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Effects of Bonds & Fed Funds on the Stock Market

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Abstract: This paper is to investigate the relationship that Treasury bonds and Fed Funds have with the stock market. This research is valuable because the stock market is a major aspect of America's economy, although many consider it unpredictable and difficult to understand. The goal of our research is to lessen this unpredictability, as well as to assess the inverse relationship that hypothetically exists between the stock market, bonds and Fed Funds. By employing an OLS regression model, this study finds the effect of Fed Funds is statistically and economically significant with regard to the stock market, also having the predicted inverse relationship. However, results for bonds are inconclusive; they are neither statistically or economically significant, nor do they consistently have an inverse relationship with stocks. Nevertheless, this paper can begin to show the hypothetical relationship that exists between stock and bond markets, and provide a basis for future research.

Keywords: *Stocks, Bonds, Fed Funds, Effects, Econometrics*

JEL Codes: C1, G0, and G12

1 Introduction: Importance of Investing

Investing has become an increasingly important aspect of our economy in the United States, especially in recent years, as it has become a necessity for many in order to feel their finances are protected for their futures. It is also an effective way to earn money without putting one's savings account at risk. This desire to protect oneself from risk is a major driver of investing, whether it be in the stock market or bonds, and this element of risk puts a high value economically on being able to generate profits on money already earned, instead of letting inflation erode those earnings while they sit in a savings account.

Being able to 'outthink the market' has long been considered as impossible by many inexperienced investors, as a common belief of the market is that stocks take a 'random walk' along some trend that is often unpredictable at best. This is commonly known as the efficient market hypothesis, the idea that you cannot beat the market because it only reacts to new information. This study is interested in whether we can minimize this unpredictability in movements of the stock market, as the more an investor can understand the market, the better their decisions and judgement will be to invest effectively. On account of these interests, we will be researching changes in the rates of stocks by way of regression analysis. We will conduct this research by analyzing the relationship bond rates (specifically treasury bonds) and the Effective Fed Funds Rate have with movements of the stock market.

Our hypothesis is that stock movements should be inversely related to bond and Fed funds interest rates. Our theory behind this is the idea that as bond prices decrease, stock prices tend to rise. This is justified by the fact that bonds are safer investments but generally provide or generate lower returns, while stocks are much riskier investments but consistently have superior revenues, and investors have to choose between them. In theory, if we can spot one of the two types of investments deviating ahead of time, we will be able to accurately predict a change in the deviation of the other. If our hypothesis is correct, it will begin to affirm the theory of inverse relationships between bonds and stocks, allowing professionals to add into their trading strategies, and enable individuals to plan their investments around an overall market outlook.

2 Data Overview and Weaknesses

To conduct this research, we will be using data pulled from the Federal Reserve Bank of St. Louis. We have identified a ten-year time frame for all of our variables, and have given a monthly time frame for this data. The time frame for our data begins in December of 2008 (12 months after a significant drop in the stock market) and ends October 2018. In total, we have 120 data points for each of these variables, giving us a combined data entry of 840 different data points. To keep a consistent basis, and to ensure our data is stationary, we have adapted all of our data to be represented on a monthly percent change basis.

Our dependent variables will be the S&P 500 (SPX) and Dow Jones Industrial Average (DJIA). We have chosen these as the two have long been considered to be accurate representations of the stock market as a whole. We also are considering them to be interchangeable in our regressions as they are extremely correlated (96.7%).

Our independent variables are the Effective Federal Funds Rate (FF), 3-Month Treasury Constant Maturity Rate (MO), 1-Year Treasury Constant Maturity Rate (YR), 5-Year Treasury Constant Maturity Rate (YR1) and 10-Year Treasury Constant Maturity Rate (YR2). A side note is that in contrast to our dependent variables, our short term bond rates vary significantly from our long-term rates. Short term rates (3-month and 1-year bonds) only correlate with long-term rates (5 and 10-year bonds) approximately 30%. Our summary stats for all our variables are outlined in the table below.

Table 1.1 Summary Statistics							
Variables (Percent Δ monthly basis)	S&P 500 (SPX)	*Dow Jones Industrial Average (DJIA)	Effective Fed Funds Rate (FF)	3-Month Maturity Rate (MO)	1-Year Maturity Rate (YR)	5-Year Maturity Rate (YR1)	10-Year Maturity Rate (YR2)
Median	1.38	1.24	0.70	2.80	1.40	0.40	0.29
Mean	1.02	0.96	2.22	14.52	1.73	0.82	0.17
Minimum	-10.56	-9.48	-66.54	-85.33	-52.00	-34.14	-30.61
Maximum	12.02	10.46	94.78	792.86	75.85	43.84	19.92
Standard Deviation	3.05	2.99	18.07	88.36	15.98	12.29	8.00
Notes* Dow Jones & S&P 500 are 96.7% correlated.							

Our dependent variables SPX and DJIA have means of 1.02% and 0.96% respectively, these represent the average percent change for the stock prices on a monthly basis. The medians of 1.38% and 1.24% tell us that the majority of our data for stocks is above the mean, suggesting the general stock market is consistently increasing, and standard deviations of 3.05% and 2.99% show us we have a fairly clustered sample. Our first independent variable is the Effective Fed Funds rate, and it is a slightly different variable than the actual Fed Funds Rate. The Effective Fed Funds rate is a weighted average of the rates that banks charge each other (banks can negotiate with each other for a higher rate than the current Fed rate). In short, it is a more accurate representation of how the market is affected by changes in the Fed Funds rate. This is why we have a maximum value of 94.78% and a minimum value of -66.54%, they may seem excessively large, but it is a more accurate representation in the context of the stock market. Our mean of 2.22% is close to what the actual Fed Funds rate is currently, but a median of 0.70%

shows most of our data is below our mean, and a standard deviation of 18.07% indicates our sample data is particularly spread out.

Our bond data for MO, YR, YR1, and YR2 have means of 14.52%, 1.73%, 0.82%, and 0.17%, respectively. This suggests that as the maturity of bonds becomes longer, the average yield is decreased. Similarly, their standard deviations, equaling 88.36%, 15.98%, 12.29%, and 8.00%, shows that changes in bond rates become more and more consistent with increasing lengths of maturity. This is consistent with the intuition that long term bonds are typically safer but have a lower percent yield. MO has a median of 2.80%, implying there are a number of outliers pulling the mean down, whereas the medians for YR, YR1, and YR2 have values quite close to their means, suggesting the data is evenly distributed.

When we look at the data we have aggregated, there is an apparent weakness that presents itself. Although we have a significant number of data points for our test, we are only looking at a period that contains one recession. The fact that we have been in the longest bull run in history is a significant contributor to this. Dow Jones' stock price has grown at a rate approximately equal to 11% annually since December of 2008, when the expected growth annually for the stock market is 7% (The same is also true of the S&P 500--their stock has grown 10% annually since 2008). This means our results in theory may be less accurate if applied in a period of recession, due to the unusually high growth rate as compared to the average return of the market. In order to find a more accurate depiction we may need to look at a series with multiple recessions for our findings to be more applicable. Our research question asks if there is a causal relationship between the change in bond value and the change in stock price and this is seen throughout a recession more than it can be seen in a period of vast expansion.

As our study is based on time series data we are obligated to run ADF tests (Augmented Dickey-Fuller Tests) on each of our variables in order to test if they are non-stationary or stationary. Due to the fact that we have appended our data to be in percent change, we have likely already adjusted the structure of our data if it was originally non-stationary. To confirm this intuition, and so that we can trust our results, we employed the level of variable version of ADF. We used AIC to determine the proper amount of lags to include. These results show that all of our variables are stationary because the p-values are smaller than critical values at 1% confidence levels. Therefore, we are able to reject the null hypothesis that our data is non-stationary. This verifies that we are able to use OLS regression models in our study. Our results for ADF tests are summarized in the table below.

Table 1.2 ADF Tests

Variable	S&P 500 (SPX)	Dow Jones (DJIA)	Effective Fed Funds (FF)	3-Month Treasury (MO)	1-Year Treasury (YR)	5-Year Treasury (YR1)	10-Year Treasury (YR2)
T-Stat	-8.405	-8.465	-8.945	-10.278	-5.753	-9.792	-9.106
P-Value	8.1e-16	5.085e-14	9.71e-16	8.853e-14	4.476e-06	5.758e-13	9.534e-12

Notes* Calculated using constant and trend using AIC to test for lags

3 Research Methodology

Our underlying theoretical relationship is that the movement of stocks should be inversely related to the movement of bonds and Effective Fed Fund rates. We expect the coefficients on Effective Fed Funds and all our bond data to be negative, as we are predicting that a negative change on bond rates should cause our dependent variables SPX and DJIA to increase. This is justifiable because if bond rates decrease, investors are more likely to buy stocks instead of bonds, leading to an increase in the price and value of whatever stocks they choose to buy. Similarly, when the Effective Fed Funds rate increases there is a decrease in the money supply in the market, and this discourages investments in the stock market.

In order to test the theoretical relationship, we will be running regressions on our data by using OLS (Ordinary Least Squares) analysis, we are also operating under the assumption that the relationship will be linear. Time series data is typically difficult to evaluate in the context of OLS, but as we have set up our data to be in a percent change format and have identified all of our variables to be stationary (by way of ADF tests on each of our variables), OLS is a valid method to test our theory.

We have defined our OLS multiple regression model to be: Expected Stock Market Yields (SPX) or (DJIA) = $\beta_1 + \beta_1 X_1(FF) + \beta_2 X_2(MO) + \beta_3 X_3(YR) + \beta_4 X_4(YR1) + \beta_5 X_5(YR2)$

SPX and DJIA are the monthly percent change of their respective stocks, FF is the Effective Fed Funds Rate monthly percent change, MO is the monthly percent change of 3-month treasury bond maturity rates, YR is the monthly percent change of 1-year treasury bond maturity rates, YR1 is the monthly percent change of 5-year treasury bond maturity rates, and YR2 is the monthly percent change of 10-year treasury bond maturity rates. Alongside this model we also will be running smaller regressions with fewer variables to test our data more thoroughly (i.e. only FF and DJIA, only Bonds and SPX, etc.) to establish a more accurate understanding of whether our findings are valid, and to provide context for readers. Based on these models we have run OLS regressions as shown below.

Table 1.3 Results

Dependent Variable Columns (1) (2) (3) = SPX: Columns (4) (5) (6) = DJIA

Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)
Effective Fed Funds Rate (FF)	−0.0406** (0.019)		−0.0450** (0.019)	−0.0414** (0.018)		−0.0447** (0.019)
3-Month (MO) Treasury Maturity Rate		−0.0004 (0.003)	−0.0021 (0.003)		−0.0012 (0.004)	−0.0029 (0.003)
1-Year (YR) Treasury Maturity Rate		−0.0177 (0.030)	0.0114 (0.034)		−0.0194 (0.030)	0.0096 (0.033)
5-Year (YR1) Treasury Maturity Rate		0.0374 (0.068)	0.0045 (0.068)		0.0283 (0.067)	−0.0044 (0.066)
10-Year (YR2) Treasury Maturity Rate		0.0854 (0.102)	0.1100 (0.097)		0.0895 (0.098)	0.1140 (0.091)
Intercept	1.1302*** (0.270)	1.0011***	1.1213*** (0.251)	1.0789*** (0.267)	0.972*** (0.259)	1.0921*** (0.249)
Adjusted R^2	0.051	0.109	0.159	0.055	0.098	0.149
F-Test (P-value)		3.05 (0.019)	2.88 (0.017)		3.24 (0.014)	3.14 (0.010)

Notes* F-Tests in columns (2) and (5) use F (4, 114): Testing significance of our Bond variable Columns (3) and (6) use F (5, 113): Testing significance of all variables

4 Discussion of Results

For the discussion below we will be referencing columns (3) and (6). Regressions in columns (1) (2) (4) and (5) are to see how FF and bonds act in the absence of the others and are included for context and for F-tests of bond variables.

In our full regression models, columns (3) and (6), there are only two variables that are statistically significant--the constant and the variable FF. The constant is significant at 1% and FF at 5%. The constant being significant is not particularly interesting, as it only means it differs significantly from 0, but as we are regressing on percent change of stock prices, a constant higher than 0 is expected, as the stock market is consistently on an upward trend. A key aspect of our results is the coefficient on FF, it is statistically significant, as well as negative. This is exactly what we predicted in our hypothesis.

However, the results from our bond variables are less conclusive, as some coefficients are negative (as predicted) but others are positive, and none are statistically significant. In column (3) the coefficient on MO is negative, although it is very small and somewhat insignificant. However, coefficients on YR, YR1, and YR2 are positive, opposite to what we predicted. Column (6) has similar results, except for the addition of variable YR1 becoming negative. As none of these are statistically significant, we cannot say these results prove anything about bonds being inversely related to stocks, only that our initial intuition is at least partially accurate.

Economic significance is a similar story with regard to our bond coefficients. In column (3) a 1% increase in bond rates in any of our coefficients will only cause a decrease of 0.002% for MO, and increases of 0.01% for YR, 0.004% for YR2, and 0.1% for YR2. For any of these to actually make a difference in stock prices there would have to be a major decrease or increase in bond rates--a change of at least a 10% would be required. Referencing table 1.1, the average change in bond rates typically averages less than 5%, and therefore a change of that magnitude is unlikely. Results from column (6) regressing on DJIA tell the same story.

In contrast to the bonds, economic significance shows extensively in the Effective Fed Funds Rate. If there is an increase of 1% in the Effective Fed Funds rate, we can expect stock prices to decrease by an amount of 0.045%. This may not seem like much unless you look at the percent changes of the Fed Funds rate. The Fed recently increased the Fed Funds rate by 25 basis points (from 2% to 2.25%). This is a 12.5% percent change, meaning the expected change in the stock market when calculated in our model is -0.56%. This is a much larger effect, and as the Effective Fed Funds rate is consistently increasing or decreasing (depending on whether the Fed is trying to stimulate or slow down the economy), this could easily make a large impact on the stock market over a long period of time. It is very interesting however that even with all this being true, the F-stat on our bond variables is significant at 5%, even though none of the individual variables are statistically significant on their own. One last interesting note on our results is that short term rates seem to have the negative effect on the stock market (Fed Funds rate and 3-month bonds) but when we look at longer maturity rates (1-year, 5-year, 10-year) the opposite seems to be true. This suggests that the stock market is seemingly impacted more by 'overnight rates' as opposed to long-term rates.

However, there are some limitations to these results. The fact that none of the coefficients on our bond data are statistically significant or particularly economically significant makes it difficult to draw a definitive conclusion about the relationship that bonds have with the stock market. Even if you were to disregard the economic and statistical significance, the fact that the sign of our coefficients are not consistently negative or positive suggests that different maturity lengths for bonds each have their own specific relationship with the stock market. In hindsight this is validated by our discussion of short-term rates only being roughly 30% correlated with long-term rates.

A second limitation of our results stems from our discussion on the weaknesses in our data. Because we are only analyzing data from the last 10 years, (during the longest bull run in the history of the stock market and only includes a few data points during the recession of the 2000s) it is difficult to conclude with certainty how applicable our results will be if applied to a period during a recession versus a stage of expansion. The only way to decide whether or not this is the case would be to pull data over a longer period of time, so as to include multiple recessions, and compare the results.

5 Conclusion

This paper looks to improve on investment techniques by analyzing how changes in the Effective Fed Funds rate and Treasury Bond rates directly influence change in the stock market. Using an OLS (Ordinary Least Squares) regression model with time series data we looked to measure the underlying hypothesis that treasury bond rates and Fed Fund rates have an inverse relationship with the stock market.

Our results showed statistical significance in the Effective Fed Funds rate at 5%, as well as economic significance. A change from 2% to 2.25% in the Fed Funds rate (a 12.5% increase) can negatively influence the stock market nearly half a percent overnight. In the real world this means if the Fed is consistently increasing or decreasing rates over a long period of time, the stock market as a whole could lose or gain 5% to 10% in value, a significant impact. In contrast, coefficients on our bonds showed little significance economically or statistically, and interestingly enough our hypothesis that bonds and Fed Funds have an inverse relationship with the stock market is only partially correct. Only the 3-month bonds and Fed Funds have a negative coefficient, suggesting that the stock market is only impacted the way our hypothesis predicted with regard to short-term rates.

Although this study only finds the Effective Fed Funds rate to be economically and statistically significant, it still has viable findings that would be very interesting to research in the future. As we have already discussed, a future study could look at the same variables as our study, but analyze a different range of data, which covers a longer period of time with more downturns in the economy, so as to get a more complete picture of the stock market's relationship with bonds and Fed Funds. A second interesting issue with our results are the inconsistent sign of treasury bond rates. It would be fascinating to research why different maturity lengths seem to react with the stock market so differently. In our study it is very unclear why they differ so drastically. It is our hope that this study can begin to affirm the inverse relationship that has only hypothetically existed previously between stock and bond markets, and that it will aid investors in their investment strategies.

References

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