An Out-of Sample Forecasting Analysis of the Granger-causal Relationship Between Fed Policy and Stock Returns

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Abstract

The question of whether Fed policy Granger-causes stock market fluctuations is an important issue both for financial economics and the design of optimal monetary policy. Most investigations of this issue have heretofore been based on in-sample analysis via conventional *F*-testing of the standard exclusionary restrictions. The main contribution of this paper is that the issue of Fed policy Granger-causing stock returns is studied through a simulated out-of-sample forecasting exercise. Using the "restricted" and the "unrestricted" time series models estimated on moving fixed windows of data, a sequence of one-step-ahead out-of-sample forecasts are computed for both classes of models. To the extent that the "unrestricted" model has no better out-of-sample forecasting performance than the "restricted" model, it is concluded that stock returns are not Granger-caused by the variable excluded from the "restricted" model. This backs up the Efficient Market Hypothesis, which states that the value of the stocks only change when unanticipated shocks are introduced into the financial market.

1. Introduction

Individuals in the financial markets are directly affected by the actions of the Federal Reserve Board. Since many believe that Fed policy strongly affects the decision making process of the financial market makers, a change in Fed Policy, or lack thereof, can have dramatic effects and consequences on the financial market as well as the economy in general.

The purpose of this paper is to test if Fed Policy, stated as the M1 growth rate, the M2 growth rate, and the Federal Funds Rate, can predict future movements in the stock market. Put differently, this paper tests to see if Fed policy "Granger-causes" stock returns. For clarification, Granger(1969) states that an event (event A) Granger-causes another event (event B) if the first event 'causes' the second event. Therefore, when event A happens, the expectation is that event B will happen as well; thus, actions can be adjusted accordingly knowing that event B will most likely occur at a lag after event A. Granger (1969) argues that if event A Granger-causes event B, then, if event A is taken out of the regression, the ability to predict event B is drastically hampered.

Much research has been conducted on this matter. However, results range from one extreme (Fed policy Granger-causes stock returns) to the other (Fed Policy has an insignificant effect in predicting stock returns). For example, Roalski and Vinso (1977), Jones and Uri (1987), and Abduaalh and Hayworth (1993) suggest that changes in Fed policy (via aggregate growth in the money supply) of yesterday are a good indicator of stock returns for today. Put differently, changes in Fed policy today help to determine (Granger-cause) the returns of the stock market in the future. Work by Sorensen (1982), Davidson and Froyen (1982), and Pearce and Roles (1983) opposes the idea that Fed policy Granger-cause stock returns. They believe that stock prices respond only to unanticipated shocks in Fed Policy.

One critical issue that must be confronted is that of rolling windows verses full samples or an "increasing window." Swanson (1998) suggests that it is important to use rolling windows due to the fact that "systems may be evolving over time." In other words, the Fed policy of the 1960's may not affect stock returns the same way as the Fed policy of the 1990's. For this reason, fixed rolling windows of 10 years, 15 years, and 20 years are used in this paper. For clarification, a fixed rolling window of 10 years means that only data during a ten year period (e.g. 1960:01-1969:12) is used to calculate the one-step-ahead out-of-sample forecast for time t (1970:01). To calculate the one-step-ahead out-of-sample forecast for time $t+1$ (1970:02) data from 1960:02-1970:01 would be used for the same 10-year fixed rolling window.

The main contribution of this paper is that the issue of Fed policy Granger-causing stock returns is studied through a simulated out-of-sample forecasting exercise. By using "restricted" and "unrestricted" time series models estimated by rolling windows of data, a sequence of one-step-ahead out-of-sample forecasts is computed for all three classes of models.

This paper is an out-of-sample analogue of Zhao (2000), which conducts a moving window in-sample analysis of Granger-causality between money and stock returns. Zhao's in-sample analysis examined the extent to which models "with money" and "without money" achieved better fits to the data. In contrast, in this paper the focus is on the comparative out-of-sample forecasting performance between the alternative models considered. If the model "with money" achieves a better forecast than the model "without money", we conclude that money Granger-causes stock returns.

The rest of this paper is organized in the following manner. Section 2 gives a brief outlay of the history and make-up of the Federal Reserve System. Section 3 looks at the two most commonly accepted theories and their views about the relationship between Fed Policy and the returns on the stock market. Section 4 describes the data used in the evaluations between Fed policy and stock returns. This section also deals with the detrending of a few variables to conduct the regressions needed to conduct the testing of the Granger-causality issue. Section 5 describes the two models used for testing Granger-causality. Section 6 discusses the importance of the information given in the tables and reports the empirical results. Section 7 reports the conclusions of this study and future work to be done to further prove or disprove the hypothesis that Fed policy Granger-causes stock returns.

2. Federal Reserve System

The Federal Reserve System (Fed) was created in 1913 by the Federal Reserve act. It created twelve regional reserve banks located in twelve distinct geographical areas. Abel and Bernanke (2001) suggest that :

> "One of Congress's primary motives in establishing the Fed was the hope that a central bank would help eliminate the severe financial crises (combinations of stock market crashes, business failures, and banking panics) that had periodically afflicted the United States before World War I."

The Fed is governed by the Board of Governors, which consist of seven governors appointed by the President. Each governor serves for 14 years, and one seat becomes vacant every two years. The leader of the Board of Governors is appointed by the

President every four years.

Decisions about the market's economy and the monetary policy are carried out by the Federal Open Market Committee (FOMC). This group consists of the president of the Federal Reserve Bank of New York, the seven board of governors, and four of the presidents from the other ten Federal Reserve Banks who switch on a set rotation. FOMC meets about every six weeks to discuss the country's economy and evaluate the incoming macrovariables since the last meeting.

3. Competing Theories

There are two competing theories when examining the Granger-causality of Fed policy on stock returns. The first one is called the Monetary Portfolio (MP) Hypothesis. Under the MP Hypothesis, Fed Policy has causal effects on stock returns. This theory suggests that when the market is in a state of equilibrium, an individual will hold a particular amount in bonds and a particular amount of stocks in his/her portfolio. When this state of equilibrium is disrupted, each individual's portfolio will be in a state of disequilibrium. To bring their portfolio back into a state of equilibrium, the individual will either sell a portion of stocks and buy bonds or sell a portion of their bond holdings and buy stocks. Whichever course of action he/she chooses depends on the individual's perceived ability to maximize returns while minimizing or maintaining risk. The easiest way to think of how disequilibrium occurs is to look at the following example:

1. The Fed increases the money supply by buying treasury notes and issuing new currency into the market.

2. This causes interest rates to decrease, which causes disequilibrium in the individual's portfolio due to the fact that expected return has decreased. This also means that the firms can borrow money at a lower rate and can

invest in projects that would not have been profitable with the higher interest rate. Thus, the riskiness of stocks decrease.

3. Investors reevaluate their portfolios. In doing so, the investor takes a portion of his money out of interest bearing accounts (bonds) and invests it in the stock market. This puts the individual's portfolio back in a state of equilibrium, and it brings the market as a whole back into a state of equilibrium.

Over time, under the MP Hypothesis, increasing the money supply will gradually and predictably increase stock returns. The opposite also holds true; decreasing the money supply will decrease stock returns. The key point of the MP Hypothesis is that the cause and effect relationship does not happen instantaneously. There is a predictable lag between the cause and the effect.

The second theory is the Efficient Markets (EM) Hypothesis. This theory assumes that everyone has perfect knowledge of all information available in the market. Therefore, the current price of an individual stock (and the market as a whole) portrays all information available at time t. The only thing that will change the price of the stock is new information. Since new information is random and unforecastable, the current value of a stock will change only when unanticipated news or events occur. This means that the average forecast error is expected to have a mean of zero and be random. Thus, stock prices will adjust quickly (instantaneously, if you will) to unanticipated news, and the forecastable error will once again be zero and random.

Since the EM Hypothesis suggests that lagged values cannot predict future values, Fed policy does not Granger-cause stock returns, according to this viewpoint. An empirical analysis of the question "Does Fed policy Granger-cause stock returns?" is that it is worth it's weight in platinum. If Fed policy Granger-causes stock returns, then there are enormous potential profits to be made in the stock market. If it can be proven that

Fed policy does not Granger-cause stock returns, then smaller profits are still possible for the individual investor, but at a cost to the financial analysts. If the later is true, and the predictive power of Fed policy on stock returns is invalid, then an individual does as well (if not better adding fees) by picking the market opposed to going to a financial analyst (and stock brokers).

4. Market Data

The stock market data used for this empirical analysis is the Standard & Poor's Composite Index (S&P500). This index is used over the other indices due to the fact that it contains stocks from the two major national stock exchanges (NYSE and AMEX) and the over-the-counter market (NASDAQ). Thus, this index should give a well-rounded perspective of the stock market in general. The price of the index is a weighted average of the 500 stocks. These stocks, picked by a committee of officials from Standard & Poor's Corporation, represent the current market conditions as a whole. Stocks may be added and deleted by the committee as they see fit.

The S&P500 index is used to measure stock market activity for all models used in this paper. The range of the monthly data is from 1959:01 to 2000:08. Figure 1 shows the value of the S&P500 for the dates specified above. Notice that there is an upward trend in the value, which represents nonstationarity in the index over this particular period. Cuthberston (1996) states that in order for a series to be stationary, it has to have a "constant mean and variance and the correlation between values y_t and y_{t+j} depends only on the time difference 'j'. Thus, the mean, variance, and correlation for any lag 'j' are independent of time." This states that a stationary series tends to often return to its mean value; and the variability of the series doesn't alter during movement through time. If there is non-stationarity in the series, then statistical inference based upon OLS point estimates is quite problematic.

In order to correct this problem, the continuously-compounded 1-month stock return series is used. This is constructed by computing the log-first differences of the S&P500 index as follows

$$s_t = ln(S\&P500_t). \quad (1)$$

Figure 2 shows the monthly returns for the S&P500 index. Note that this series appears to be far more stationary than the series displayed in Figure 1.

5. Model Specification and Granger-causality Testing

Models used in this paper consist of four different factors that could cause potential changes in the returns to stocks. The first is the value of past returns on the S&P500 index. Cycles exist in the market where what happened at time *t-1* helps determine what happens at time *t*, and thus what will happen at time *t+1*. Lags and specifications of lags will be dealt with later in this paper.

The next factor that could cause changes in stock returns is Fed Policy. The three measures used to show Fed policy are the M1 money supply, the M2 money supply, and the Federal Funds Rate. Figure 3 shows the M1 and M2 money supply, and Figure 4 shows the Federal Funds Rate.

The aggregate M1 money supply is made up of currency, Travelers' checks, demand deposits, and other checkable deposits. Abel and Bernanke (2001) state that M1 is the most liquid of the official money measures in the US. The aggregate M2 money supply includes all the items in the aggregate M1 money supply plus savings deposits, small-denomination time deposits, and Money Market Mutual Funds. Once again looking at Figure 3, it is clear to note that both the aggregate M1 and M2 money supplies are increasing at an increasing rate. This means that the issue of nonstationarity is again questioned. Figure 5 shows the growth rates of both M1 and M2. Upon examining Figure 5, the issue of a constant variance seems to be violated. To rectify this situation, the natural log of M1 and M2 are used. This appears to cause the monthly growth rates to have a constant variance, which can be seen in Figure 5.

The Fed Funds Rate is the interest rate that banks pay other banks to borrow money. This rate is used instead of the discount rate due to the fact the Fed Funds Rate changes more often than the discount rate, which seems to cause the Fed Funds Rate to more accurately portray the market conditions than the discount rate. Although the Fed Funds rate is not directly controlled by the government, it has a strong correlation with the discount rate. No transformation into logs is needed for the Federal Funds Rate.

The third of the four factors is the rate of inflation. The inflation rate is an important element in determining stock returns due to the fact that during times of high inflation, people recognize that the market is in a state of economic difficulty. People are laid off work, which could cause production to decrease. When people are laid off, they tend to buy only the essential items. Thus, production is cut even further. This eats into corporate profits, which in turn makes dividends diminish. When dividends decrease, the expected return of stocks decrease, causing stocks to depreciate in value. Inflation is measured using both the CPI and PPI. The CPI and PPI-based inflation rates are graphed in Figure 6.

The final factor that causes stock returns measured in this paper is interest rates.

The rates of interest used in this paper are the 3-month t-bill, the 1-year bond, the 10-year bond, and the spread between the 10-year bond and the 3-month t-bill, which can be seen in Figure 7. As expected by the liquidity of money assumption, the 3-month t-bill usually has the lowest interest rate, and the 10-year bond usually has the highest rate. This is because a 3-month t-bill is more liquid than a 10-year bond. In order to entice individuals to invest in a 10-year bond over the 3-month t-bill, a premium rate above the 3-month t-bill rate is needed. Individuals also see a 10-year bond as more risky than a 3-month t-bill, which is due to the fact that interest rates could go up and the individual with a 10-year bond is locked into a fixed rate for the entire 10 years. The individual who invested in the 3-month t-bill can take advantage of the increased rates, due to the short maturity on the t-bill.

There are two models used for this paper. This first model is the unrestricted model. The lag order (λ) of the model is chosen by finding the value that minimizes the Akaike Information Criterion (AIC) value. Diebold (1998) presents an argument in favor of using the AIC, over the Schwarz Information Criterion (SIC), since, even though the AIC is an inconsistent model selection criterion, it is asymptotically efficient. Thus, the unrestricted model looks like the following:

$$s_t = \alpha_0 + \sum_{i=1}^{\lambda} (\beta_{i,1} * s_{t-i} + \beta_{i,.2} * m_{t-i} + \beta_{i,3} * n_{t-i} + \beta_{i,4} * r_{t-i}) + e_{t,1} \tag{2}$$

where $t = t1,\ldots,T$, and where s_t is the monthly growth rate of the stock price for period t, m_t is the fed policy factor(M1, M2, and Fed Funds Rate) for period t, n_t is the monthly growth rate of inflation for period t, r_t is the interest rate for period t, α_0, $\beta_{i,1}$, $\beta_{i,2}$, $\beta_{i,3}$, and $\beta_{i,4}$ (for $i = 1,2,3,\ldots,\lambda$) are coefficients to be estimated, and $e_{t,1}$ is a white noise error term.

The second of the two models is the restricted model. The restricted model is the same as the unrestricted model with the exception that the Fed policy factor has been excluded from the equation. One key point is that the lagged parameter λ in the restricted model must be the same as the value of λ in the unrestricted model. The unrestricted model is as follows:

$$s_t = \alpha_0 + \sum_{i=1}^{\lambda} (\beta_{i,1} * s_{t-i} + \beta_{i,3} * n_{t-i} + \beta_{i,4} * r_{t-i}) + e_{t,2} \qquad (3)$$

where $e_{t,2}$ is a white-noise error term.

6. Empirical Results

Given the different money, price, and interest rate series used in this study, out-of-sample forecast comparisons can be made for seventy-two sets of unrestricted and restricted models. In this section, seven different criteria are used to see if Fed policy Granger-cause stock returns. Three of the seven criteria (white noise check, bias check, and MZ regressions) are used to evaluate the performance of a single forecast. Two of the criteria (encompassing tests and MSPE ratios) are used to compare two different forecasts. The normality criterion is used to check for skewness and leptokurtosis in the one-step-ahead out-of-sample forecast errors. This normality check is important in assessing the statistical significance in departures from the MSPE ratio for different models.

A. White Noise Check

In doing forecasts, having white noise is important. In particular, Diebold (1998) demonstrates that "optimal" forecasts should have white noise one-step ahead forecast errors. Thus, rejection of the white noise null hypothesis for a sequence of one-step-ahead forecasts errors is an indicator that the underlying forecasts are less than optimal.

Columns 2 through 3 of Panel A in Tables 1 through 3 deal with this white noise check. This is done by looking at the *p*-value of the Ljung-Box Q-statistic at the 24th lag to see if the forecast errors are white noise. The Ljung-Box Q-statistic looks at the sum of all of the autocorrelations and tests to see if they are all jointly equal to zero (this is what the *p*-value tests). If they are equal to zero, then the one-step-ahead error terms are white noise. All twenty-four regressions for each of the two models fail to reject the null that the one-step-ahead error terms are white noise at the 5% level of significance. Therefore, the error terms are considered white noise.

B. Bias Check

To check for bias, the out-of-sample forecast errors are regressed on a constant. For the one-step-ahead forecast errors not to be biased means that the error terms must be, on average, equal to zero. If not, then the error terms are forecastable, which entails bias. The null used to test bias is that the constant term is zero.

Columns 4 through 5 of Panel A in Tables 1 through 3 deal with the bias issue for the two models. In Table 1, only the unrestricted model has two regressions that are considered bias at the 10% significance level. This is due to the rejection of the null that the constant is equal to zero. In Table 2, the restricted model has two statistically significant values at the 10% significance level. Accordingly, we conclude that the models considered generate unbiased forecasts at the 5% significance level.

C. Normality Check

To test the normality assumption, the Jarque-Berra (JB) test is used. The JB test evaluates to see if the skewness is zero and the kurtosis is three. If skewness is positive, then the distribution is skewed right. If the kurtosis is greater than three, then the distribution will have fat tails. Both of these conditions (and their converse) will cause the distribution to be non-normal. Columns 6 through 7 on Panel A in Tables 1 through 3 show that all twenty-four regressions for both models reject the null at the 10% significance level if the skewness is equal to zero and that the kurtosis is equal to three. This suggests that the one-step-ahead error terms for both models in all three windows are not distributed normally, which suggests caution in interpreting the *p*-values for the MSPE *F*-tests reported below.

D. Mincer-Zarnowitz Regression

The Mincer-Zarnowitz Regression regresses the actual value of the stock return against the forecast value and tests the null hypothesis that the constant is zero and that the slope coefficient is one. The actual regression looks as follows:

$$y_{t+h} = \beta_0 + \beta_1 y_{t+h,t} + \varepsilon_{t+h}, \qquad (4)$$

where y_{t+h} is the actual stock value at time $t+h$, $y_{t+h,t}$ is the forecasted stock value for time $t+h$ at time t, and ε_{t+h} is the error term at time $t+h$. If the forecast is optimal with respect to the information used to generate it, then $\beta_0=0$ and $\beta_1=1$. In Columns 8 and 9 of Panel A in Table 1, the unrestricted and the restricted models have *p*-values less than .000001. By virtue of this information, the null can be rejected a the 5% significance level. This suggests that the models are not optimal predictors of the actual value.

The only time that the null cannot be rejected using the restricted model or the unrestricted model is in the 20-year fixed window. Even then, the unrestricted model fails to reject the null at the 5% significance level only once out of the twenty-four regressions, and the restricted model fails to reject the null at the same level of significance only nine out of the twenty-four regressions. Therefore, neither model does a good job at predicting the actual values.

E. Encompassing

Forecast encompassing is used when there are two or more competing forecasts. Diebold (1998) states that forecast encompassing is used to determine if "one forecast incorporates all of the relevant information in competing forecasts." If the forecast is encompassed by another, then nothing can be gained by combining the forecasts. Columns 2 through 3 of Panel B in Tables 1 through 3 entail all of the information on the issue of encompassing. In Table 1, neither the restricted model nor the unrestricted model encompasses the other. Table 2 suggests the same results as Table 1, except that the restricted model encompasses the unrestricted model once (instead of zero) out of the twenty-four regressions for the 15-year fixed window.

In Table 3, the results are more mixed, and therefore more complex. The unrestricted model encompasses the restricted model six times, while the restricted model encompasses the unrestricted model nineteen times out of the twenty-four regressions. We conclude that neither model encompasses the other model for the 10-year and 15-year fixed windows, but the 'restricted' model encompasses the 'unrestricted' model in more than 75% of the regressions for the 20-year fixed window.

F. MSPE ratios

The mean squared predicted error ratios are important in determining which model has lower mean squared predicted error. The one-step-ahead MSPE is calculated by taking the average of the squared one-step-ahead out-of-sample forecast errors. The model that has the lowest mean squared prediction error is considered the best model out of the ones tested. If the unrestricted model has a lower MSPE than the restricted model and the MSPEs are statistically different, then Fed policy Granger-causes stock returns. The mean squared prediction errors of two models can then be compared by dividing one by the other. If the value is greater than one, then the denominator has a lower MSPE, and is thus a better model to use. If the value is less than one, then the numerator has a lower MSPE.

Column 4 for Panel B in Tables 1 through 3 convey the information of MSPE ratios. The restricted model has a lower MSPE than does the unrestricted model for all but one of the seventy-two regressions.

G. MSPE ratios (p-value)

The *p*-value for the MSPE ratios looks at the null that the MSPE ratio for the two models in each case is equal to one. The results for Tables 1 through 3 suggest that the MSPE ratios for the restricted model and the unrestricted model are never significantly different from each other at the 5% level of significance. Since the MSPE for the restricted model and the unrestricted model are not statistically different from each other, Fed policy does not Granger-cause stock returns. One key point eluded to earlier is the normality issue. These one-step-ahead forecast errors are not normally distributed. Even though this paper rejected the idea that Fed policy Granger-cause stock returns, this assumption was made on normally distributed one-step-ahead forecast errors. The rejection of normality urges caution in interpreting the *p*-values of these tests that the MSPE ratios are equal to one. It would be interesting to explore this problem further.

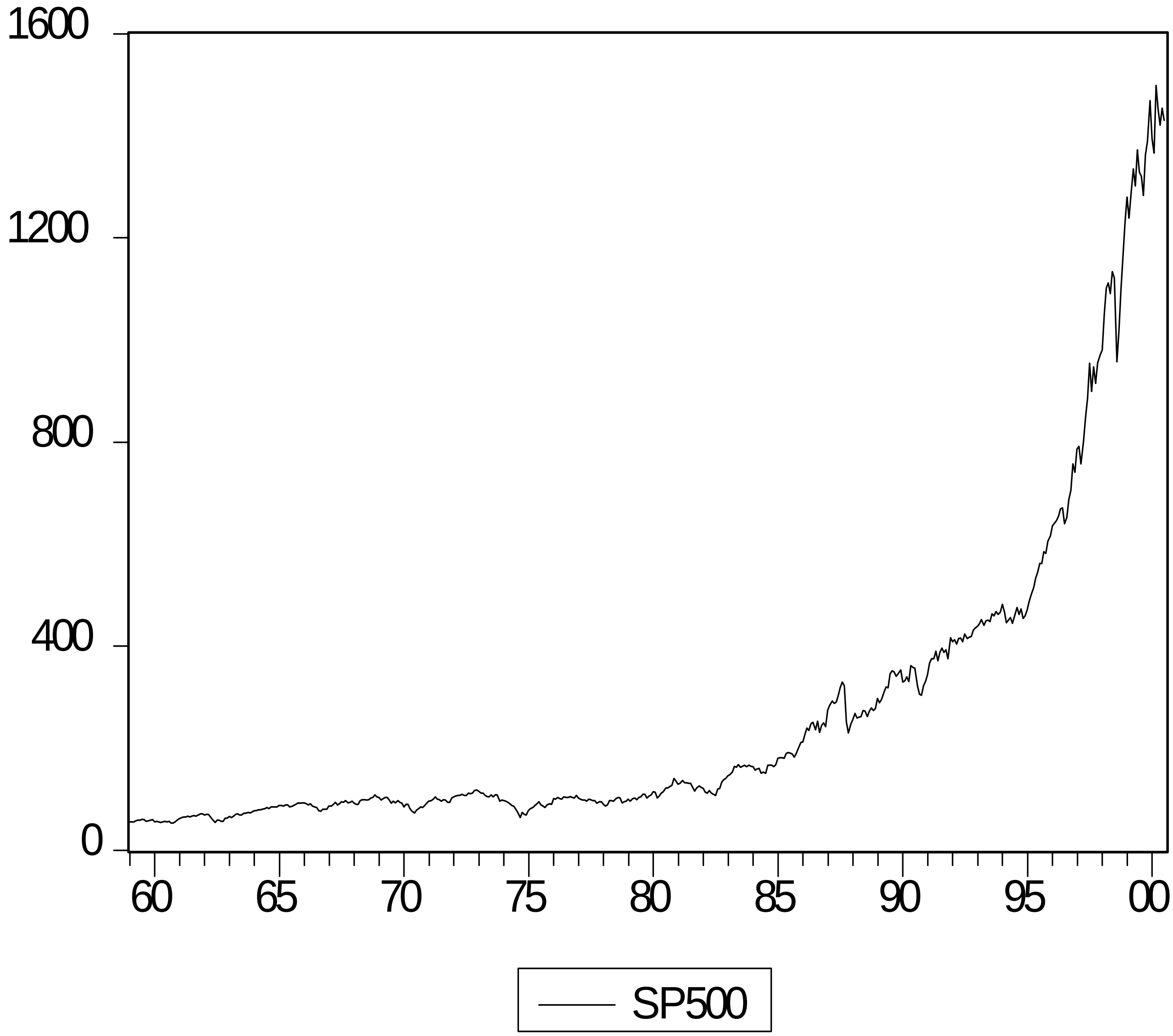
7. Conclusions

By looking at the MPSE ratios and the *p*-values for the MPSE ratios, the evidence in favor of the claim that Fed policy Granger-cause stock returns is quite weak. Even though the MSPE ratios for the unrestricted model are smaller in all but one of the seventy-two regressions, which is a necessary condition for Fed policy to Granger-cause stock returns, the difference is insignificant at conventional significance levels. Therefore, one model does as well as the other in predicting MSPE.

It can be concluded from this research that Fed policy does not Granger-cause stock returns. In future work, I hope to allow the lags for each variable to be independent of the other variables, therefore allowing each variable to take on a specific lag. In addition, I plan on exploring the extent to which my hypothesis test results on the MSPE ratios are possibly distorted by the apparent non-normality of the forecast errors.

Figure 1

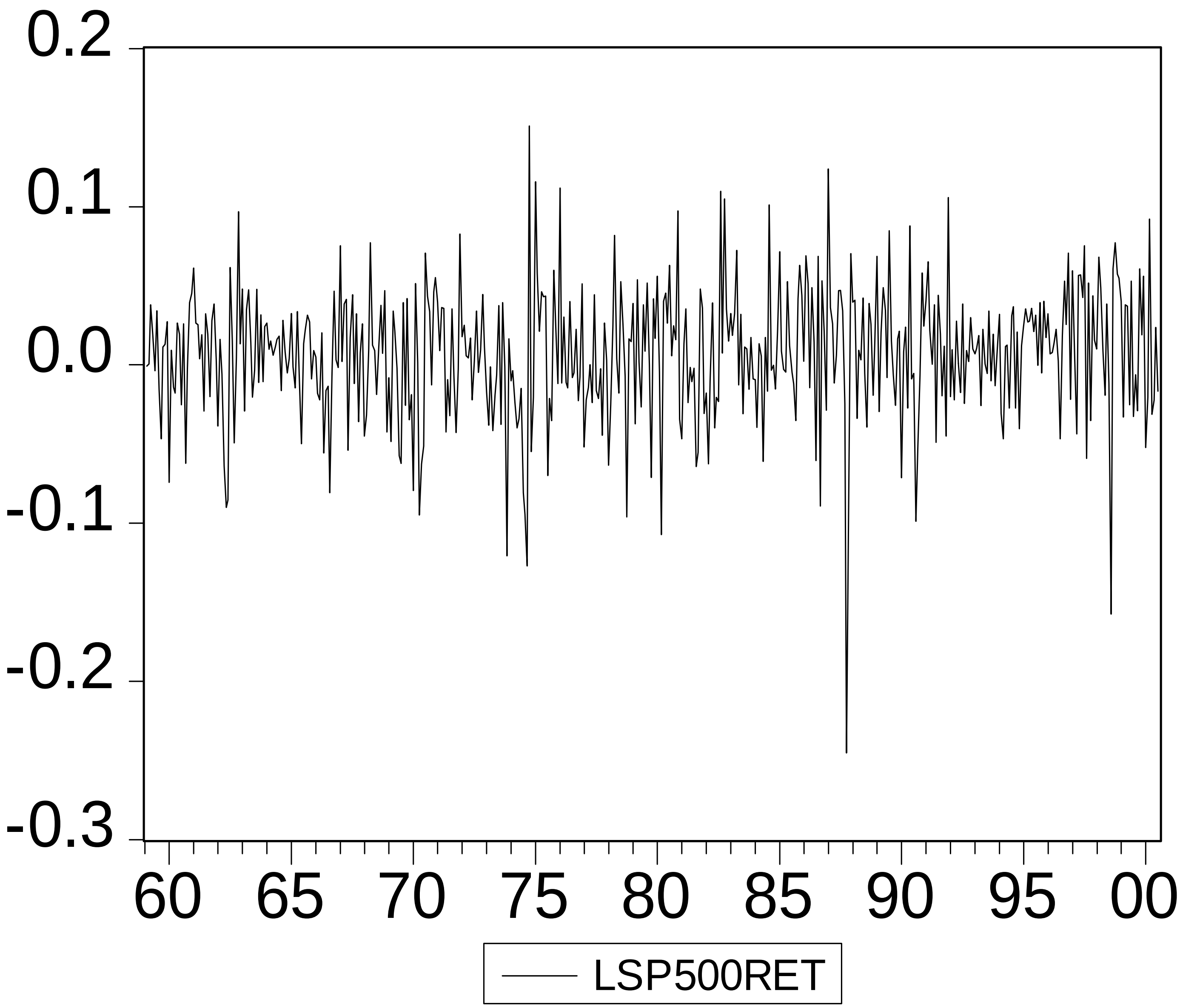
Time Series Plot of S&P500 Index, 1959:01 - 2000:08



Note: This graph shows the time series plot of the monthly value of the S&P500 Index from 1959:01 to 2000:08.

Figure 2

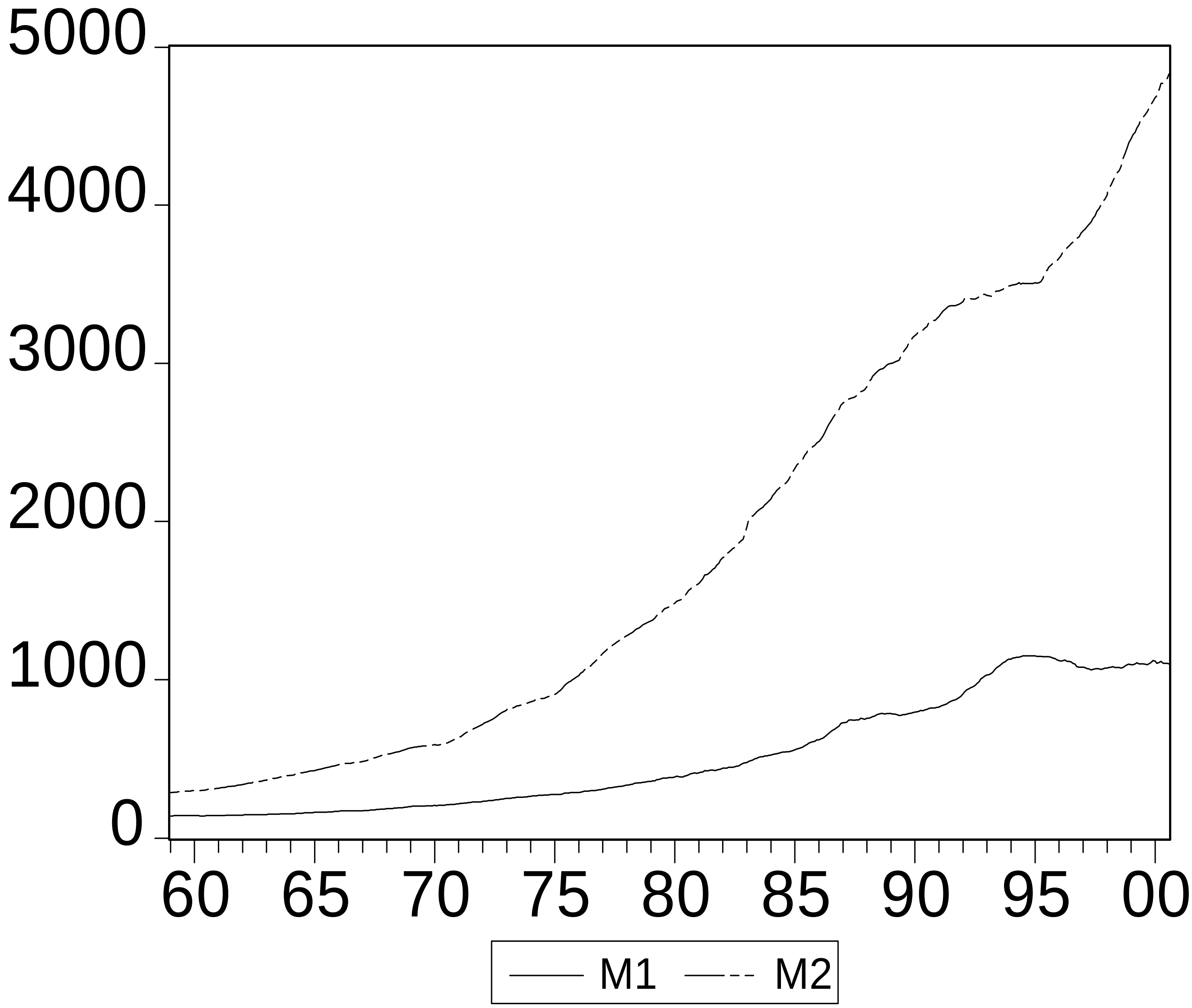
Time Series Plot of S&P500 Index Monthly Returns, 1959:01 - 2000:08



Note: This graph shows the times series plot of the monthly returns, defined as 100 times the log of the first-differenced S&P500 Index from 1959:01 to 2000:08.

Figure 3

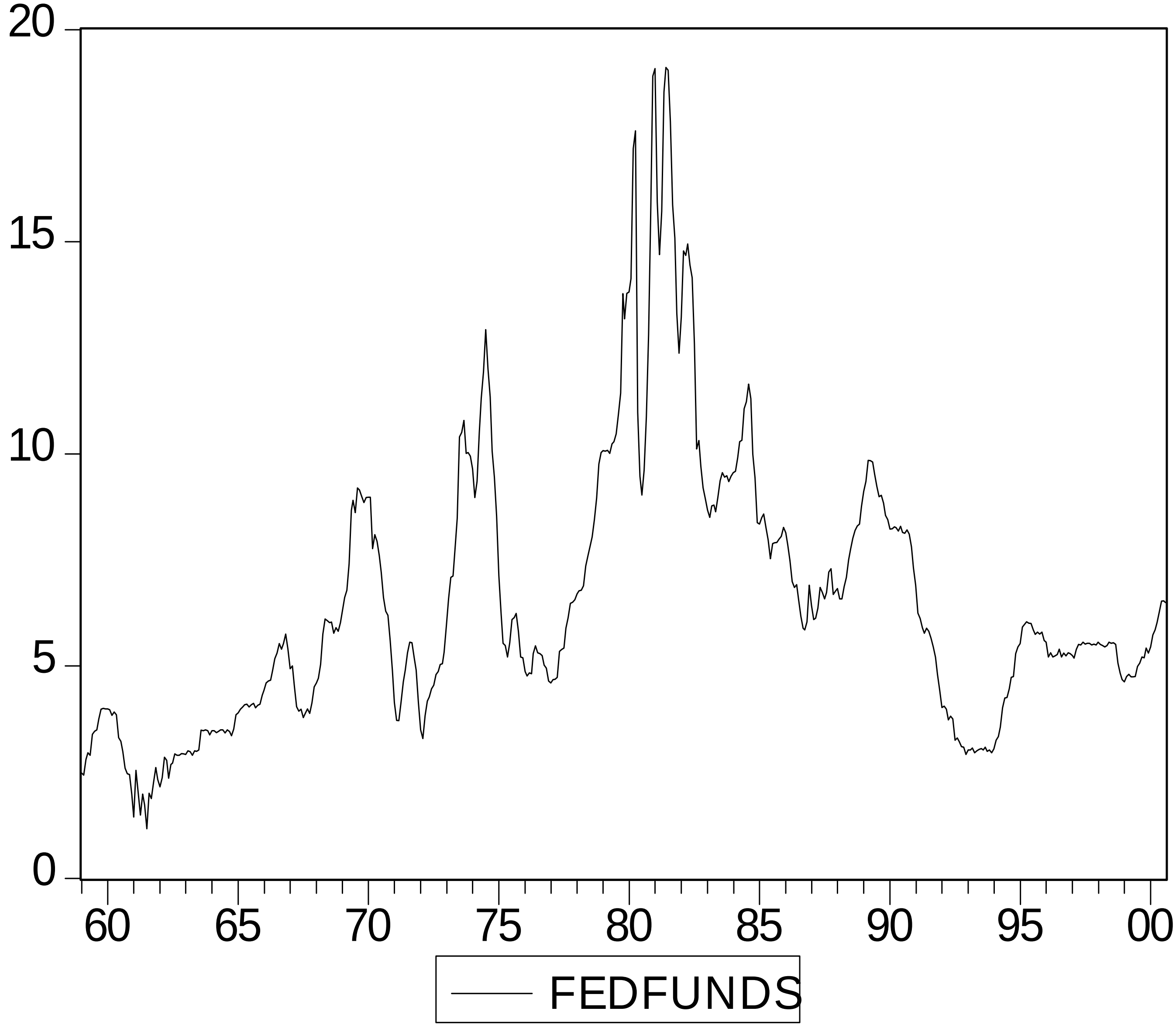
Time Series Plots of the M1 and M2 Money Supply, 1959:01 - 2000:08



Note: This graph shows the time series plots of the M1 and M2 aggregate money supply from 1959:01 to 2000:08.

<u>**Figure 4**</u>

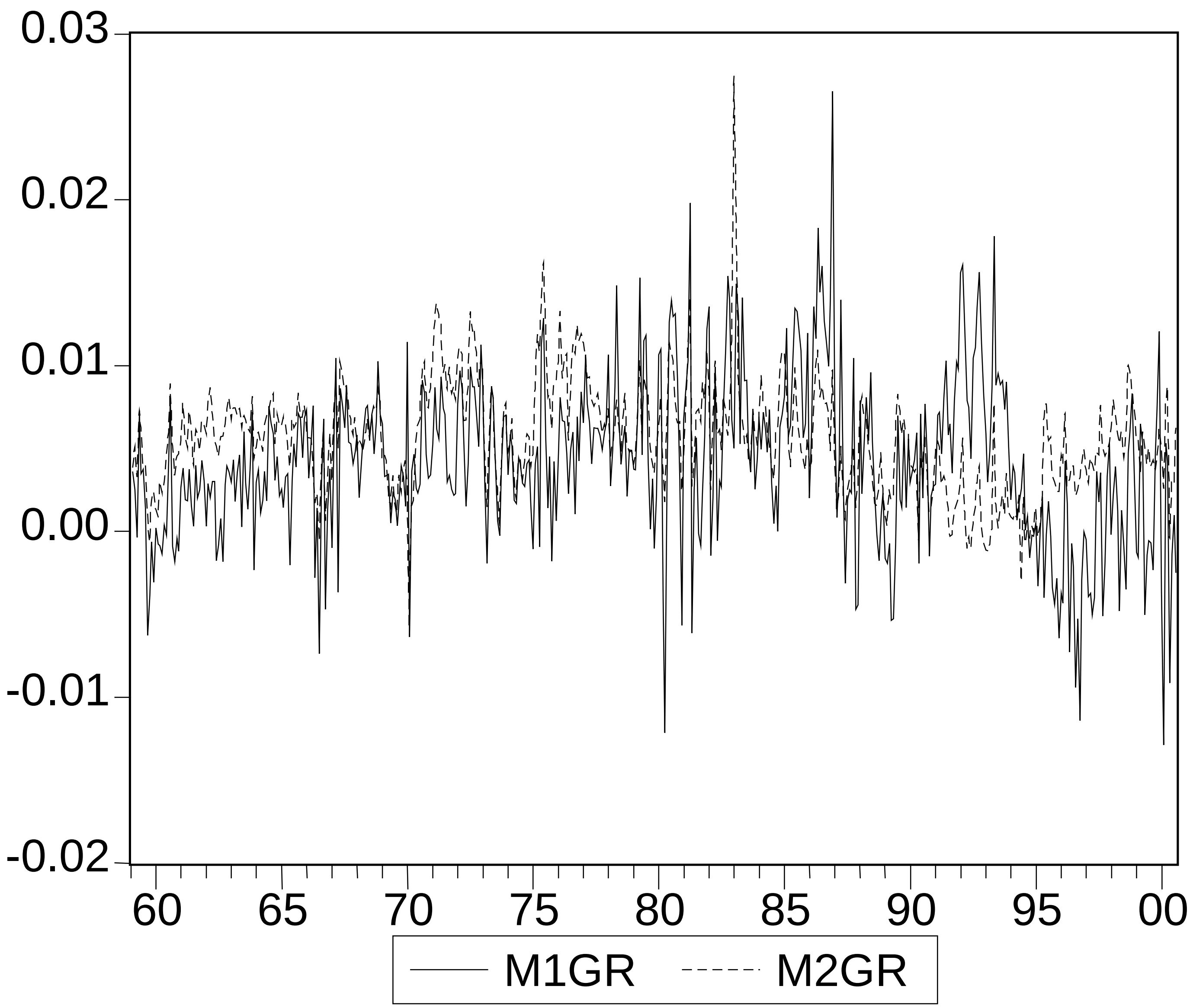
Time Series Plot of the Federal Funds Rate, 1959:01 - 2000:08



Note: This graph shows the time series plot of the Federal Funds Rate from 1959:01 to 2000:08.

Figure 5

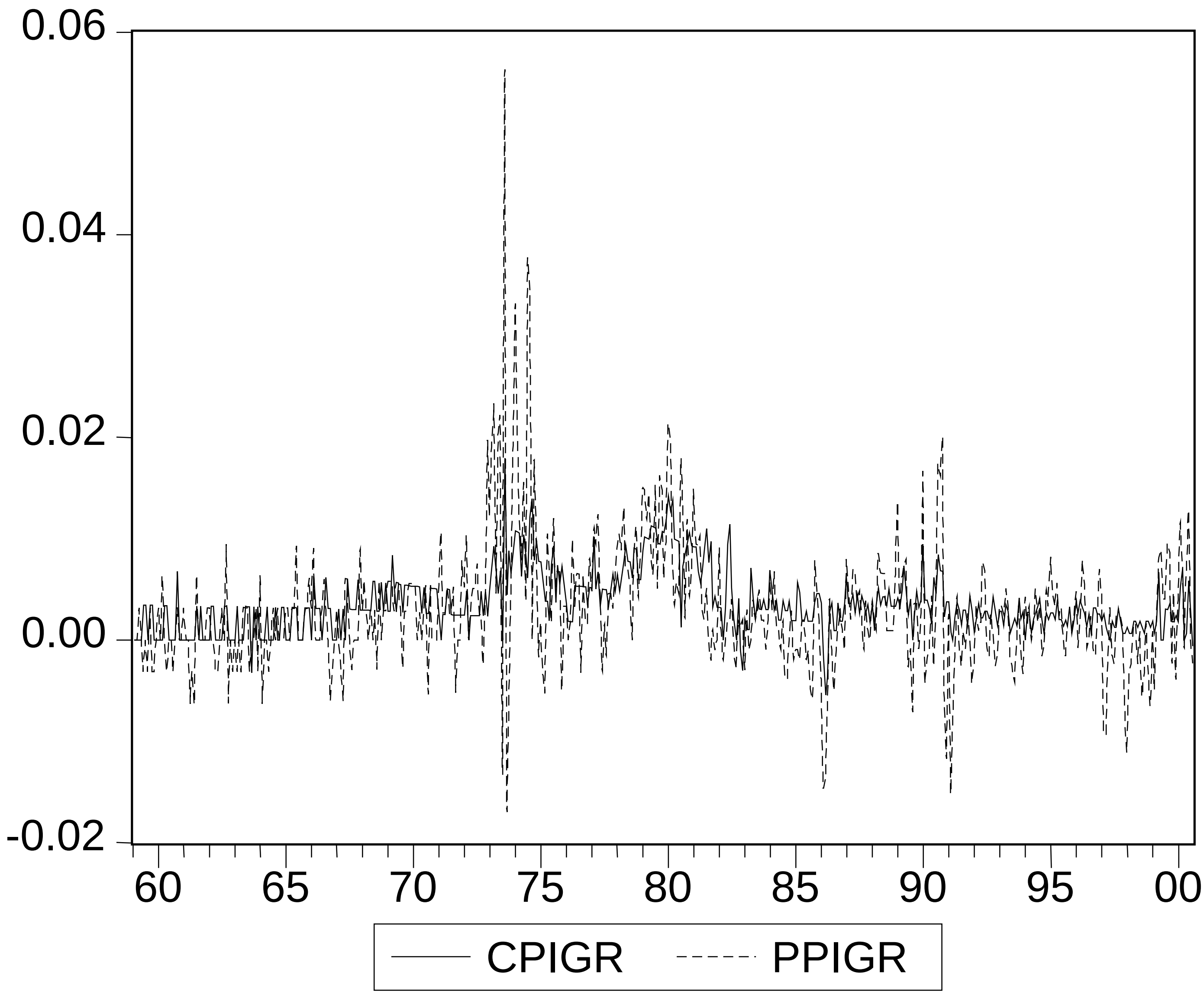
Time Series Plots of the M1 and M2 Monthly Growth Rates, 1959:01 - 2000:08



Note: This graph shows the time series plots of the monthly growth rates, defined as the log of the first difference of the M1 and M2 aggregate money supply from 1959:01 to 2000:08.

Figure 6

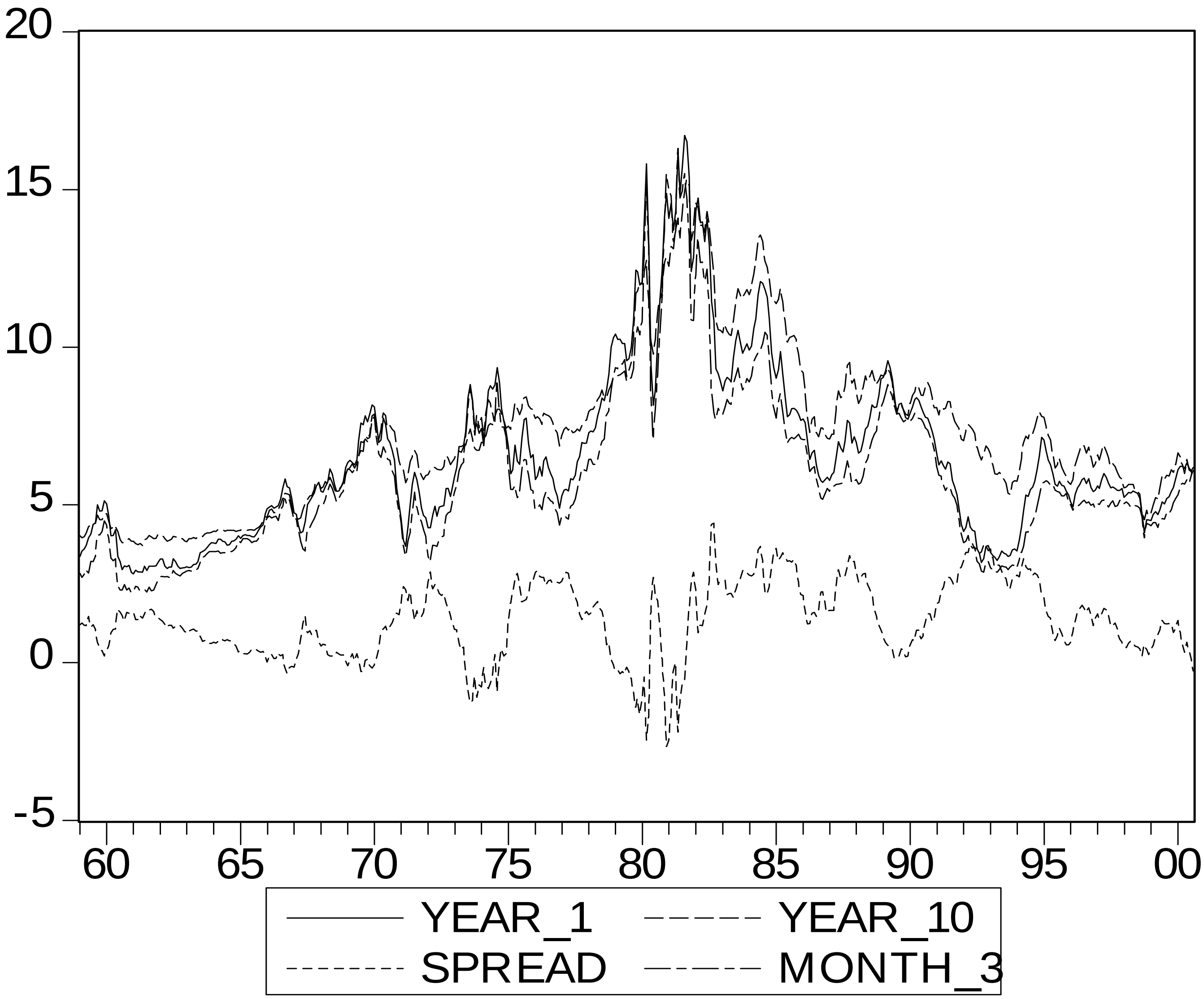
Time Series Plots of the CPI and PPI Monthly Inflation Rates, 1959:01 - 2000:08



Note: This graph shows the time series plots of the monthly inflation rates, defined as the log of the first difference of the CPI and PPI from 1959:01 to 2000:08.

Figure 7

Time Series Plots of the 3-Month T-Bill Rate, 1-Year Bond Rate, 10-Year Bond Rate, and Spread, 1959:01 - 2000:08



Note: This graph shows the time series plots of the 3-month t-bill rate, the 1-year bond rate, the 10-year bond rate, and the spread (10-year bond rate minus the 3-month t-bill rate) from 1959:01 to 2000:08.

TABLE 1: 10-Year Fixed Window

Panel A

	White Noise Check		Bias Check (p-value)		Normality check (p-value of JB test)		M-Z Test (p-value of F-stat)	
	e1	**e2**	**e1**	**e2**	**e1**	**e2**	**e1**	**e2**
s m1 n1 r1	0.046	0.149	0.0787	0.1838	<.000001	<.000001	<.000001	<.000001
s m1 n1 r2	0.443	0.435	0.0844	0.1687	<.000001	<.000001	<.000001	<.000001
s m1 n1 r3	0.750	0.622	0.1455	0.1440	<.000001	<.000001	<.000001	<.000001
s m1 n1 r4	0.793	0.742	0.1705	0.2877	<.000001	<.000001	<.000001	<.000001
s m1 n2 r1	0.762	0.627	0.2039	0.1309	<.000001	<.000001	<.000001	<.000001
s m1 n2 r2	0.613	0.596	0.1949	0.1872	<.000001	<.000001	<.000001	<.000001
s m1 n2 r3	0.492	0.765	0.5512	0.2864	<.000001	<.000001	<.000001	<.000001
s m1 n2 r4	0.428	0.420	0.4420	0.4332	<.000001	<.000001	<.000001	<.000001
s m2 n1 r1	0.484	0.234	0.6096	0.3706	<.000001	<.000001	<.000001	<.000001
s m2 n1 r2	0.702	0.355	0.8453	0.4319	<.000001	<.000001	<.000001	<.000001
s m2 n1 r3	0.640	0.418	0.7100	0.4768	<.000001	<.000001	<.000001	<.000001
s m2 n1 r4	0.339	0.266	0.8530	0.4867	<.000001	<.000001	<.000001	<.000001
s m2 n2 r1	0.587	0.502	0.9231	0.1774	<.000001	<.000001	<.000001	<.000001
s m2 n2 r2	0.564	0.584	0.6869	0.6869	<.000001	<.000001	<.000001	<.000001
s m2 n2 r3	0.599	0.748	0.9855	0.2821	<.000001	<.000001	<.000001	<.000001
s m2 n2 r4	0.761	0.500	0.5687	0.5294	<.000001	<.000001	<.000001	<.000001
s m3 n1 r1	0.090	0.201	0.4287	0.3420	<.000001	<.000001	<.000001	<.000001
s m3 n1 r2	0.524	0.530	0.3494	0.2403	<.000001	<.000001	<.000001	<.000001
s m3 n1 r3	0.338	0.872	0.5866	0.2537	<.000001	<.000001	<.000001	<.000001
s m3 n1 r4	0.741	0.658	0.5602	0.6637	<.000001	<.000001	<.000001	<.000001
s m3 n2 r1	0.347	0.508	0.3105	0.2058	<.000001	<.000001	<.000001	<.000001
s m3 n2 r2	0.486	0.530	0.6386	0.3427	<.000001	<.000001	<.000001	<.000001
s m3 n2 r3	0.386	0.721	0.6875	0.5838	<.000001	<.000001	<.000001	<.000001
s m3 n2 r4	0.246	0.401	0.4085	0.5106	<.000001	<.000001	<.000001	<.000001

Notes: The *s* represents the S&P500 index. m*1, m2*, and *m*3 represent the M1 money supply, the M2 money supply, and the Federal Funds rate respectively. *n1* and *n2* represent the PPI and the CPI respectively. r*1, r2, r3,* and *r4* represent the 3-month t-bill, the 1-year bond, the 10-year bond, and the 10-year bond minus the 3-month t-bill respectively.

Panel B

	Encompassing (p-value for F-stat) f1 en. f2	f2 en. f1	MSPE Ratios f1/f2	MSPE Ratios (p-value) f1/f2
s m1 n1 r1	<.000001	<.000001	1.168620	0.067740
s m1 n1 r2	<.000001	<.000001	1.132095	0.117250
s m1 n1 r3	<.000001	<.000001	1.132394	0.116752
s m1 n1 r4	<.000001	<.000001	1.115370	0.147710
s m1 n2 r1	<.000001	<.000001	1.047884	0.326968
s m1 n2 r2	<.000001	<.000001	1.073112	0.249428
s m1 n2 r3	<.000001	<.000001	1.120799	0.137238
s m1 n2 r4	<.000001	<.000001	1.082628	0.223364
s m2 n1 r1	<.000001	<.000001	1.099326	0.182067
s m2 n1 r2	<.000001	<.000001	1.001991	0.492394
s m2 n1 r3	<.000001	<.000001	1.026154	0.402273
s m2 n1 r4	<.000001	<.000001	1.159029	0.078687
s m2 n2 r1	<.000001	<.000001	1.067613	0.265310
s m2 n2 r2	<.000001	<.000001	1.071630	0.253652
s m2 n2 r3	<.000001	<.000001	1.088371	0.208518
s m2 n2 r4	<.000001	<.000001	1.088818	0.207391
s m3 n1 r1	<.000001	<.000001	1.072854	0.250160
s m3 n1 r2	<.000001	<.000001	1.057968	0.294569
s m3 n1 r3	<.000001	<.000001	1.137163	0.109046
s m3 n1 r4	<.000001	<.000001	1.086492	0.213303
s m3 n2 r1	<.000001	<.000001	1.034427	0.372806
s m3 n2 r2	<.000001	<.000001	1.072615	0.250841
s m3 n2 r3	<.000001	<.000001	1.150226	0.089964
s m3 n2 r4	<.000001	<.000001	1.075536	0.242618

TABLE 2: 15-Year Fixed Window

Panel A

	White Noise Check		Bias Check (p-value)		Normality check (p-value of JB test)		M-Z Test (p-value of F-stat)	
	e1	**e2**	**e1**	**e2**	**e1**	**e2**	**e1**	**e2**
s m1 n1 r1	0.580	0.669	0.1211	0.0945	<.000001	<.000001	<.000001	<.000001
s m1 n1 r2	0.504	0.710	0.1310	0.0992	<.000001	<.000001	0.000081	0.000991
s m1 n1 r3	0.789	0.811	0.2548	0.2678	<.000001	<.000001	<.000001	0.000029
s m1 n1 r4	0.695	0.704	0.6406	0.6708	<.000001	<.000001	0.000703	0.003951
s m1 n2 r1	0.475	0.710	0.1919	0.1293	<.000001	<.000001	<.000001	<.000001
s m1 n2 r2	0.597	0.880	0.1347	0.1208	<.000001	<.000001	<.000001	<.000001
s m1 n2 r3	0.640	0.812	0.2222	0.2375	<.000001	<.000001	<.000001	<.000001
s m1 n2 r4	0.619	0.700	0.3155	0.3243	<.000001	<.000001	<.000001	<.000001
s m2 n1 r1	0.837	0.932	0.4583	0.1327	<.000001	<.000001	<.000001	<.000001
s m2 n1 r2	0.777	0.885	0.4411	0.1382	<.000001	<.000001	0.000002	0.000055
s m2 n1 r3	0.631	0.635	0.5927	0.4756	<.000001	<.000001	0.000028	0.000280
s m2 n1 r4	0.616	0.690	0.6624	0.5190	<.000001	<.000001	<.000001	0.000001
s m2 n2 r1	0.645	0.748	0.2803	0.1212	<.000001	<.000001	<.000001	<.000001
s m2 n2 r2	0.758	0.828	0.2236	0.1399	<.000001	<.000001	<.000001	<.000001
s m2 n2 r3	0.665	0.749	0.2349	0.3975	<.000001	<.000001	<.000001	<.000001
s m2 n2 r4	0.574	0.744	0.5561	0.3690	<.000001	<.000001	<.000001	<.000001
s m3 n1 r1	0.670	0.837	0.5589	0.1412	<.000001	<.000001	<.000001	<.000001
s m3 n1 r2	0.761	0.872	0.5606	0.1318	<.000001	<.000001	0.000004	0.000266
s m3 n1 r3	0.600	0.720	0.9557	0.6386	<.000001	<.000001	<.000001	0.000358
s m3 n1 r4	0.535	0.752	0.3991	0.4765	<.000001	<.000001	<.000001	0.000002
s m3 n2 r1	0.516	0.501	0.3036	0.1291	<.000001	<.000001	<.000001	<.000001
s m3 n2 r2	0.668	0.760	0.4334	0.1154	<.000001	<.000001	<.000001	<.000001
s m3 n2 r3	0.539	0.758	0.4971	0.4208	<.000001	<.000001	<.000001	<.000001
s m3 n2 r4	0.327	0.493	0.1782	0.3581	<.000001	<.000001	<.000001	<.000001

Notes: The *s* represents the S&P500 index. m*1, m2*, and *m*3 represent the M1 money supply, the M2 money supply, and the Federal Funds rate respectively. *n1* and *n2* represent the PPI and the CPI respectively. r*1, r2, r3,* and *r4* represent the 3-month t-bill, the 1-year bond, the 10-year bond, and the 10-year bond minus the 3-month t-bill respectively.

Panel B

	Encompassing (p-value for F-stat)		MSPE Ratios	MSPE Ratios (p-value)
	f1 en. f2	f2 en. f1	f1/f2	f1/f2
s m1 n1 r1	0.000001	0.000049	1.029304	0.400044
s m1 n1 r2	0.014973	0.177299	1.016285	0.443684
s m1 n1 r3	0.000003	0.004792	1.049256	0.336678
s m1 n1 r4	0.015895	0.081780	1.010764	0.462606
s m1 n2 r1	<.000001	<.000001	1.030661	0.395586
s m1 n2 r2	<.000001	0.000105	1.039134	0.368221
s m1 n2 r3	<.000001	0.000017	1.046834	0.344103
s m1 n2 r4	0.000000	0.000043	1.033295	0.386994
s m2 n1 r1	<.000001	<.000001	1.029649	0.398907
s m2 n1 r2	0.000541	0.015790	1.022292	0.423359
s m2 n1 r3	0.005064	0.045932	1.014517	0.449721
s m2 n1 r4	0.000086	0.001555	1.019065	0.434241
s m2 n2 r1	<.000001	<.000001	1.037068	0.374819
s m2 n2 r2	<.000001	0.000040	1.041837	0.359668
s m2 n2 r3	<.000001	0.000065	1.041442	0.360914
s m2 n2 r4	<.000001	0.000005	1.020559	0.429192
s m3 n1 r1	0.000002	0.000002	0.998142	0.506505
s m3 n1 r2	0.000110	0.004770	1.024952	0.414459
s m3 n1 r3	0.000002	0.013572	1.058265	0.309773
s m3 n1 r4	0.000035	0.000844	1.021108	0.427344
s m3 n2 r1	<.000001	<.000001	1.022463	0.422786
s m3 n2 r2	<.000001	0.000002	1.041090	0.362025
s m3 n2 r3	<.000001	0.000015	1.051596	0.329578
s m3 n2 r4	<.000001	0.000001	1.040243	0.364702

TABLE 3: 20-Year Fixed Window

Panel A

	White Noise Check		Bias Check (p-value)		Normality check (p-value of JB test)		M-Z Test (p-value of F-stat)	
	e1	**e2**	**e1**	**E2**	**e1**	**e2**	**f1**	**f2**
s m1 n1 r1	0.656	0.739	0.3809	0.2775	<.000001	<.000001	0.034837	0.093382
s m1 n1 r2	0.778	0.855	0.2391	0.2010	<.000001	<.000001	0.012561	0.099327
s m1 n1 r3	0.866	0.932	0.2910	0.2510	<.000001	<.000001	0.002573	0.056522
s m1 n1 r4	0.759	0.765	0.6176	0.5090	<.000001	<.000001	0.124798	0.147711
s m1 n2 r1	0.719	0.726	0.1400	0.1865	<.000001	<.000001	0.000024	0.000164
s m1 n2 r2	0.866	0.874	0.2187	0.3029	<.000001	<.000001	0.000128	0.000852
s m1 n2 r3	0.973	0.942	0.2988	0.3820	<.000001	<.000001	0.000332	0.001724
s m1 n2 r4	0.773	0.786	0.4836	0.4982	<.000001	<.000001	0.002724	0.009109
s m2 n1 r1	0.782	0.701	0.3178	0.2970	<.000001	<.000001	0.000235	0.006636
s m2 n1 r2	0.911	0.817	0.2895	0.2628	<.000001	<.000001	0.008881	0.136990
s m2 n1 r3	0.900	0.868	0.3114	0.4645	<.000001	<.000001	0.037139	0.246252
s m2 n1 r4	0.776	0.781	0.5461	0.4935	<.000001	<.000001	0.001926	0.020731
s m2 n2 r1	0.845	0.858	0.1474	0.2131	<.000001	<.000001	<.000001	0.000006
s m2 n2 r2	0.840	0.847	0.1397	0.2409	<.000001	<.000001	0.000032	0.007702
s m2 n2 r3	0.742	0.831	0.1413	0.3399	<.000001	<.000001	0.001584	0.037252
s m2 n2 r4	0.756	0.727	0.6306	0.5790	<.000001	<.000001	0.000022	0.002689
s m3 n1 r1	0.687	0.804	0.4996	0.3556	<.000001	<.000001	0.000021	0.002325
s m3 n1 r2	0.866	0.870	0.3675	0.2658	<.000001	<.000001	0.000287	0.115423
s m3 n1 r3	0.891	0.898	0.9307	0.5068	<.000001	<.000001	0.001026	0.167000
s m3 n1 r4	0.632	0.779	0.6043	0.4797	<.000001	<.000001	0.000129	0.000464
s m3 n2 r1	0.577	0.734	0.3742	0.2421	<.000001	<.000001	<.000001	0.000005
s m3 n2 r2	0.831	0.820	0.2508	0.2749	<.000001	<.000001	0.000024	0.049977
s m3 n2 r3	0.803	0.873	0.4646	0.4353	<.000001	<.000001	0.000195	0.058836
s m3 n2 r4	0.674	0.791	0.1947	0.4637	<.000001	<.000001	<.000001	0.000004

Notes: The *s* represents the S&P500 index. m*1, m2*, and *m*3 represent the M1 money supply, the M2 money supply, and the Federal Funds rate respectively. *n1* and *n2* represent the PPI and the CPI respectively. r*1, r2, r3,* and *r4* represent the 3-month t-bill, the 1-year bond, the 10-year bond, and the 10-year bond minus the 3-month t-bill respectively.

Panel B

	Encompassing (p-value for F-stat)		MSPE Ratios	MSPE Ratios
	f1 en. f2	f2 en. f1	f1/f2	f1/f2
s m1 n1 r1	0.350776	0.934515	1.007998	0.475017
s m1 n1 r2	0.107016	0.945601	1.017872	0.444591
s m1 n1 r3	0.010396	0.377919	1.096443	0.409127
s m1 n1 r4	0.694028	0.855663	1.001704	0.494659
s m1 n2 r1	0.005127	0.034948	1.015727	0.451155
s m1 n2 r2	0.010425	0.068658	1.015443	0.452026
s m1 n2 r3	0.008646	0.043780	1.013275	0.458690
s m1 n2 r4	0.105331	0.360898	1.010062	0.468613
s m2 n1 r1	0.012927	0.316384	1.026338	0.418984
s m2 n1 r2	0.040116	0.838409	1.025021	0.422933
s m2 n1 r3	0.103294	0.856723	1.017348	0.446191
s m2 n1 r4	0.065077	0.357932	1.013956	0.456592
s m2 n2 r1	0.000002	0.001463	1.056960	0.331517
s m2 n2 r2	0.000994	0.266938	1.046523	0.360292
s m2 n2 r3	0.019499	0.420795	1.025288	0.422132
s m2 n2 r4	0.001698	0.219116	1.040303	0.377979
s m3 n1 r1	0.000610	0.058692	1.037820	0.385143
s m3 n1 r2	0.000768	0.410296	1.052393	0.343963
s m3 n1 r3	0.001471	0.551218	1.049360	0.352354
s m3 n1 r4	0.009139	0.044356	1.012926	0.459765
s m3 n2 r1	0.000008	0.002012	1.046399	0.360641
s m3 n2 r2	0.000152	0.272566	1.062787	0.315982
s m3 n2 r3	0.000613	0.194630	1.047940	0.356315
s m3 n2 r4	0.000020	0.003491	1.042942	0.370428

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