Another Look at the Predictive Power of the Yield Spread: New Evidence

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The yield spread, i.e. the spread between the long-term Treasury yield and the short-term yield, has long been regarded as a good predictor of future economic activity. There is also a plethora of research that posits a strong relationship between real stock returns and future economic activity. This study investigates the dynamic relationship among the yield spread, real stock returns and real economic activity for the United States. Four alternative measures of the yield spread are employed to determine the sensitivity of the empirical results with respect to the choice of the yield spread. It is found that the yield spread measured as the gap between the 10-year and the 3-month Treasury yields is a good predictor of the real economic activity. Furthermore, the yield spread with the federal funds rate as the proxy for the short-term interest rate is a good prognosticator of future real stock returns.

Keywords: yield spread, stock returns, real economic activity

INTRODUCTION

The yield spread, i.e. the spread between the long-term Treasury yield and the short-term yield, has long been regarded as one of the most accurate predictors of future economic activity. Economists and investors routinely subscribe to the doctrine that the increasing yield spread predicts future economic expansion and the declining or negative yield spread presages future economic contraction.

Both academic literature and news media have touted the predictive power of the yield spread for quite some time. Estrella and Harvoudelis (1991), Estrella and Mishkin (1998), and Estrella (2005) show that the slope of the yield curve, measured as the gap between the 10-year Treasury yield and the 3-month Treasury bill rate, predicts real economic activity for up to 4 years ahead and forecasts recessions for up to two years into the future with remarkable degree of accuracy.[1] They also find that the yield spread outperforms other predictors of economic activity, such as the inflation rate, the index of leading economic indicators, the level of short-term interest rate, and survey forecasts. These results have been validated by more recent studies, such as Stock and Watson (2001), Rudebusch and Williams (2008) and Bauer and Mertens (2018).[2] However, Estrella, Rodrigues and Schich (2003) detect some degree of instability in the models employed by previous researchers to ascertain the predictive power of the yield curve.[3]

Conference Board, a prestigious non-profit research organization with over 1000 corporations as its subscribed members, uses the spread between the 10-year Treasury bond yield and the federal funds rate as one of the 10 components of its widely used Leading Economic Index. During recent years, there has been a flurry of articles in financial websites asserting that the shape of the yield curve serves extremely well as a reliable precursor of future economic activity and the stock market. For example, Coppola (2008) and Marte (2019), documenting that every recession since the World War II has been preceded by an inverted yield curve with average lag time of 15 months, states that the yield spread measured as the gap between the 10-year Treasury yield and the 2-year yield is more accurate predictor of the future economic activity than other economic variables.[4]

The theory behind the inextricable link between the yield spread and future economic activity is very straightforward. Expectations theory of term structures states that changes in the long-term yield reflect the changes in the investors' expectations about future economic activity, inflation rate, and interest rates, among others. Assume the economy is currently mired in recession. In such event, Federal Reserve (FED) would be compelled to lower the target for the federal funds rate to stimulate the sluggish economy.[5] Short-term interest rates, such as the Treasury bill yield, would immediately decline. At the same time, anticipating more robust economic activity in the future, households would increase the demand for loans to finance the purchase of durable goods, such as automobiles and houses, and firms would borrow more funds to expand their productive capacity to meet the increased demand for their goods, thereby propping up long-term interest rates. The yield spread will then increase, due to an increase in the long-term interest rate and a concomitant drop in the short-term interest rate. Therefore, steeper yield curve presages sustained economic expansion in the future.

In the similar manner, declining or negative yield spread portends future economic contraction. FED would be duty bound to ratchet up the target for federal funds rate in response to escalating inflation rate triggered by overheated economic activity. Other short-term rates would immediately shoot up. If both households and businesses expect future economic activity to stagnate due to FED's contractionary monetary policy, then the demand for loanable funds will subsequently drop and the long-term interest rate will decline. Therefore, the yield curve will either flatten or become inverted before the economy deteriorates.

There is another compelling reason why inverted yield curve is deemed as an accurate predictor of future recession. Banks' profit tends to suffer when the yield curve is inverted. Banks borrow short-term from depositors and lend long-term in the form of mortgages and Treasury bonds. When the yield curve is inverted, the deposit rate or the cost of short-term borrowing exceeds the lending rates. Therefore, banks' profit inevitably sags and they will have to tighten lending standards to minimize their exposure to further risk, thereby making it more difficult for consumers to obtain loans to purchase durable goods and businesses to secure funds to expand their productive capacity. Retrenchment in both consumer and business spending will then precipitate economic slowdown.[6]

It is also amply documented in the literature that stock returns predict future economic activity [e.g., Fama (1981)]. If investors expect the economic activity will be more robust in the future, they will then anticipate increases in the firms' earnings and dividends. Since stock returns reflect the present value of firms' future dividends, stock returns will quickly rise in anticipation of economic expansion. By the same reasoning, stock returns tend to fall before economic downturn. A slowdown in real economic activity will translate to plummeting corporate earnings and stock returns will decline accordingly.

If both the yield spread and stock returns predict future economic activity, then an inextricable link among the yield spread, real stock returns and real economic activity should exist. Therefore, a rigorous study of these relationships within a multivariate framework is warranted at this juncture.

The objective of this study is to investigate the dynamic relationship among the yield spread, real stock returns and real economic activity for the United States for the period 1982-2018. Specifically, this study tests three hypotheses -- (i) yield spread precedes real economic activity, (ii) real stock return precedes real economic activity, and (iii) yield spread precedes real stock returns -- within the Vector Autoregressive (VAR) framework. Furthermore, this study employs four alternative measures of the yield spread to determine the sensitivity of the empirical results with respect to the choice of the yield spread.

This paper is organized as follows. Section II lays out the empirical framework for this study and proposes several testable hypotheses. Section III provides the description of data utilized in this study. Section IV presents the empirical findings, and the paper concludes with a concise summary of the empirical results in Section V.

EMPIRICAL FRAMEWORK

Three hypotheses introduced in Part I can be readily tested within the Vector Autoregressive (VAR) framework. Granger causality test procedure will be performed in the context of the following standard Vector Autoregressive (VAR) model of 3 equations:

$$Zt = \alpha + A_1 Z_{t-1} + A_2 Z_{t-2} + A_3 Z_{t-3} + \ldots\ldots\ldots + A_p Z_{t-p} + \varepsilon_t \quad (1)$$

where $Z_t = [RSR_t, YS_t, RECON_t]'$, α is a 3 x 1 vector of constant terms, A_i is a 3 x 3 matrix of coefficients for i = 1,2, … p, where p is the optimal lag length of the VAR model, and ε_t is a 3 x 1 vector of serially uncorrelated white-noise error terms with zero mean and a variance-covariance matrix $\sum_e$. RSR_t is the real stock return at time t, YS_t is the spread between the long-term Treasury yield and the short-term rate at time t, and $RECON_t$ is the real economic activity at time t.

The following null hypotheses will be tested using the standard F-test statistic in the context of the VAR model to determine causal relationships among these three variables:

H_0 *: $a_{32}(1) = a_{32}(2) = a_{32}(3) = \ldots\ldots\ldots = a_{32}(p) = 0$, (i.e., yield spread does not Granger cause real economic activity),*

H_0 *: $a_{31}(1) = a_{31}(2) = a_{31}(3) = \ldots\ldots\ldots = a_{31}(p) = 0$, (i.e., real stock return does not Granger cause real economic activity), and*

H_0 *: $a_{12}(1) = a_{12}(2) = a_{12}(3) = \ldots\ldots\ldots = a_{12}(p) = 0$, (i.e., yield spread does not Granger cause real stock returns)*

$a_{ij}(p)$ in above null hypotheses represents the i, jth coefficient of the A_p matrix, which gauges the impact of the pth lagged value of the jth variable on the variable i.

If estimated coefficients of the jth variable as a group is found to be statistically significant, then the past values of the variable j can explain variations in the variable i and therefore the variable j Granger causes the variable i. If, on the other hand, estimated coefficients of the jth variable as a group is statistically insignificant, then the past values of the variable j are not useful in explaining current fluctuations in the variable i and the variable j does not Granger cause variable i.

The appropriate lag length of the VAR model must be determined prior to estimation. If the lag length is too small, the model may suffer from misspecification error and, if the lag length is too large, the model may run the risk of being overparametrized. The appropriate lag length, p, of the VAR model will be determined using the likelihood ratio test statistic of the following form [Sims (1980)]:

$$(N-k)(\log|\textstyle\sum_r| - \log|\textstyle\sum_u|), \quad (2)$$

where N is the number of observations, k is the number of parameters estimated in each equation of the unrestricted VAR model, and $\sum_r$ and $\sum_u$ respectively represent the variance/covariance matrix of the restricted and unrestricted VAR models. The restrictive model contains p lags and the unrestrictive model contains lags greater than p (say q, where q >p). This statistic has an asymptotic χ^2 (Chi-square) distribution with degrees of freedom equal to the number of restrictions in the system. Large value of this statistic should lead to the rejection of the null hypothesis that the lag length of the VAR model is p, and q should be chosen as the appropriate lag for the VAR model. The likelihood ratio statistic is computed with lag lengths ranging from 4 to 12 at the increments of 4.

Since same lag length is imposed on all equations within the VAR model, the OLS estimation method, which yields consistent and asymptotically efficient estimates under this restriction, is employed to estimate the VAR model in this study.

DATA

Four alternative measures of the yield spread (YS_t) are employed in this study – (i). 10-year Treasury yield minus 2-year Treasury yield (T10Y2Y), (ii). 10-year Treasury yield minus 3-month Treasury bill yield (T10Y3M), (iii). 10-year Treasury yield minus federal funds rate (T10YFF), and (iv). Moody's Corporate AAA yield minus federal funds rate (AAAFF). Monthly data on these variables are obtained from the Federal Reserve Economic Data (FRED) published by the Federal Reserve Bank of St. Louis.

Popular financial websites, such as Forbes.com and CNBC.com, have traditionally employed T10Y2Y as the yield spread in their much-publicized articles on how an inverted or flattening yield curve accurately predicts the future recession.[7] Academic articles [e.g., Estrella and Hardouvelis (1991), and Estrella and Mishkin (1998)], on the other hand, have long espoused T10Y3M as the measure of the yield spread, reflecting their belief that the 3-month Treasury yield dictates the trend for short-term interest rates. Although T10YFF and AAAFF are not widely used proxies for the yield spread, these two measures of the yield spread are included this study for the sake of comparison. Several studies [e.g., Laurent (1989)] claim that the yield spread using the federal funds rate as the short-term yield is a very useful guide of the direction of the future monetary policy and can therefore predict the future economic condition with reasonable degree of accuracy.

Nominal monthly stock returns are proxied by the S&P 500 Index returns, which are obtained from the Bloomberg Terminal. RSR_t, real stock return at time t, is computed as the nominal stock return at time t minus the inflation rate at time t. Nominal stock return at time t is calculated as the log SP_t – log SP_{t-1} , where SP_t is the S&P 500 Index at time t. The inflation rate at time t is calculated as the log CPI_t - log CPI_{t-1}, where CPI_t is the Consumer Price Index at time t.

Real economic activity is obviously best captured by the real GDP. Unfortunately, the monthly data for the real GDP are not published, although the quarterly data for the real GDP are readily available. Therefore, monthly data for industrial production (IP) obtained from the FRED database are used as the proxy for the monthly real economic activity. Real economic activity at time t, $RECON_t$, is defined as the log IP_t – log IP_{t-1}.

Dynamic relationship among real stock returns, real economic activity and the yield spread are examined in this study for the period January 1982 – August 2018. The choice of this specific time period is dictated by the fact that data for T10YFF are available only from January 1982.

EMPIRICAL RESULTS

Table 1 presents the results of the Granger causality test with 4 alternative measures of the yield spread. The optimal lag length of the VAR model is determined as 12 by applying the likelihood ratio test. The following hypotheses are tested:

H_0: $a_{32}(1) = a_{32}(2) = a_{32}(3) = \dots\dots\dots = a_{32}(p) = 0$, *(i.e., yield spread does not Granger cause real economic activity),*

H_0 : $a_{31}(1) = a_{31}(2) = a_{31}(3) = \dots\dots\dots = a_{31}(p) = 0$, *(i.e., real stock return does not Granger cause real economic activity), and*

H_0 : $a_{12}(1) = a_{12}(2) = a_{12}(3) = \dots\dots\dots = a_{12}(p) = 0$, *(i.e., yield spread does not Granger cause real stock return)*

TABLE 1
GRANGER CAUSALITY TEST RESULTS, 1982-2018

Null Hypothesis	F-Test
I. T10Y2Y as the Yield Spread	
H_0: Yield spread does not Granger cause real economic activity	F(12,390) = 1.1467
H_0: Real stock return does not Granger cause real economic activity	F(12,390) = 3.6106*
H_0: Yield spread does not Granger cause real stock return	F(12,390) = 1.1763
II. T10Y3M as the Yield Spread	
H_0: Yield spread does not Granger cause real economic activity	F(12,390) = 1.7221*
H_0: Real stock return does not Granger cause real economic activity	F(12,390) = 3.7999*
H_0: Yield spread does not Granger cause real stock return	F(12,390) = 1.3077
III. T10YFF as the Yield Spread	
H_0: Yield spread does not Granger cause real economic activity	F(12,390) = 1.2217
H_0: Real stock return does not Granger cause real economic activity	F(12,390) = 3.4869*
H_0: Yield spread does not Granger cause real stock return	F(12,390) = 2.1079*
IV. AAAFF as the Yield Spread	
H_0: Yield spread does not Granger cause real economic activity	F(12,390) = 0.8121
H_0: Real stock return does not Granger cause real economic activity	F(12,390) = 3.6463*
H_0: Yield spread does not Granger cause real stock return	F(12,390) = 1.6780*

*- significant at the 5% level.
Null hypotheses tested are

$H_0 : a_{32}(1) = a_{32}(2) = a_{32}(3) = \ldots\ldots\ldots = a_{32}(p) = 0$, (i.e., yield spread does not Granger cause real economic activity),

$H_0 : a_{31}(1) = a_{31}(2) = a_{31}(3) = \ldots\ldots\ldots = a_{31}(p) = 0$, (i.e., real stock return does not Granger cause real economic activity), and

$H_0 : a_{12}(1) = a_{12}(2) = a_{12}(3) = \ldots\ldots\ldots = a_{12}(p) = 0$, (i.e., yield spread does not Granger cause real stock returns)

where $a_{ij}(p)$ in above null hypotheses represents the i, jth coefficient of the A_p matrix in the equation (1):

$$Z_t = \alpha + A_1 Z_{t-1} + A_2 Z_{t-2} + A_3 Z_{t-3} + \ldots\ldots\ldots + A^p Z_{t-p} + \varepsilon_t$$

The variables in the vector Z_t are real stock returns (RSR), yield spread (YS), and real economic activity (RECON). Monthly data for these variables are employed for the period January 1982 – August 2018.

T10Y2Y= the yield spread between the 10-year and 2-year Treasury bonds; T10Y3M = the yield spread between the 10-year and 3-months Treasury bonds; T10YFF = the yield spread between the 10-year Treasury bond and the federal funds rate; and AAAFF = Moody's Corporate AAA yield minus the federal funds rate.

As can be seen from Table 1, the null hypothesis of no Granger causality from the yield spread to the real economic activity is not rejected for all models except when T10Y3M is used as the proxy for the yield spread. That is, the yield spread is a good predictor of the real economic activity with T10Y3M, i.e., the spread between the 10-year and the 3-month Treasury yields, as the proxy for the yield spread. These results are therefore consistent with those of scholarly articles on the predictive power of the yield curve, such as Estrella and Hardouvelis (1991) and Estrella and Mishkin (1998). The presence of a strong link between T10Y3M and the future economic activity can be attributed to the fact that T10Y3M is not influenced by the volatility in term premium [see Rudebusch and Williams (2007)]. Interestingly, the yield spread proxied by T10Y2Y, i.e., the spread between the 10-year and 2-year Treasury yields, that is heavily favored by the financial media does not Granger cause the real economic activity. Therefore, a legion of articles in the financial websites claiming that either flattening or inversion of the yield curve (T10Y2Y) always precedes recession should be interpreted with deep skepticism. Still the empirical results are not as robust as one might have expected. It could be that the proxy used for the real economic activity in this study, industrial production (IP), may not accurately mirror the changes in the real GDP over time.

It comes as no surprise that the null hypothesis of no Granger causality from real stock returns to real economic activity is rejected for all four models. This finding is consistent with the Efficient Market Hypothesis (EMH) which posits that the current real stock return is a good predictor of future economic activity. EMH is predicated on the assumption that stock prices fully capture the present value of future earnings and dividends which are strongly linked to the future economic activity. A myriad of scholarly articles, such as Fama (1970, 2013), in the past have generated ample empirical support for this hypothesis.

The null hypothesis of no Granger causality from the yield spread to the real stock returns is not rejected when both T10Y2Y and T10Y3M are used as proxies for the yield spread. These results are consistent with the findings of Fama and French (2019) and Franck (2019). Fama and French (2019), using both T10Y2Y and T10Y3M as measures of the yield spread for twelve countries, find that the yield spread is a poor predictor of future stock returns.[8] Franck (2019) observes that even after the yield spread, as measured by T10Y2Y, is inverted, the stock market rallies for about 18 months although the economic activity steadily deteriorates. Faria and Verona (2019), on the other hand, present evidence that the yield spread proxied by T10Y3M is still a good predictor of future stock returns.

It is worth noting that the null hypothesis is rejected when both T10YFF and AAAFF are used as the proxies for the yield spread. These two proxies use the federal funds rate as the short-term interest rate. These results seem plausible since the federal funds rate is the tool that the Federal Reserve employs to achieve its dual objective of maximum job growth and stable inflation rate, and changes in the federal funds rate signal the Fed's outlook on future economic activity [see Laurent (1989)]. Since real stock returns accurately reflect future economic activity, it is not surprising that the yield spread, when the federal funds rate is used as the short-term rate, is an accurate predictor of future real stock returns. So, there is a glimmer of hope that the investors may be able to execute profitable trading strategies based on the changing shape of the Treasury yield curve with the federal funds rate as the short-term interest rate.

Econometric textbooks [e.g., Enders (1995)] suggest that the traditional Granger causality test should be conducted in conjunction with more robust test procedures to shed additional light on the dynamics of these causal relationships. In this regard, two additional tests --block exogeneity test and variance decomposition analysis -- are performed next. Block exogeneity test is designed to ascertain whether lagged values of a given variable Granger causes other variables within a VAR model. Block exogeneity test utilizes a likelihood ratio test statistic very similar to equation (2):

$$(N-c)(\log|\textstyle\sum_r| - \log|\textstyle\sum_u|), \tag{3}$$

where N is the number of observations, c is the total number of parameters estimated in the unrestricted VAR model, and $\sum_r$ and $\sum_u$ respectively represent the variance/covariance matrix of the restricted and unrestricted models. This statistic has an asymptotic χ^2 distribution with degrees of freedom equal to twice the number of lagged values of a variable excluded in the restricted model. $\sum_u$ can be obtained by estimating equation (1) with p lagged values of all three variables (RSR , YS, RECON). In order to determine, for example, whether the yield spread (YS) Granger causes either the real stock return (RSR) or the real economic activity (RECON), $\sum_r$ is obtained by estimating equation (1) with p lagged values of YS excluded. Large value of this test statistic should lead to the rejection of the null hypothesis that the yield spread (YS) does not Granger cause either real stock returns (RSR) or real economic activity (RECON).

TABLE 2
BLOCK EXOGENEITY TEST RESULTS, 1982-2018

Null Hypothesis	Likelihood Ratio Test
I. T10Y2Y as the Yield Spread	
H_0: Yield spread does not Granger cause real stock return or real economic activity	27.8214
I. T10Y3M as the Yield Spread	
H_0: Yield spread does not Granger cause real stock return or real economic activity	35.9162*
I. T10YFF as the Yield Spread	
H_0: Yield spread does not Granger cause real stock return or real economic activity	39.2506*
I. AAAFF as the Yield Spread	
H_0: Yield spread does not Granger cause real stock return or real economic activity	29.6367

*- significant at the 5% level.
Block exogeneity test utilizes a likelihood ratio test statistic very similar to equation (2):

$$(N-c)(\log|\Sigma_r| - \log|\Sigma_u|), \quad (3)$$

where N is the number of observations, c is the total number of parameters estimated in the unrestricted VAR model, and Σ_r and Σ_u respectively represent the variance/covariance matrix of the restricted and unrestricted models. This statistic has an asymptotic χ^2 distribution with degrees of freedom equal to twice the number of lagged values of a given variable excluded in the restricted model. Σ_u can be obtained by estimating equation (1) with p lagged values of all three variables (RSR, YS, RECON). Σ_r is obtained by estimating equation (1) with p lagged values of a given variable excluded.

T10Y2Y= the yield spread between the 10-year and 2-year Treasury bonds; T10Y3M = the yield spread between the 10-year and 3-months Treasury bonds; T10YFF = the yield spread between the 10-year Treasury bond and the federal funds rate; and AAAFF = Moody's Corporate AAA yield minus the federal funds rate.

As can be seen from Table 2, results obtained with the block exogeneity procedure mirror those obtained from the Grange causality test. The null hypothesis that the yield spread does not Granger cause either the real stock return or the real economic activity is not rejected at the 5% significance level with T10Y2Y and AAAFF as the proxies for the yield spread. However, the null hypothesis is rejected when either T10Y3M or T10YFF is used as the yield spread. That is, the yield spread as measured by T10Y3M is a good predictor of either the real economic activity or the real stock return, which is consistent with our findings from the Granger causality test that T10Y3M predicts the future real economic activity. Also, the result that the yield spread as measured by T10YFF possesses strong predictive power is buttressed by our findings that T10YFF is an accurate predictor of the real stock returns. Although the results from the block exogeneity test are sensitive to the choice of the proxy used for the yield spread, it can be concluded that the yield spread as measured by either T10Y3M or T10YFF is a valuable forecasting tool for either future stock returns or future economic condition. The result that T10Y2Y is not a good predictor of either the real stock return or the economic activity should be disheartening to the financial columnists who in the past have effusively praised the predictive power of T10Y2Y.

TABLE 3
VARIANCE DECOMPOSITION ANALYSIS RESULTS, 1982 – 2018

A. Real Stock Returns

Percentage (%) of Forecast Error Variance Accounted by Shocks or Innovations in the Yield Spread				
Horizon	T10Y2Y	T10Y3M	T10YFF	AAAFF
3 months	.014	.428	.087	.231
6 months	1.315	1.092	1.956	1.991
12 months	3.546	2.467	4.178	3.977
24 months	3.585	2.874	4.800	4.276

B. Real Economic Activity

Percentage (%) of Forecast Error Variance Accounted by Shocks or Innovations in the Yield Spread				
Horizon	T10Y2Y	T10Y3M	T10YFF	AAAFF
3 months	.462	.742	.751	.167
6 months	1.526	1.678	1.080	.261
12 months	2.463	2.580	2.041	1.565
24 months	2.593	2.808	2.294	1.811

Equation (1) can be rewritten as $Z_t - A_1Z_{t-1} - A_2Z_{t-2} - A_3 Z_{t-3} - \dots - A_p Z_{t-p} = B(L) Z_t = \alpha + \varepsilon_t$, where $B(L) = (I - A_1 L - A_2L^2 - A_3L^3 \dots - A_pL^p)$ is a polynomial of degree p in the lag operator such that $L^p Z_t = Z_{t-p}$. Then, Z_t can be expressed as

$$Z_t = B^{-1}(L)\,\alpha + B^{-1}(L)\,\varepsilon_t = C_0 + C(L)\,\varepsilon_t = C_0 + \sum_{k=0}^{\infty} C(k)\,\varepsilon(t-k),$$ where C(k) is a 3 x 3 matrix with

coefficients representing the impact of a shock at time t-k on Z_t. Then the percentage of the n-period forecast error variance of the i_{th} variable that can be explained by a shock in the jth variable at time t can be expressed as

$$\left[\sigma^2_j \sum_{k=0}^{n-1} C_{ij}^2(k) \Big/ \sum_{m=1}^{3} \sigma^2_m \sum_{k=0}^{n-1} C_{im}^2(k) \right] \times 100$$

where σ^2_j is the variance of a shock in the jth variable, $C_{ij}(k)$ represents i,j th coefficient of the C(k) matrix that measures the impact of a random shock in the jth variable on the variable i after k periods. $C_{ij}(k)$ is also known as the impulse response function.

The variance decomposition analysis is performed next to gauge the impact of a random shock or an innovation in a given variable on the variance of the forecasting error of another variable within a VAR model. More specifically, if a shock in the j^{th} variable adequately explains the forecast error variance of the i^{th} variable at all forecast horizons, then the j^{th} variable is deemed as a significant determinant of the i^{th} variable.[9] As can be seen from Table 3, a shock in the yield spread proxied by T10YFF and AAAFF respectively account for 4.8% and 4.276% of the forecast error variance of real stock returns after 24 months. However, the percentage of the forecast error variance of real stock returns is only 2.874% for T10Y3M after 24 months. So, the impact of the yield spread is more significant on the real stock returns with either T10YFF or AAAFF as its proxy. This result concurs with the earlier findings that the yield spread with the federal funds rate as the short-term interest rate forecasts the future real stock returns.

Unfortunately, the impact of the yield spread on the real economic activity is not statistically significant, where the percentage explained by an innovation in the yield spread ranges from only 1.811% with AAAFF as the yield spread to 2.808% with T10Y3M as the yield spread after 24 months. These results somewhat corroborate our findings that only the yield spread proxied by T10Y3M is a reliable predictor of the real economic activity. As stated before, the weakness in these results can be attributed to the usage of the industrial production as the proxy for real economic activity.

CONCLUSION

This study rigorously investigates the dynamic relationship among the yield spread (proxied by four alternative measures), real economic activity, and real stock returns. We find that the results, although quite robust, are sensitive to the choice of the yield spread. Yield spread measured as the 10-year Treasury yield minus 3-month Treasury yield predicts real economic activity, which is consistent with the findings of scholarly articles investigating the predictive power of the yield spread. Yield spreads using the federal funds rate as the proxy for the short-term interest rate do fare well in predicting real stock returns, probably because stock returns are unduly sensitive to the federal funds rate, which signals the future direction of the FED's monetary policy. These results collectively indicate that, notwithstanding the pronounced volatility of the yield curve over time, the yield curve is still a convenient and valuable tool that astute investors can utilize in predicting the future course of the economy as well as stock returns.

Financial media is deluged with articles claiming that the yield spread measured as the gap between the 10-year Treasury yield and 2-year Treasury yield has an excellent track record in predicting both future economic activity (especially recessions) and future stock returns. Unfortunately, these assertions are not supported by this study, and investors therefore must exercise extreme caution when relying on news media as the source of investment tips since the consequence of engaging in financially imprudent behavior can be quite severe. At the same time, investors may be able to execute profitable equity trading strategies by using the yield spread with the federal funds rate as a proxy for the short-term interest rate.

ENDNOTES

1. Results of Estrella and Hardouvelis (1991) and Estrella and Mishkin (1998) are based on the out-of-sample forecasts generated with quarterly data for the United States. They employ this specific yield spread because it obviates the need to adjust for the underlying term premium.
2. Rudebusch and Williams (2008) find that the widely acclaimed forecasts generated by the Survey of Business Forecasters under the auspice of the Federal Reserve Bank of Philadelphia are less accurate in predicting the recession than the spread between the three-month and 10-year Treasury yields for forecast horizons up to four quarters.
3. Using monthly data for Germany and the United States, Estrella, Rodriguez, and Schich (2003) conclude that the models that employ the yield spread as a predictor of recession are more stable than those using the yield spread to predict the inflation rate.
4. Marte (2019) writes ominously that the inverted yield curve on August 14th, 2019 should send "a loud warning that the U.S. economy might be headed toward a recession". She was right! The spread between the 10-year and 2-year Treasury yields has briefly turned negative in mid-August of 2019. The United States plunged into deep recession in the second quarter of 2020 due to the forced national lockdown to prevent further spread of Covid-19 virus that was raging across the country. The inverted yield curve in 2019 preceded the 2020 recession by approximately 7 months. It is beyond anyone's imagination how a brief inversion of the yield curve during the summer of 2019 was able to prognosticate the economic crisis of catastrophic proportion unleashed by the Coronavirus pandemic in 2020.
5. FED has dual mandate – maximum job growth and stable inflation rate. If FED is concerned that the economic condition will quickly deteriorate and the likelihood of recession will elevate, then it will promptly lower the target for the federal funds rate. Long-term interest rates will immediately decline due to FED's open market operation. Lower cost of borrowing will stimulate both consumption expenditures and business spending, and painful economic contraction may be avoided.

If the economy is expanding at a rapid pace and the signs of nascent inflation are more visible, then the FED will raise the target for the federal funds rate as an attempt to apply the brake on the bustling economy. Higher interest rates will dampen both the consumer and business spending and the economic contraction will ensue.

6. According to the 2018 St.Louis Fed Report, when the yield curve inverted in 2000, the percentage of banks in the U.S. tightening their lending standard rose from less than 10% to 60%.
7. Several scholarly articles, such as Christensen (2018), also employed within a VAR model T10Y2Y as the proxy for the yield spread.
8. Using monthly data for the United States and 11 other countries, Fama and French (2019) find that inverted yield curve contains no information on future stock returns. They hypothesize at the outset, if inverted yield curve predicts future recessions and negative stock returns precede recessions, then inverted yield curve should forecast negative stock returns. Therefore, switching from stocks to Treasury bills after the yield curve inverts should generate positive return. However, they find that an active strategy that entails shifting from stocks to Treasury bills after inversion of the yield curve reduces investors' returns for all countries. Moreover, these results are invariant with respect to the choice of the yield spread.
9. Please refer to pp.310-312 of Enders (1995) for an excellent description of the variance decomposition analysis.

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