, using a 5-year prediction windows appears to be best with an approximate 1.3% geometric annualized excess return over buy-and-hold.

In terms of correct trading decisions, the correct percentage for the S&P 500 shows the percentage of time equities outperformed. Over this period, equities outperform roughly 59% of the quarterly time periods. Correct percent for each variable shows how often the prediction from using that variable correctly predicts whether equities or 10-year T-bonds outperform over the following quarter. Bauer & Dahlquist (2012) show a correct call needs to be made approximately 57% of the time during 2000-2011 to outperform a buy-and-hold strategy. Only the Fed Model meets this hurdle regardless of predicted time horizon, although equity allocation is close and has better returns. The yield spread theoretically meets the hurdle but only because it never signals to exit equities.

In a final effort to determine if a combination of variables can outperform equity allocation by itself, predictions are developed using all six variables in a multiple regression. Although not shown, using a combination of models does not improve results, and in fact makes them worse. In addition, combining any one of the variables with equity allocation also did not improve results. Adding the Shiller CAPE did best, but with minimal to no improvement in returns along with a reduced probability of making a correct trading call.

Although using equity allocation's 5-year predictions may be useful for trading, its predictive ability was not identified until 2013. Since that time, using equity allocation within the trading rule defined in this study, has led to an annual underperformance of 1.5% as of May 2020 as it signaled an overvalued market starting January 2017. In its defense, one would have avoided the 2020 Covid-19 crash, but its long-term predictive ability does not appear to be easily transformed into consistent profitable trading. Its first true out-of-sample test has led to underperformance, much like every other variable examined in this study.

4. Conclusion

Predicting stock returns is dubious business. In the short-run, most research suggests it is impossible. In the long-run, however defined, it may be possible. Most "long-run" stock-market predictions are from 5 to 10-year horizons using a variety of models and variables. This study examines the equity allocation model and compares it to five of the more popular metrics including PE, Shiller CAPE, Fed Model, yield spread, and Buffet's Ratio (Market Cap/GDP).

On the surface, all the metrics appear to have some predictive power, but only the equity allocation percentage initially appears to be useful for trading purposes. Even with its 6-month reporting lag, this study finds when the metric suggests future 5-year excess equity returns are expected to be less than the 10-year T-bond yield, it may behoove an investor to reduce exposure to equities and invest in 10-year treasuries until the signal reverses. This simple strategy results in a 1.3% greater annualized return relative to 100% in equities while reducing risk demonstrated by better minimums, lower VaRs, and higher Sharpe Ratios.

However, equity allocation as a predictive market indicator was not identified until 2013. Since that time, using it as a trading tool has led to a 1.5% annual underperformance as of May 2020. Thus, equity allocation appears to be yet another long-run market prediction tool that looks graphically useful but is difficult if not impossible to convert into a successful trading tool.

Time will tell whether equity allocation along with the rest of the variable studied here remain valuable prediction tools going forward. We live in a new information age where everyone has instant access to data and computer power that was simply not available even 25 years ago. Yahoofinance for instance did not appear until 1997. Pretending we could have corralled all this data together on a computer, run regressions, and then used what if statements in spreadsheets to create trading rules back in 1990 is an optimistic assumption. Even ignoring that issue, converting the predictions into actionable profitable trading rules does not appear to beat a simple buy-and-hold strategy. Thus, be wary of all trading anomalies and models that could have worked including the equity allocation model. It may be the single greatest predictor of future stock returns, but appears to be no more useful for trading than any other predictors.

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