THE PENNSYLVANIA STATE UNIVERSITY
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DEPARTMENT OF ECONOMICS

The Yield Curve versus the Corporate Spread: An Evaluation of the Predictive Nature of Both

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Abstract

This paper compares the relationship between the slope of the yield curve and a number of economic variables that include unemployment, stock prices, gold, industrial production and inflation to the relationship between the corporate spread and the same variables. Empirical results, using vector autoregressions and impulse response functions, conclude that the corporate spread contains useful predictive information. However, the yield curve acts in response to Federal Reserve Bank actions and reactions. I conclude that due to the great moderation and the glut of savings, the corporate bond spread is a more accurate forecaster of future economic climates than the more traditionally scrutinized yield curve slope.

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Introduction

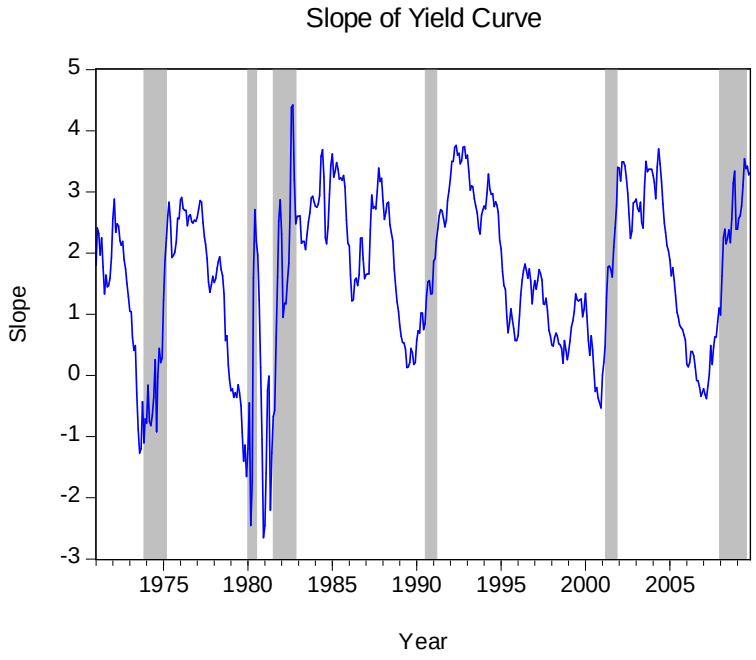
Economists use complicated mathematical and statistical models in an effort to predict changes in the economic climate. Yet there are also other more simplistic methods of analysis are commonly employed as well. The shape of the yield curve has been a key economic tool used to determine the future of economic activity for decades. The yield curve is a graphical representation of the yield on United States Treasury debts at various maturities, both long and short-term, at a given point in time. Analysis of patterns between long and short-term interest rates can be traced to 1913 to studies conducted by noted institutional economist Wesley Mitchell. However, despite its historical popularity as a leading indicator, there is a new, growing sector of literature suggesting that it has lost considerable forecasting power in the past two decades. Further fueling the debate, the true predictive power of the spread came under increased scrutiny during the mid 2000s due to an event deemed the "conundrum." Essentially, the yield curve became inverted, which has traditionally signaled an oncoming recession[1]. However the imminent recession did not occur as expected. In fact, there was large-scale global growth. This has led to a demand for different, more effective methods of evaluating future conditions.

A newer tool used for its leading indicator properties is the corporate bond spread. The bond spread is primarily used to evaluate the risk of bonds issued by corporations of different appraised credit worthiness. It assesses the extra yield that an investor can achieve from a bond with high credit risk compared to one with low credit risk. While not a traditional method of measuring economic conditions, it has begun to increase its presence in economic discussions,

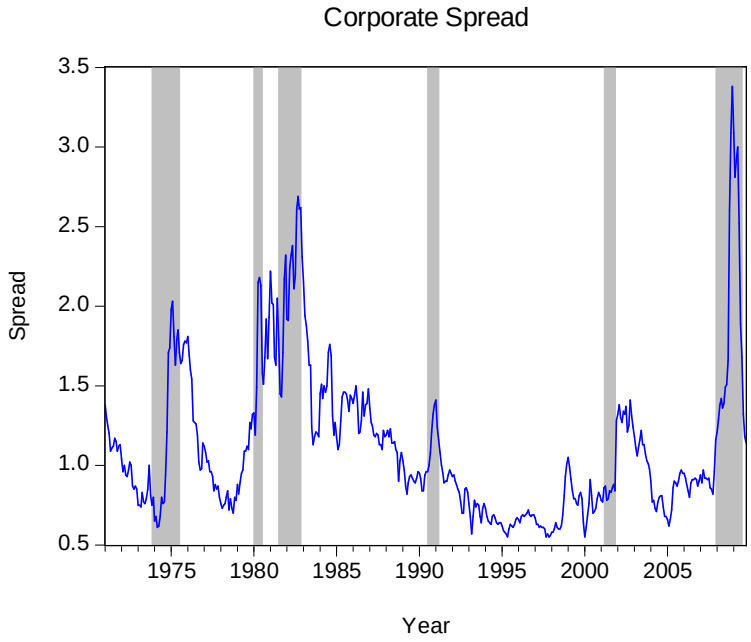
[1] Interpretation of the slope of the yield curve will be covered more fully in the Background Section. See pages 4-5.

particularly within the last decade as its Treasury bond counterpart, the yield curve, has begun to falter.

A simple visual analysis of both the yield curve and the corporate spread shows interesting results as can be seen by the graphs of both below (1.1 & 1.2). The grey shaded areas represent recessions. Both the yield curve slope and corporate spread appear to have strong reactions during the times of declining growth. However, the corporate spread looks to be a much cleaner interpreter of recessions, peaking only during downturns. Conversely, the yield curve is much more unstable. Peaks and valleys are more frequent and not always related to recessions, providing another reason that further, more formal analysis of both is warranted.



Graph 1.1



Graph 1.2

This paper aims to compare the efficacy of the yield curve and the corporate spread as forecasters of not only output, which traditionally has been the focus of much of the literature, but also a variety of other economic variables. Specifically examined in this study is inflation, gold, the stock market, unemployment and industrial production. Moreover, I will not focus solely on the yield curve and corporate spreads' effect upon the variables but will also evaluate the converse relationship. I intend to robustly analyze the entire relationship between the two spreads and the selected variables to more effectively establish the entire macroeconomic picture.

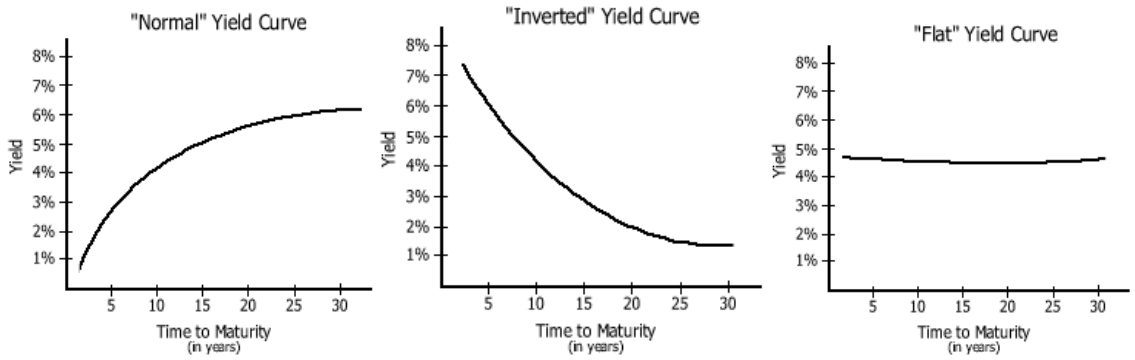
Structurally, this paper is broken down into five sections. The first part will give a general overview of both the yield curve and the corporate bond spread to familiarize the reader with terminology and important background information. The second section is a review of past literature on the subject of both. The third portion discusses the data collection and analysis processes. Next, the fourth section is an evaluation of the empirical results. Finally, the fifth

section concludes with an overview of my findings and suggestions as to why I noticed what I did.

Background

A. The Yield Curve

A yield curve describes the relationship between the interest rates and the time to maturity of a given debt. Fundamentally, it is a line that plots interest rates on bonds with equal credit-worthiness but different dates of maturity at a given point in time. The term yield curve can be applied to any group of equally rated bonds. However, it is most frequently used in regard to the evaluation of the spreads on government issued U.S. Treasury debt, and is also referred to as the term structure of interest rates. The U.S. Treasury yield curve is constructed by comparing the 30-year, 10-year, 5-year, 2-year and 3-month yields on government debt securities on the Y-axis and the time to maturity on the X-axis (see Graph 2.1). For the purposes of this paper, when using the phrase yield curve, it specifically will refer to the spreads on government issued debt. The curve contains information on both inflationary expectations as well as monetary policy actions (Zhang 2002). However, because it is based upon bonds that are essentially risk-free, it does not consider information about credit risk, making it distinctly different from the corporate spread.



Graph 2.1

Particularly of concern to economists and Wall Street investors alike is the slope or shape of the yield curve. There are three basic types of curve shapes as can be seen in Graph 2.1 above: normal, flat (or humped), and inverted. A normal curve is one in which long-term bonds have a higher yield than short-term bonds. Under this circumstance, the curve is considered normal and the economy is believed to be growing at a regular pace. There are a number of theories proposed to explain this occurrence. These theories will be explained in detail in the paragraph below. Additionally, there is an important distinction between a normal curve and what is considered a steep curve. A steep slope indicates that the economy is expected to see high growth in the future, and is often noticed at the end of a recession. Short-term rates will remain low; however, once economic activity begins to progress, long-term rates will rise with the increase in the demand for capital.

The inverted yield curve is one in which short-term bonds have higher yields than their long-term counterparts. This shape is traditionally assumed to predict an oncoming recession. Intuitively, if investors believe that growth will slow in the future and short-term yields will fall, they are more willing to hold long-term bonds because the yields are guaranteed. The increase in demand of long-term bonds decreases their yields eventually depressing them below short-term bond yields. Finally, a flat curve is, as one would assume based upon its name, a curve in which

short and long-term rates effectively are the same. Often, this type of curve has been interpreted as a sign of transition from one extreme of the business cycle to the other, or otherwise uncertainty in the economy.

There are four theories commonly used as explanations for the shape of the yield curve: the pure expectations theory, the liquidity preference theory, market segmentation theory and the preferred habitat theory (Mishkin 2007). Each theory has its own successes and shortcomings in explaining the behavior of the yield curve, which has led to debate within the field as to which properly explains the movement of U.S. Treasury bond yield movements.

1. The Pure Expectations Theory

   Pure expectations theory involves expectations of future short-term interest rates. It assumes that bonds with varying maturities are perfect substitutes and thus the slope of the curve is entirely dependent upon expectations. In other words, the yield on a long-term bond reflects market expectations of the average of short-term bond yields (Mishkin 2007). For example, if one expects that, on average, short-term bonds will increase by 6% in the following 10 years, then the yield on the 10-year will also be 6%. This theory can explain both the normal, upward sloping yield curve, the average of short-term yields is higher than the current short-term yield, as well as the inverted curve, average short-term yields are declining below the current short yield. However, it lacks the ability to explain why the slope usually slopes upward (Mishkin 2007). In practice, short-term rates are equally likely to fall as they are to rise which would imply a flat curve if pure expectations were completely correct.

2. The Liquidity Preference Theory

The liquidity preference theory is similar to the pure expectation theory in that it holds that bonds with differing maturities are substitutes. However, it also declares that long-term rates reflect not only future expectations of short-term rates but also an investing premium for holding the long-term bonds, which is sensitive to movements in supply and demand of the bond (Mishkin 2007). Essentially, they are not *perfect* substitutes. This premium, known either as the term or liquidity premium, acts as compensation for the investor due to the higher risk involved with holding bonds for a longer period and greater uncertainty of the return. Thus, long-term rates are generally higher than short-term rates, causing the upward slope. How, then, can this theory explain the occasional downward-sloping curve if the liquidity premium is always positive? If short-term rates are expected to significantly fall below the current short-rate so that the premium does not matter then it is possible to witness an inverted curve.

3. Market Segmentation

   Contrary to the aforementioned theories, market segmentation is based upon the idea that bonds with different maturities are *not* substitutable, meaning that supply and demand of the debts are independent or "segmented" with no concern for expected returns on other bonds with differing maturities (Mishkin 2007). Investors tend to favor more liquid assets due to the lower risk associated with lending money for a shorter period of time (Mishkin 2007). This means that, since liquidity decreases with time to maturity, investors prefer short-term bonds. As is the case with bonds, an increase in demand will create a higher price and lower yield, explaining the normal shape of the curve. However, this theory does not accurately explain why

yields on bonds of differing maturities tend to move together (which they empirically do) because it assumes segmentation. Also, it fails to indicate why the yield curve slopes upward when short-term yields are low and vice versa because it does not show how supply and demand varies for short-term bonds and long-term bonds (Mishkin 2007).

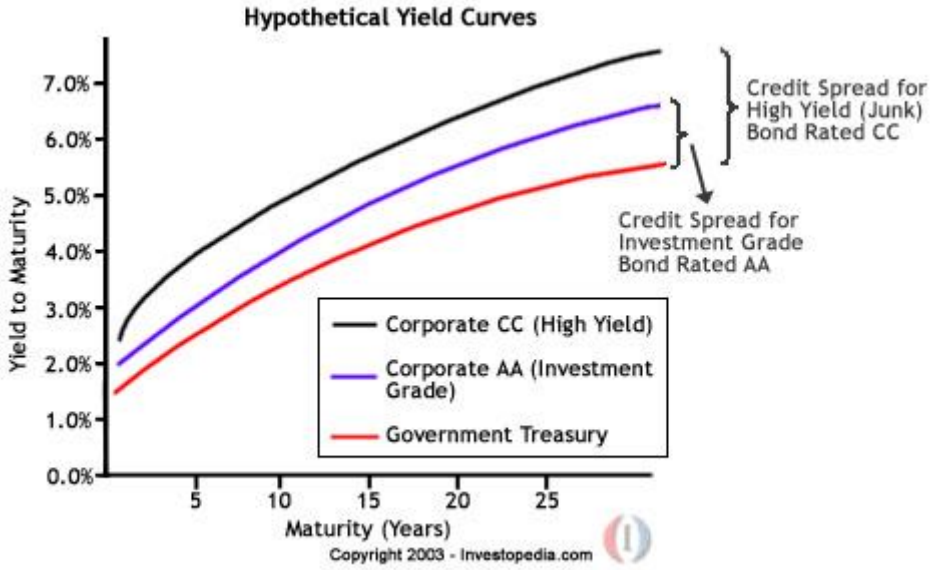
4. Preferred Habitat Theory

   Finally, we must consider the preferred habitat theory or the notion that investors have specific horizons in which they prefer to invest (Mishkin 2007). Because of this preference, investors demand a premium in order to invest outside of their ideal maturity or "habitat." It is believed that short-term investors are more common and thus long-term rates require a premium and are higher than their short-term counterparts (Mishkin 2007). The occasional inversion of the curve can be explained using logic similar to that used to explain the liquidity preference theory. Short-rate must fall so significantly that the premium becomes inconsequential.

B. The Corporate Spread

Companies issue corporate bonds as a method of raising funds for business endeavors and expansions. Corporate bonds provide higher interest rates than treasury bonds due to the inherent risks associated with the issuers. This inherent risk is termed default risk and generally considered the possibility that the corporation will be unable to make the payments to the investor as promised. The corporate spread, itself, is the tool that measures the difference between yields of different bonds due to the variation in their credit quality or rating. The graph below (Graph 2.2) indicates a hypothetical but typical situation concerning corporate bonds with

differing creditworthiness and Treasury yields. As can be seen, the bonds with the lowest default risk provide the lowest yields as they are least likely to default.



(Harper 2003)

Graph 2.2

Because different issuing institutions are different in terms of financial stability and creditworthiness, yields on bonds varies across companies as well. Some corporations are entirely denied the option to offer bonds. Creditworthiness is determined by various credit rating agencies such as Moody's Investor Service, Standard and Poor's and Fitch IBCA. These agencies designate a bond as either investment grade or below investment grade. Investment grade bonds are typically more attractive to conservative investors as they offer a high amount of principal and are generally the least likely to default. Conversely, the below investment grade bonds, also referred to as "junk bonds," are preferred by aggressive investors who are willing to take on the increased risk for the possibility of a higher return. A table describing the rating system of the three big agencies can be found on the next page (Table 2.1).

Bond Credit Quality Ratings

Credit Risk	RATING AGENCIES Moody's*	Standard & Poor's**	Fitch IBCA**
INVESTMENT GRADE			
Highest quality	Aaa	AAA	AAA
High quality (very strong)	Aa	AA	AA
Upper medium grade (strong)	A	A	A
Medium grade	Baa	BBB	BBB
NOT INVESTMENT GRADE			
Lower medium grade (somewhat speculative)	Ba	BB	BB
Low grade (speculative)	B	B	B
Poor quality (may default)	Caa	CCC	CCC
Most speculative	Ca	CC	CC
No interest being paid or bankruptcy petition filed	C	D	C
In default	C	D	D

*The ratings from Aa to Ca by Moody's may be modified by the addition of a 1, 2 or 3 to show relative standing within the category.
**The ratings from AA to CC by Standard & Poor's and Fitch IBCA may be modified by the addition of a plus or minus sign to show relative standing within the category.

(PIMCO 2006) **Table 2.1**

When evaluating the spread it is changes in the default risk that are primarily captured by its movements, which leads to it being known primarily as a indicator of the overall health in the economy. The "flight to safety" as it is sometimes referred, explains how fluctuations in the corporate spread often indicate fluctuations in the economy. At the first signs of a recession or depressed growth, investors run to the very highly rated Aaa bonds for fear of default by less creditworthy corporations. As demand and prices for these safer bonds increases, the yields on the bonds fall. Conversely, those fleeing *to* the Aaa bonds will be fleeing *from* the riskier Baa bonds causing a decline in demand and price and an increase in the yields, causing a significant increase in the spread. In his paper entitled, "On the Predictive Power of Interest Rates" Ben Bernanke (1990) discussed why the spreads on corporate bonds have been informative about the larger economy:

> …The difference between a risky return and a safe return on assets of the same maturity, it is a measure of perceived default risk. Suppose that, for whatever reason, investors expect the economy to turn down in the near future; because this will increase the riskiness of privately issued debt, the current spread between private and safe public [and private] debt will be bid up. (Bernanke 1990)

The corporate spread essentially acts as a gauge of risk and investors' confidence in the future economic state.

It is important to reevaluate the nature of the predictive power of the yield curve and corporate bond spread as there have been changes in the economic climates since much of the past research has been formed, notably the onset of the conundrum in the mid 2000s, the technological boom of the 1990s, the implementation of the EURO and the emergence of new economies such as China and India. It is my intention that through my research, new ways of interpreting and drawing conclusions from both the yield curve and the corporate spread will emerge.

Literature Review

A. The Yield Curve

The literature focused upon the yield curve as a predictor is expansive, and cannot fully be covered. However, there are a number of papers that must be noted for their importance to the study of Treasury bonds. Kessel (1965) markedly discussed the curve's predictive power specifically concerning the expectations hypothesis and liquidity preference. He determined that the spreads between long and short-term rates tend to be small before recessions and at the peak of expansions and large during periods following business cycle troughs. However, most literature linking the yield curve and the larger economic climate began in the late 1980s with Harvey (1988) and Laurent (1988). Harvey (1988) determined that the expected term structure

includes information that can be used to predict changes in consumption growth, and Laurent (1988) used the spread as a forecast tool for gross national product trends. Campbell (1987) and Fama and French (1989) both determined that the yield curve can predict returns on a number of different financial assets. Stock and Watson (1988) contributed to that notion as well when they included the yield curve as a leading indicator in their extensive economic indicators index. Through the use of modern econometric tools, their directory of leading, lagging and coincident indicators was a substantial update to the work conducted by a National Bureau of Economic Research study in 1937 aimed at gaining a better understanding of business cycles.

Conversely, in one of his earliest papers Bernanke (1990) denied that the curve was the best predictor of future growth and instead claimed that the commercial paper spread, or the spread on corporate bonds with fixed maturities of less than 270 and U.S. Treasury debts of similar maturities, was more accurate. In spite of this, he amended his earlier conclusion in the paper he co-authored with Blinder (1992), claiming that by using a non-linear model, the term structure is a better forecaster of output than most other methodologies.

Haubrich and Dombrosky (1996), also using a linear model, found that the curve had historically been an accurate predictor. However, it began to falter in the years following 1985. Ahrens (1999) and Phillips (1999) propose using "regime-switching" models and determined that the yield curve is the earliest predictor as its lags prove to be the longest. Furthermore, and contrasting with some of the earlier work of Bernanke and Blinder (1992) and Haubrich and Dombrosky(1996), Ahrens (1999) finds the predictive power has remained intact during the period of 1959-1995.

Yet, all of these publications warn that the yield curve by itself cannot solely by used as a determinant of policy actions. Additionally, there has also been research done that denies its

reliability and determined that it is not the most accurate measure. A study conducted by Erenburg and Goebel (2001) concludes that while there is a link between the curve and output, there are much better methods with which to predict production. Particularly, they prefer the international/domestic interest rate spread, and believe that it progressively has become more important while the yield curve declines in efficacy.

Other papers explore the possibility that the curve's predictive ability does not cross national borders. A study by Bange (1996) concluded that the yield spread is useful when considering the United States, Japan and Germany. However, it is not the best predictor for the United Kingdom and Japan, which are inflation and stock returns, respectively. Davis and Fagan (1997) and Smets and Tsatsaronis (1997) determined estimates were not stable over time and the curve was not an effective predictor for European data.

And still yet, research has been done that concludes that the curve does not predict as it once did. Gamber (1996) concluded that previous to 1980, the curve proved accurate. However, he ultimately finds that the yield spread only provides useful information when the Federal Reserve Bank does not respond to changes in that same variable. Similarly Kozicki (1998) argues that there is a common flaw among the prior papers, specification error. She determined that for this reason the R^2s are inaccurate. The coefficient is simply reflecting the correlations between the yield spread and inflation and thus is a reflection of the monetary policy of the time. More recently, Stock and Watson (2003) found that although the spread did become negative prior to the recession of 2001, it was a much smaller turn than history would imply.

B. The Corporate Spread

Compared to the vast amount of research conducted on treasury yields, the database of knowledge of the corporate bond spread is distinctly smaller and also more recent. Gertler and

Lown (1999) determined that high-yield corporate bond spread is an effective tool in analyzing future business cycle changes. High yield refers to the high-risk, less-than-investment grade bonds. Using Moody's rating system, high-yield bonds are rated Ba to Ca (see Table 2.1 on page 10). They use quarterly data to compare the high-yield spread with other leading indicators. However, Duca (1999) points out that the results of Gertler and Lown (1999) depend too heavily upon the high-yield bond collapse that occurred during the late 1980s and early 1990s and could be a coincidence. Also, Mody and Taylor (2004) and Stock and Watson (2003) find there is distinct evidence that the corporate spread proves a more effective predictive tool than the yield curve. Furthermore, Chan-Lau and Ivaschenko (2001) demonstrates the predictive nature of the investment-grade spread, a tool similar to the corporate spread which measures the difference between risk-free Treasury bonds and investment-grade corporate bonds.

Some, but not all, of the literature on the yield curve appears to support the hypothesis of a decline in its efficacy as a predictor of changes in the economic climate. Additionally, I believe that the limited knowledge of the corporate bond spread warrants further excavation using a larger sample size.

Methods of Analysis

All the data used in this paper were gathered from the St. Louis Federal Reserve Bank's economic database (FRED) and the Board of Governors of the Federal Reserve. Both databases report monthly information on a variety of nominal and real economic variables. I collected month-end data of the 3-month and 10-year Treasury rates and the rates on Moody's Baa and Aaa corporate bonds using FRED database. This data was used to construct the slope of the

yield curve and the corporate bond spread. The sample period is from January 1971 through October 2009[2]

In order to robustly analyze the results a number of diagnostic tests were conducted. Initially, I tested each series for unit roots by employing the standard augmented Dickey-Fuller tests. Testing for unit roots is often the first test to conduct when dealing with time series data, as the existence of unit roots often result in some serious econometric issues. If a series contains a unit root, then inference testing, that is, testing the significance of a variable's coefficient is invalid using ordinary least squared regression techniques. Usually, if a variable does contain a unit root, then a first difference of the variable rids the series of the unit root. In particular, consider the following equation where X_t is the series under investigation (the series we are testing for a unit root):

(1) $X_t = \alpha + ßX_{t-1} + e_t$

X_t = Variable under investigation
α = constant
ß = coefficient
e_t = white noise error term

Subtracting X_{t-1} from both sides we have:

(2) $X_t - X_{t-1} = \alpha + ßX_{t-1} + e_t - X_{t-1}$

and

(3) $\Delta X_t = \alpha + (ß-1)X_{t-1} + e_t$

The Dickey-Fuller test is used to determine if ß=1, i.e., to test if the series contains a unit root. A ß=1 implies that changes in X_t are random and unpredictable (often referred to as white noise).

[2] Data for unemployment begins in January 1973.

The augmented Dickey-Fuller tests add lagged dependent variables to the right-hand side of equation (3) to rid the equation of serial correlation. The results of the augmented Dickey-Fuller test the unit root test are lag sensitive, meaning that it was necessary to carefully detect the proper lags for each test (we tested all our series). The criterion we employed was to keep adding lagged differences until we minimized the Schwarz Criterion (also known as the Bayesian Information Criterion). Specifically, the Schwarz Criterion is a form of regularization in which it is possible to select a parametric model when there are differing numbers of parameters. The variables that proved to be stationary (no unit root) were inflation and the unemployment rate, while the variables that required differencing (contained a unit root) were the Dow Jones Industrial Average, gold prices, and industrial production.

Vector autoregressions (VARs) were used to capture the dynamic relationship between the yield curve and the corporate spread and the other selected economic variables. This type of simultaneous estimation is popular in macroeconomic research due in part, to the ease of interpretation regarding the dynamic relationship between numerous times series variables. In my analysis, I only consider 2 variables at a time and examine how a "shock" to one series affects, through time, the behavior of the other series. In other words, I only consider two variable VARs. Consider the following two variable system:

(4) $X_t = \alpha_0 + \alpha_1 X_{t-1} + \alpha_2 Y_{t-1} + e_{xt}$

(5) $Y_t = \beta_0 + \beta_1 X_{t-1} + \beta_2 Y_{t-1} + e_{yt}$

where X and Y are time series, α and ß are parameters to be estimated, and e's are error terms. For explanatory purposes, consider updating the system above one period (month):

(6) $X_{t+1} = \alpha_0 + \alpha_1 X_t + \alpha_2 Y_t + e_{xt+1}$

(7) $Y_{t+1} = \beta_0 + \beta_1 X_t + \beta_2 Y_t + e_{yt+1}$

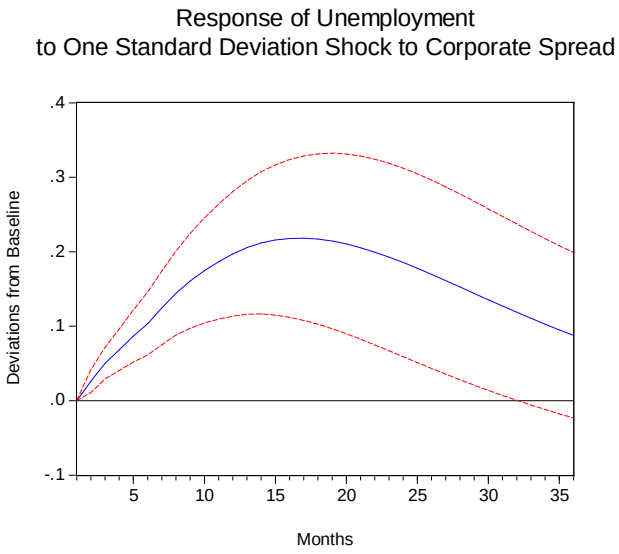
Consider the following simple example. Let X = money growth and Y = GDP growth. I estimate simultaneously equations (4) and (5) and obtain the coefficients (α's and β's). I then shock money growth by one standard deviation in an upward direction (e_{xt} rises). Of course this shock or impulse, as it is referred to in VAR analyses, influences money growth (X) directly via equation (4). But does it also influence GDP growth (Y)? The answer of course depends on whether there exists a significant relationship between the two series. According to equation (4), when e_{xt} goes up, X_t goes up immediately. If we examine equation (7), GDP growth will be influenced next period by β_1 times the change in X_t. The shock to X_t also influences X_{t+1} via equation (6), which therefore, would influence Y_{t+2} via an updated equation (7) below:

(8) $Y_{t+2} = \beta_0 + \beta_1 X_{t+1} + \beta_2 Y_{t+1} + e_{yt+2}$

As you can see, the shock to X_t will affect both series through time and in this particular example, using X = money growth and Y=GDP growth, we are testing whether or not monetary policy works and for how long. For example, if there is no change in GDP growth given a shock to money growth, then I can argue that money is neutral and does not effect real GDP growth (monetary policy is neutral). If I see a significant movement in GDP, then I say money is non-neutral and therefore, monetary policy works. If GDP growth goes up for a while and then

returns to its baseline, then I can say money is non-neutral in the short run but neutral in the long run, which of course is the conventional wisdom regarding the Fed's model of the economy.

VAR analysis includes the use of impulse response functions that trace out the dynamic response of Y to shocks to X and the other way around. I use impulse response functions extensively throughout this paper. The graph on the next page (Graph 3.1) will be analyzed in the next section but will be used for explanatory purposes here. Because they are so heavily relied upon in my analysis, it is important to understand how to accurately interpret impulse response functions. The graph represents how the unemployment rate will react to a positive, one standard deviation shock to the corporate spread. A positive shock to the slope of the yield curve indicates an increase in the difference between short-term yields and long-term yields. A positive shock to the corporate spread denotes an increase in the difference between rates on riskier Baa bonds and relatively safe Aaa bonds. The dotted red lines represent the 95% confidence interval. Essentially, if the solid black line (designated .0 on the graph) falls outside of the red dotted lines, then I can say, with 95% confidence that the "shocked" variable affects the other. In this case, I can say that a shock to the corporate spread will affect the unemployment rate for about 32 months with 95% confidence. Additionally, the X-axis measures the length that the shock affects the variable not shockedwhile the Y-axis measures the magnitude of the effect.



Graph 3.1

Data Analysis

This section provides the results of my analysis. It is broken down into five sub-sections, each evaluating a different economic variable. The individual sections begin with an explanation of the reason for the inclusion of the variable in the analysis. It then describes priors based upon current economic theory. Finally, the results will be examined and explained. It should be noted that in addition to the full-section analysis, the data set for each variable was split in an effort to measure the progression of the relationship between the yield curve or the corporate spread and the given variable. The findings of these split-section analyses will be provided if results prove to be of significant interest.

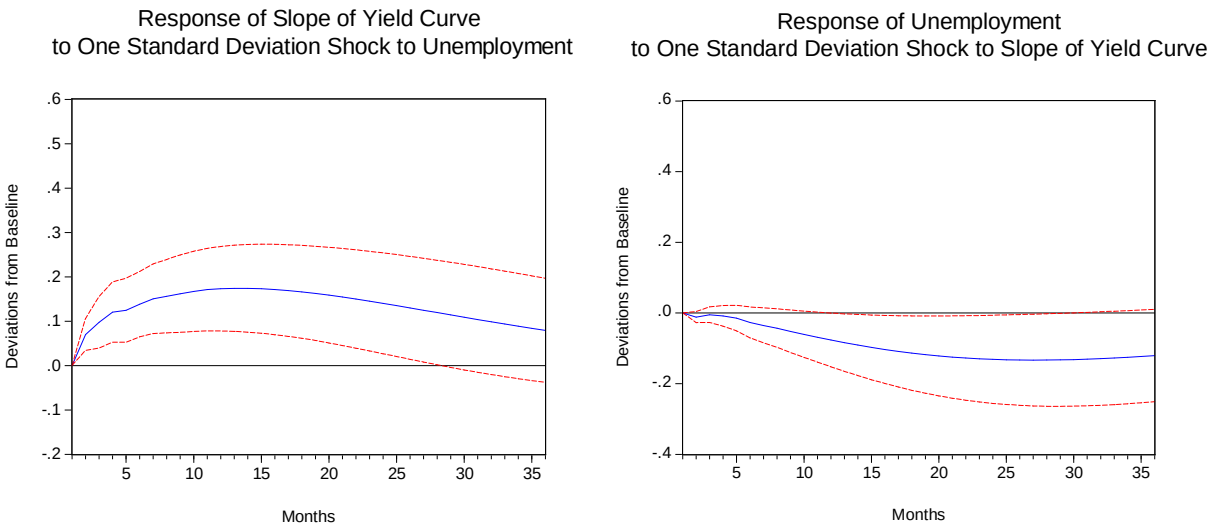
A. Unemployment

The analysis begins by reviewing the dynamics between unemployment and the slope of the yield curve and the corporate bond spread. The unemployment rate, as we know, measures the number of individuals available and willing to work yet unable to find a job (while excluding

people who have not actively searched for employment in the past four weeks, otherwise known as discouraged workers). It is often used in macroeconomic studies as one of the essential economic indicators that assess the health of the current economic condition and is considered a key component of the Dual Mandate upheld by the Federal Reserve Bank. Unemployment becomes a greater concern when one considers its implications upon real output. Essentially, less workers leads to less productivity and thus less real output. Its larger effect on the economy makes it an essential component of this analysis.

1. The Yield Curve

Based upon current economic theory, the yield curve slope presumably would respond to an unemployment shock by increasing. Unemployment, as part of the Dual Mandate, is a key concern of the Federal Reserve regulators. That is, the Federal Reserve Bank currently sustains what is referred to as the Dual Mandate, which commands policies remain aimed at maintaining steady growth and low unemployment. As such, we would expect that an increase in unemployment would spark the interest and concern of federal regulators. Thus, an increase in the unemployment rate would spur the Fed to lower interest rates, or cause an increase in the slope of the curve (short rates decrease while long rates remain intact). Additionally, theory dictates that a positive shock to the slope of the yield curve, caused by the Federal Reserve Bank lowering rates, would lower the rate of unemployment because the boost to the economy from the lowered cost of borrowing (Federal Reserve San Francisco).

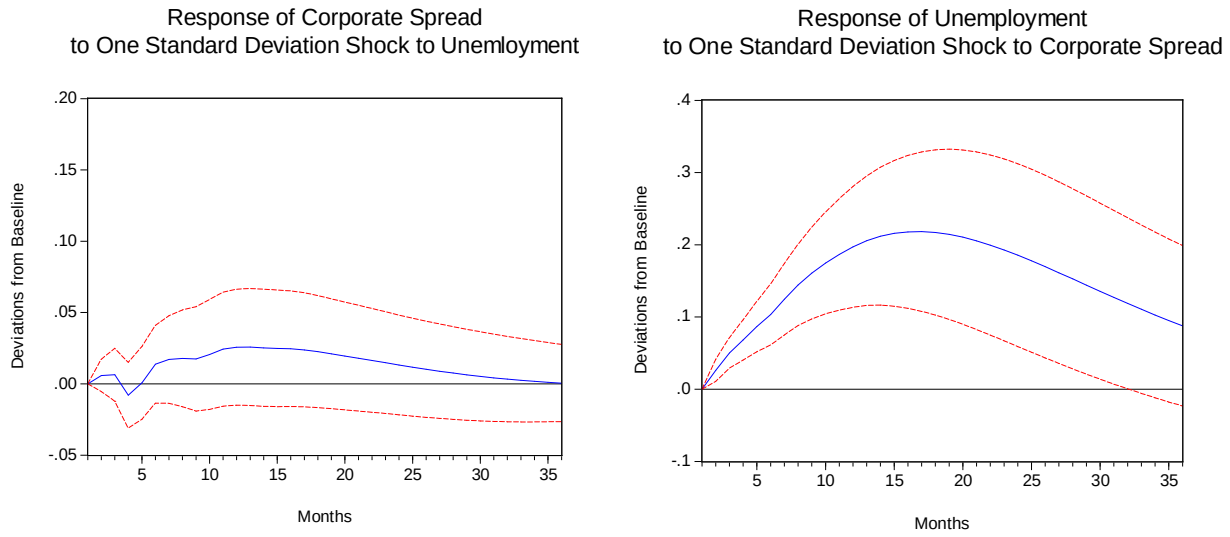


Overall, the results are consistent with the initial predictions and certainly show a relationship between the two variables. The impulse response graph on the left indicates an immediate and significant, 28-month positive response of the yield curve slope to a shock from the unemployment rate, which is indicative of a responsive Federal Reserve System dedicated to maintaining a low level of unemployment. Also, as can be determined by the impulse response graph on the right, unemployment reacts to shocks to the yield curve after a lag of about a year. This reaction points to the ability of the Fed to competently control unemployment by changing interest rates. Overall, the above results both the efforts and the ability of Federal Reserve officials in maintaining a stable, low level of unemployment.

2. The Corporate Spread

Concerning the corporate spread, theory dictates that there should be a response from unemployment to a corporate spread shock but not necessarily the other way around. As we know, unemployment's designation as a lagging indicator suggests that it summarizes past events as opposed to predicting future ones. Thus, because the corporate spread tends to be an indicator of the larger economic condition and the risk associated with it, the spread should lead the unemployment rate and accurately contain information that would help it to predict

fluctuations in the unemployment rate. Using similar logic, we would assume little, if any, response from the corporate spread to a shock in the unemployment rate.



As expected, the corporate spread had little reaction to a positive shock to the unemployment rate as can be seen by the graph on the right. However, when considering unemployment in relation to an increase in the corporate spread, the unemployment rate does increase and stay elevated for nearly three years. Intuitively, the increase in the corporate spread indicates increased uncertainty in the larger economic condition, a subsequent increase in the unemployment rate is a natural response of the economy during time of uncertain economic times, which would already be shown in an increase in the spread.

B. Stock Market

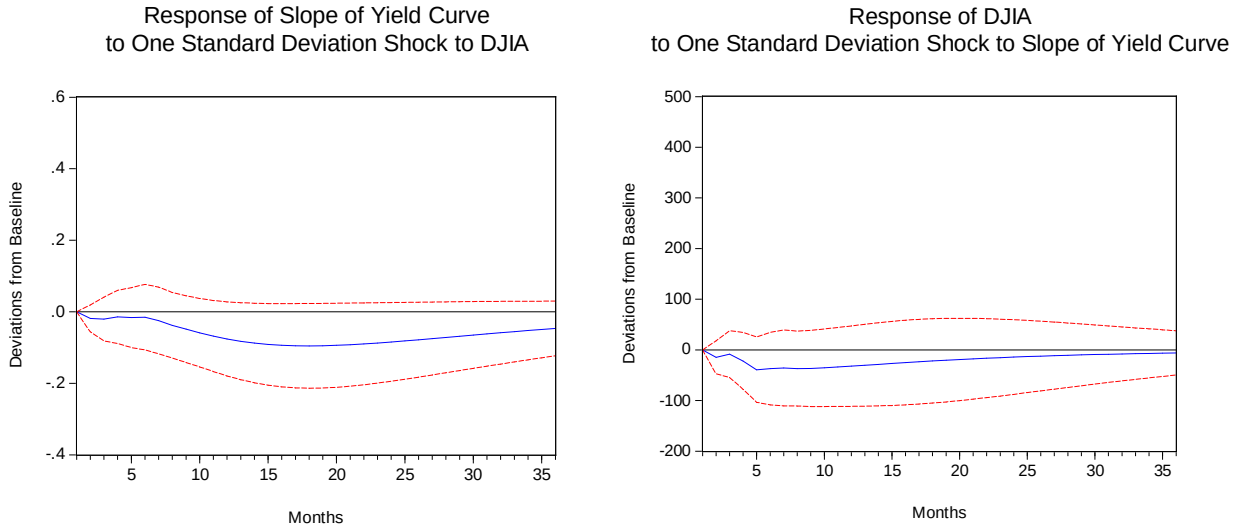
The relationship between the slope of the yield curve and corporate spread and trends in the stock market were evaluated next. Specifically, the Dow Jones Industrial Average (DJIA), or Dow, was used due to its widely scrutinized and studied nature by both economists and financial analysts alike. Considered an officially accepted economic indicator, it is often believed that

significant decreases in stock prices indicate an oncoming recession while a large increase in prices is conducive to future growth (Stock and Watson 2003).

1. The Yield Curve

Theoretically, the connection between the interest rates and the stock market are considered fairly indirect and warrant discussion. Due to Federal Reserve Bank policies and their focus on the Dual Mandate we would assume very little response from the yield curve slope to movements in the DJIA. The Federal Reserve Bank officials insist upon remaining neutral to stock market fluctuations by using major stock indices solely as indicators (Federal Reserve San Francisco). Therefore, if the Fed does adhere to this policy, there should be no response from the yield curve.

However, another sector of theory suggests differently. It has been proposed that stock prices reflect expectations about the economy on the whole and can therefore predict economic fluctuations, meaning that Federal Reserve officials would monitor stock rates more closely than they say, whether it be purposefully or incidentally. Furthermore, while investors focus on individual companies and their performance, interest rates also can affect the borrowing and lending of money. When interest rates are increasing, investors tend to place money in the more temping bonds, which puts downward pressure on stock prices. Conversely, decreased interest rates means that a lender is receiving less interest and stocks become the more temping investment. The consequent shift to stocks allows companies to use financing at a cheaper rate and increase future earnings potential, which also increases stock prices.

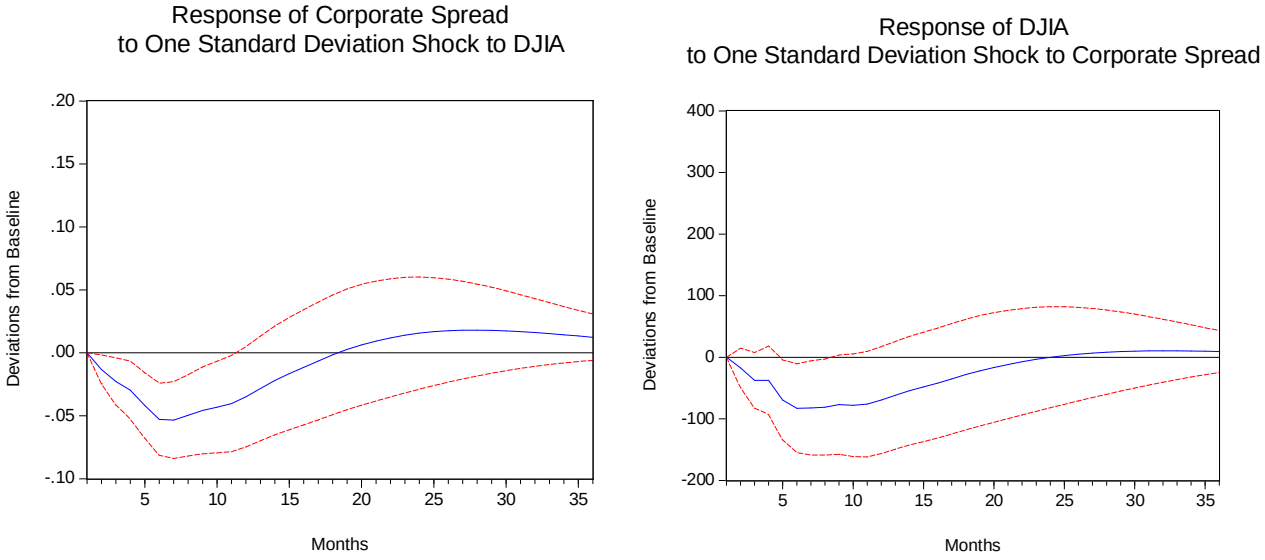


Results relating the yield curve slope and the DJIA proved to be unrelated and inconclusive in both regards as can be seen by the impulse response graphs above. There does not appear to be any evidence that the yield curve can accurately predict fluctuations in the movement of the Dow. Similarly, movements in the DJIA appear to have no relation to interest rates and the curve. This implies that The Federal Reserve effectively maintains neutrality concerning changes in stock market prices, and investors tend to be more motivated by other means, not interest rates.

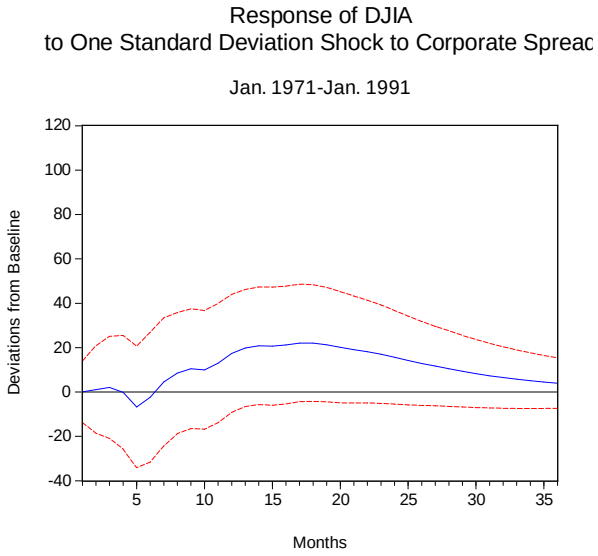
2. The Corporate Spread

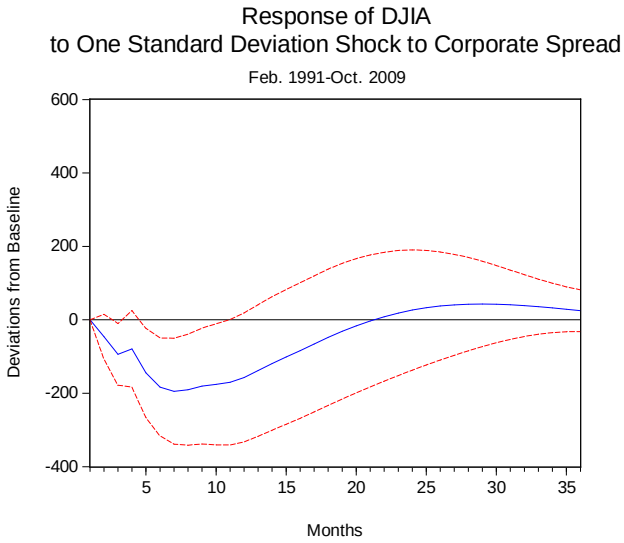
In theory, we would expect to discover a negative relationship between the corporate spread and the Dow Jones Industrial Average. Due to its sensitivity to confidence in the economy as a whole, one of the corporate spread's key objectives is to measure the investors' faith in positive return on stock prices which tends to assure that the risk of defaulting for the corporation is very low. In addition, an increase in the corporate spread indicates a higher cost of borrowing to corporations. Financing becomes more expensive and thus future earnings

decline causing downward pressure on stocks. Thus, a positive shock to the corporate spread would decrease the DJIA and vice versa.



The analysis of the corporate spread does not waver from expectations as it reveals a distinct and telling relationship in both regards. The graph on the left illustrates that the corporate spread responds to a positive shock to the Dow by immediately decreasing and remaining depressed for nearly a year. This movement accurately exhibits the sensitivity to stocks associated with corporate bonds, and is aligned with current theory. Conversely, the Dow indicates a three-month decrease with a lag of five months when the corporate spread is positively shocked. With the corporate spread rising, there is less of a sense of confidence in the economy which spurs a decrease in stock prices. However, the somewhat muted and lagged response could indicate that bond investors are much more sensitive to the overall economic outlook than stock investors. Or, more likely, the somewhat muted response from the DJIA to the corporate spread indicates that there are a multitude of other variables that affect stock prices (Fama et al. 1969).





In order to excavate more deeply into the corporate spread and DJIA analysis, the sample was split into two distinct groupings. The break came at January 1991 which was selected for its proximity to a number of economic changes such as the end of the Volcker period of Federal Reserve policy and the recession of 1990. It was determined that prior to 1990, the corporate spread did very little to predict any movements in the stock market as can be noted by the graph on the left. Yet, within the past 20 years, it has become significantly more valuable as a method of prediction showing results similar to those found when evaluating the whole sample, perhaps suggesting its overall increase in efficacy of predicting economic conditions. It appears that investors are more conscious of the corporate spread as an indicator and thus more attentive to the larger economic situation when evaluating their stock portfolios.

C. Gold

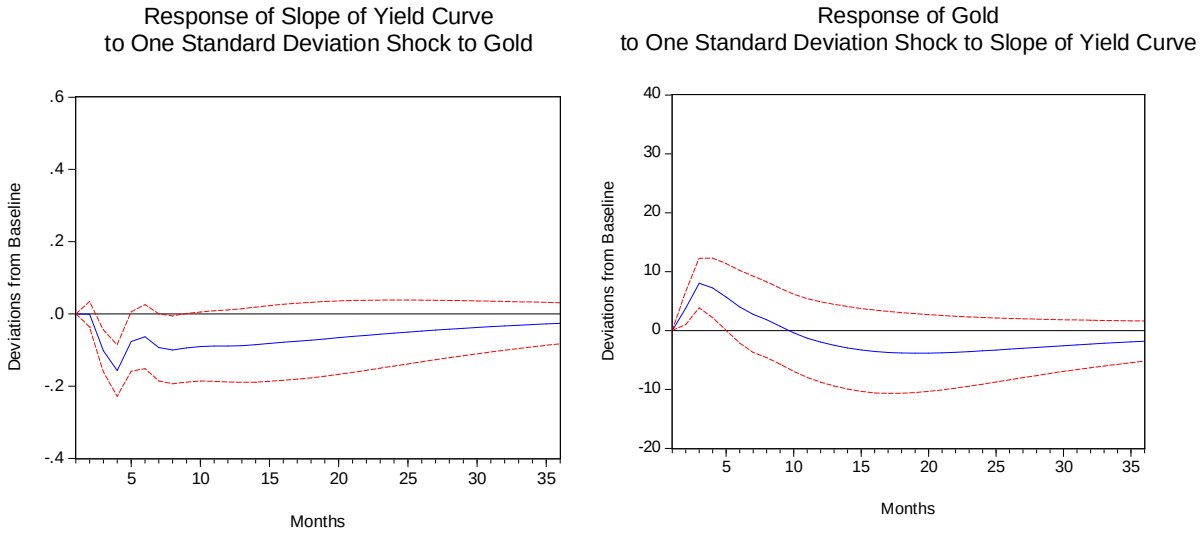
Gold was evaluated due to its nominal nature and its relation to inflationary expectations. Historically, gold as an investment has served as a hedge (protection) against inflation as well as

a hedge against a currency that is declining in value. This makes sense since all else constant, a declining currency is inflationary.

1. The Yield Curve

Due to its reputation as an inflation hedge, we would assume a connection between the slope of the yield curve and gold prices. It is well documented that a shock to the yield curve that increases its slope typically signals higher inflation. We discuss this reality in more detail when we consider inflation in sub-section E. If investors feel that shocks to the yield curve does signal higher inflationary expectations, then we should observe a positive relationship between shocks to yield curve slope and the price of gold, as investors will naturally hedge against this higher expected inflation by buying gold.

In terms of the other way around, that is, the reaction of the slope of the yield curve to shock to gold prices, some discussion is in order. If the Fed is using gold as a pertinent informational variable in conduction monetary policy, then a positive shock to gold prices will result in the Fed tightening and in this case, the slope of the yield curve will flatten. This being the case, the relationship would be negative. Alternatively, if the shock to gold prices is dismissed by the Fed and investors in terms of serving as a reliable signal of future inflation, then the yield curve may stay stable and therefore, we would see no significant relationship between a shock to gold and the reaction of the slope of the yield curve. Finally, the relationship may be positive if higher gold prices do signal higher inflation and thus, results in a steeper yield curve. This result is sensitive to the behavior of the Fed, since a dovish (unemployment-targeting) Fed could live with this steeper yield curve for example, if the economy was coming out of a recession. But if the Fed were hawkish (inflation-targeting), this result would be reversed, as discussed above.



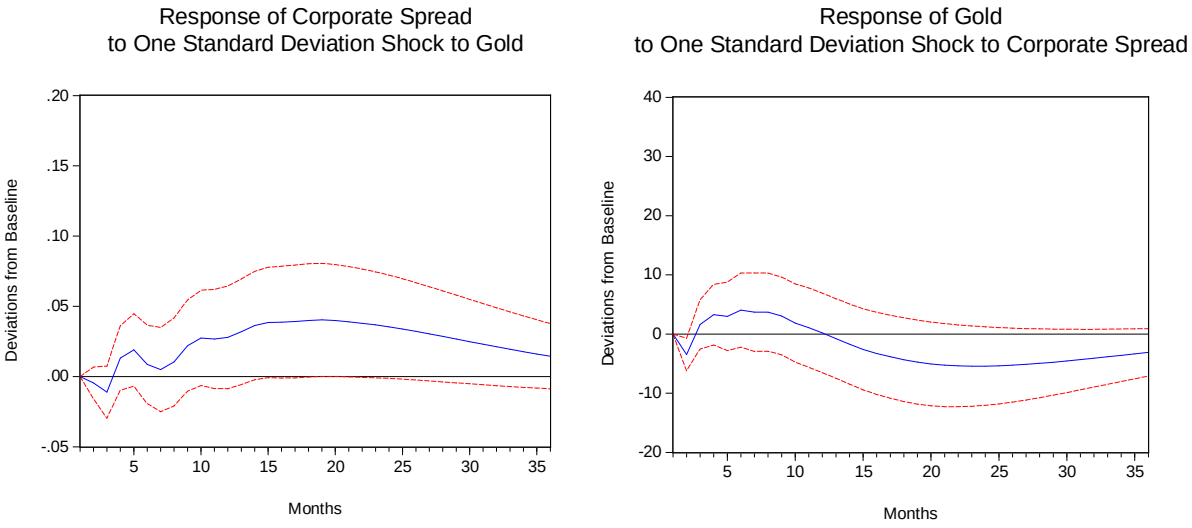
A shock to the yield curve (right hand impulse response function) does result in a significant positive spike in gold prices, consistent with the narrative above, that a steeper yield curve signals higher inflation and thus, investors hedge this higher expected inflation by buying gold. In the left hand panel, the results indicate a hawkish (inflation-targeting) central bank, since a positive shock to gold results in a flattening of the yield curve, consistent with the central bank tightening when gold prices shock upward. The results infer that the central bank does have gold 'on its radar screen' and reacts accordingly. Put differently, the results in the right hand panel suggest that gold does serve a role as an important informational variable for the Fed and their all important forecasts of future inflation and inflationary expectations.

2. The Corporate Spread

With regard to evaluating the corporate spread in relation to gold prices, we would think that if we shock the corporate spread in the upward direction, this would suggest a weakening economy and thus, investors will lose their appetite for gold as an inflation hedge. In this case, the relationship would be negative. This result is sensitive to the source of the weaker economy. If the source of the weak economy is weaker aggregate demand, then the prior above makes

sense, as inflationary pressures fall with the weaker demand. Conversely, if the weaker economy is due to an adverse supply shock, then inflationary pressures would be building, and thus, gold would look more attractive in terms of a hedge and thus, we would observe a positive relationship between the two series. If it is a little of both, which is likely the case, then we would observe an insignificant relationship between the two.

With regard to the corporate spread responding to shocks to gold, the reaction depends again on the reaction of the Federal Reserve. If the Fed views gold prices as a reliable informational variable regarding its inflation signaling, then the corporate spread would rise, indicating a hawkish Fed that is going to 'spoil the party.' Conversely, if the Fed is dovish and therefore, does not react aggressively to the positive shock to gold prices, then the economy might be headed for stronger growth and along with it, a lower corporate spread. Given the results (immediately above) that indicate a hawkish Fed, I would think the former would prevail, that is, higher gold prices result in a higher corporate spread.



The results in the right hand graph suggest an immediate drop in gold prices given a positive shock to the corporate spread. This fact is consistent with a higher corporate spread

signaling weaker aggregate demand and thus, lower inflation making gold less attractive as a hedge. The left hand graph suggests that after 15 months, the corporate spread with rise given a positive shock to gold prices, suggesting a relative hawkish Fed, as discussed above. The 15 month lag is interesting since most believe that monetary policy works with lags and 15 months is certainly in the range of 6 months to 24 months, the typical range that is though to be correct when discussing the effectiveness lag in monetary policy. This result must be viewed with caution, as the significance is weak (i.e., the 95% confidence band often includes zero).

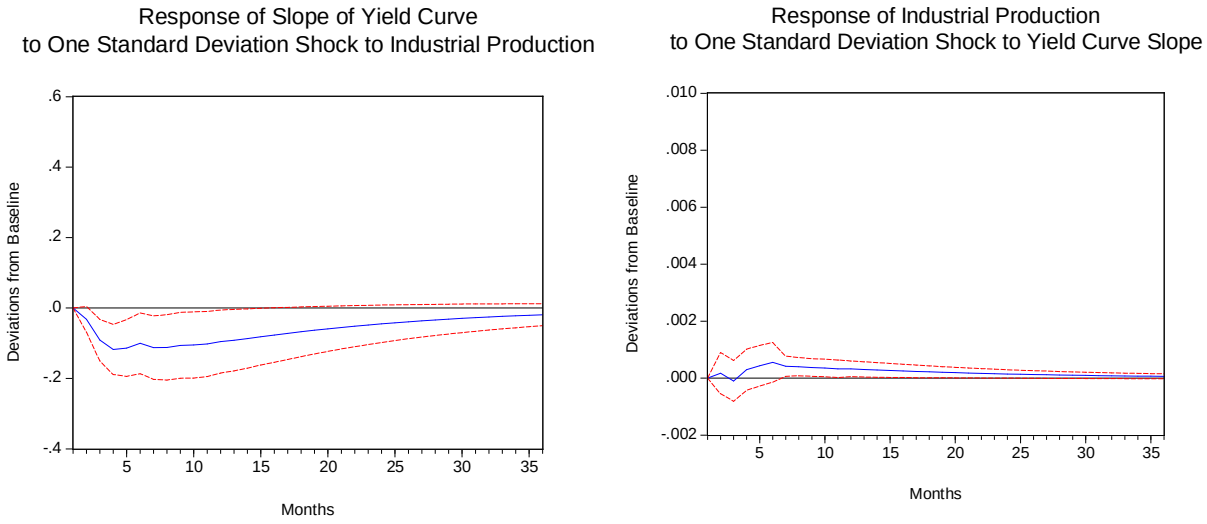
D. Industrial Production

Next, output was considered, and industrial production was selected as the metric of output. Industrial production is defined as the total output of U.S. factories, thus it is an effective gauge of overall manufacturing output, not including services, in the United States. The industrial sector itself consists of manufacturing, mining and utilities. It is the oldest regularly published economic series, beginning its standard publication shortly after World War I ended in 1919. As such, it was viewed as a measure of the predominant force of total U.S. economic activity, manufacturing. At the time, this was essentially the equivalent to the measure of GDP. Despite its early origins, it is still a useful real measurement of wealth evaluated today and useful for our purposes.

1. The Yield Curve

Theoretically, we expect to notice a decline in the yield curve relative to a shock to industrial production. Very simply, an increase in industrial production indicates an overheating of the economy, as it is a metric of output. Rapidly increasing output (like rapidly decreasing output) sends a red flag to regulators. The Federal Reserve Bank is charged with maintaining steady growth. Too much output causes inflationary concerns which subsequently cause the Fed

to raise short-term rates in an effort to stamp out high inflationary expectations and restore a stable rate of growth. The Fed's actions would therefore decrease the slope of the yield curve. Moreover, we would expect to see a positive response from Industrial Production to a yield curve shock. If the Federal Reserve lowers short-term rates the cost of borrowing decreases. Businesses begin to increase investment spending and consumers start purchasing more durable goods (such as cars) because interest rates are lower. The combination of lower borrowing costs and higher demand for products would cause a boost to industrial production.

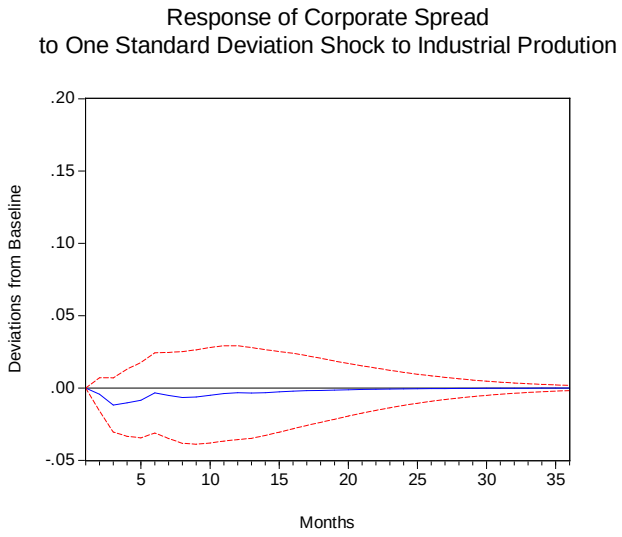


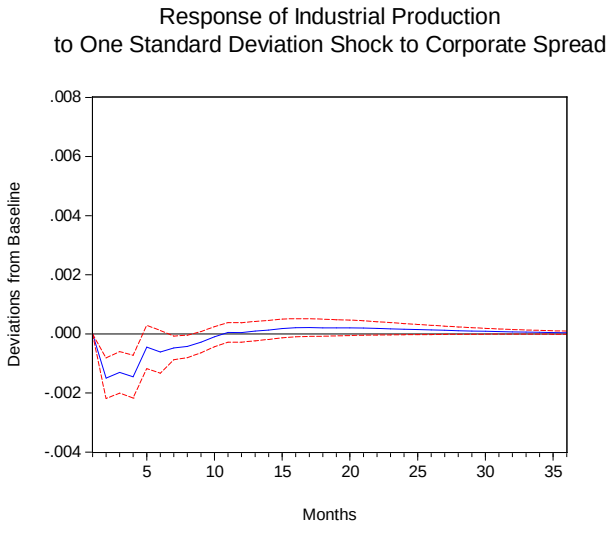
Results signify that the priors were correct. The right graph shows that after a lag of about seven months, industrial production increases. Logically, it will take a few months for corporations to begin to increase investment as there are a number of considerations for companies before they undertake a new business endeavor. Similarly, consumers' consumption patterns will also lag rates as consumers require time to consider the implications of purchasing a good which has a long shelf-life such as a car or house, and usually costs more than typical items. The graph on the left indicates after a very short lag, about two months, the slope of the

yield curve decreases, proving the Fed's response to high growth and its fear of high inflation expectations.

1. Corporate Spread

The corporate spread's relation to uncertainty and risk again dictates the relationship expectation. With risk-averse investors becoming more uncertain about future economic conditions, they are less willing to place their money in riskier corporate bonds. This hurts industrial production as many corporations look to the capital raised by the use of bonds to increase production. Thus, we would expect to notice a decline in industrial production when the corporate spread is shock. The converse relationship is a little more difficult to determine. It is possible that a positive shock to industrial production would lead to a decrease in the corporate spread as well. When corporations increase production, it could signify positive things for the economy in general, which would theoretically lower the spread as people are more comfortable investing in lower-rated bonds.





Results show that, as expected, industrial production does react negatively to a shock to the corporate spread. Corporations cannot expand and invest when investors are shunning their lower rated bonds. However, concerning the response of the corporate spread to an industrial production shock, the corporate spread does not respond. This possibly indicates that investors do not consider or closely study industrial production as an economic indicator and are therefore indifferent to a shock to it.

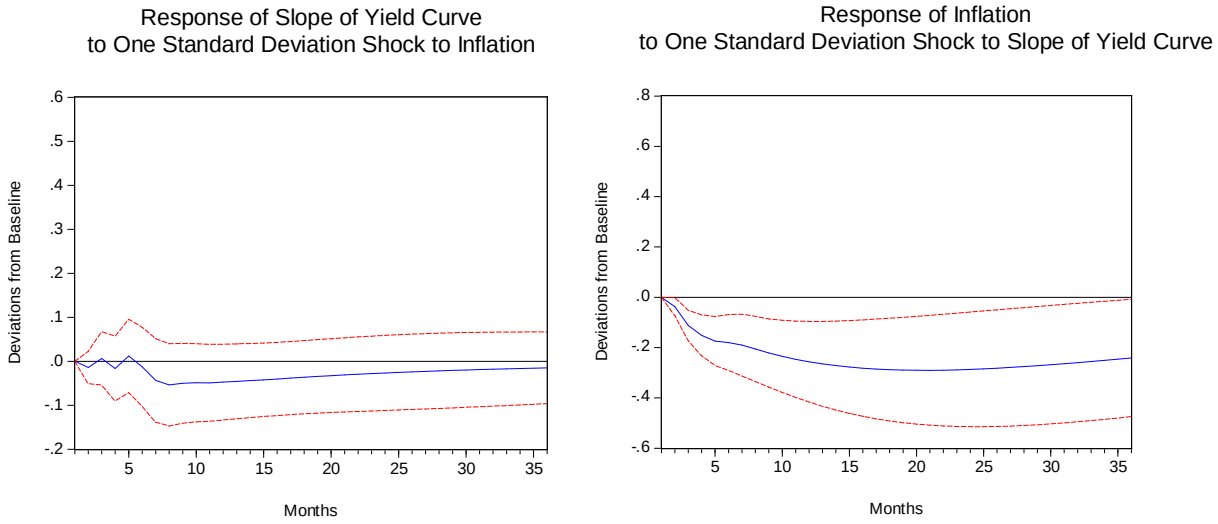
E. Inflation

Finally, inflation will be examined. Inflation is the rise in the price level of goods and services in an economy over a specific period of time. Essentially, as price levels increase, each unit of currency can purchase fewer goods thus inflation hurts the purchasing power of money. However, interest rates can have both positive and negative effects upon the overall economy, and their control is vital to the policy makers and the Federal Reserve Bank. The method of assessing inflation and what is used in this analysis is the inflation rate. The inflation rate is the rate of increase of the consumer price index. Because of its relation to a number of important economic variables, its inclusion in this paper was necessary.

1. The Yield Curve

As with a few of the other variables analyzed, there is difficulty determining a prior for inflation, as there is significant debate as to causation. We would expect that as inflation rises so too would the slope of the yield curve due to the increase in inflationary expectations. Because inflation is expected to increase in the future, investors will demand higher yields on their investments to offset the higher inflation. With short-term rates remaining the same, an increase in long-term rates causes the slope of the yield curve to increase. However, similar to the discussion concerning gold (sub-section C), if the Federal Reserve Bank is active and quick in

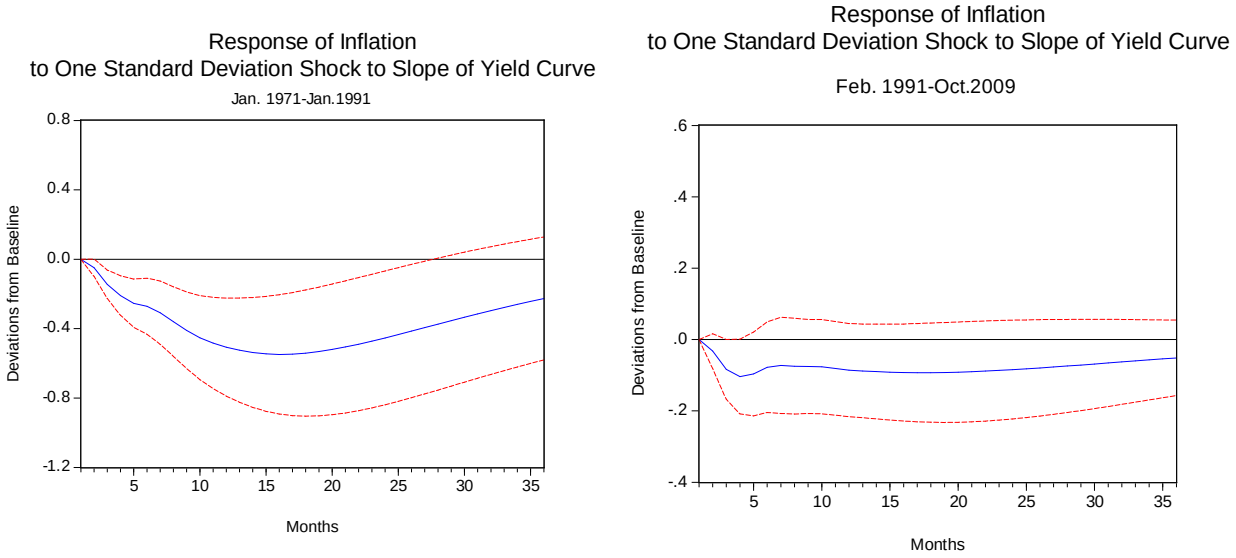
fighting inflation by increasing short-term rates to fight expectations then it is possible that the yield curve would decrease or remain the same depending on the magnitudes the shock to inflation and the subsequent Fed action.



Results indicate a responsive and effective Federal Reserve Bank. There does not seem to be any reaction from the yield curve to changes in inflation, indicating the effectiveness of Federal Reserve policy. Furthermore, inflation tends to decrease with a positive shock to the yield curve. If expected inflation increases, the yield curve becomes steeper because the long-term rates are determined using inflationary expectations. However, the active Federal Reserve Bank notices this phenomenon and quickly reacts by raising short-term rates in order to attempt to halt inflation. This series of actions causes the yield curve to remain unaffected by the increase in inflationary expectations as shortly after long-term rates rise so do the short rates.

This occurred in November of 1994 while Alan Greenspan was the Chairman of the Federal Reserve Bank. Throughout the month, the rate on the ten-year treasury continued to grow. Noticing this, Greenspan wanted to stamp out inflationary expectations by lowering rates. Despite normal current economic conditions and the protest of many other economists, the

Federal Reserve Bank raised rates by 75 basis points, an unprecedented raise for Greenspan's tenure. In the time following the rate increase, the ten-year began to fall back to acceptable rates and inflation was successfully contained.

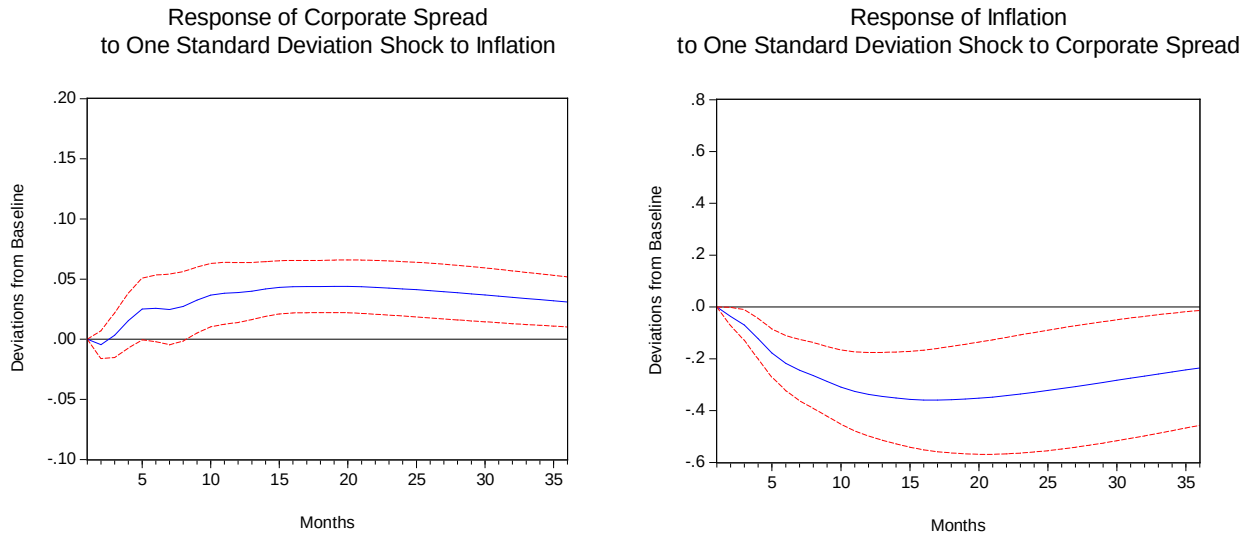


If we observe the second sample series compared to the first, we notice a failure of inflation to react to changes in the yield curve. This can be attributed to the Volcker period of Federal Reserve Bank policy. Paul Volcker was an inflation hawk, and as such raised interest rates continually in an attempt to "break the back of inflation." While Volcker was Chairman of the Federal Reserve Bank, inflation was his main concern. Due to his efforts, we notice a muted response during the period following the mid-80s.

2. The Corporate Spread

The theoretical prior relating inflation to the corporate spread again requires some discussion since the prior depends on whether the shock to inflation is from aggregate demand or aggregate supply. If the source of the inflation is demand-pull, then the spread should fall since the higher demand results in lower default risk. If the source of inflation is cost-push, or supply side, then the inflation is signaling higher default risk. The adverse supply shock causes the high

inflationary pressures so, in this case, the spread would increase. There is also the possibility that the increased inflation may be caused by both a supply and demand shock in which case we would notice a weak or non-response. It is an empirical question that must be tested. When considering inflation's response to a corporate spread shock, because a shock to the spread indicates a weaker economy, we would expect to notice a decrease in inflation. It has been proven that with a weakening economy inflationary pressures tend to decline.



The results indicate that inflation does, in fact, react negatively to a corporate spread shock (right graph). As explained above, it appears that the corporate spread accurately indicates the weakening economy and inflationary pressures response accordingly to this. Additionally, the left panel suggests that, adverse supply shocks occur more frequently than positive demand shocks as can be deduced from the increased corporate spread. However, this does not mean that shocks are always cost-push. It simply means that changes in inflation

Conclusion

Overall, the results indicate a waning of the yield curve's relation to the variables. Evaluating the yield curve in regard to gold, industrial production and inflation, results appear to point to a very hawkish Fed, trying to halt inflation. It also appears that Federal Reserve officials are effective in their efforts. Moreover, results from the analyses of unemployment and the Dow point to officials maintaining faithful to the Dual Mandate, which they herald are their main objectives. Overall, the yield curve tended to respond more to the actions of the Federal Reserve Bank as opposed to predicting future economic conditions.

The corporate spread conversely, responds to and predicts a number of economic variables. Due to its effectiveness at measuring risk in the general economy, it related to the Dow and inflation while also indicating the type of shocks, either supply or demand, causing fluctuations in gold and inflation. Similarly to other recent economic literature by Gertler and Lown (1999), Mody and Taylor (2004) and Stock and Watson (2003), it appears that the corporate spread must be considered as a primary leading indicator while the yield curve must be reevaluated.

There are a number of possible explanations for the recent shift. The phrase great moderation, coined by economist James Stock, is often used to describe the general decline in economic volatility in the past two decades. The smoother indicators include major economic variables such as GDP, unemployment rate and inflationary expectations (Stock and Watson 2002). This phenomenon is believed to have been caused by better policy, improved productivity and a certain amount of luck (Stock and Watson 2002). Less volatility has led to a number of economic effects. In regard to this analysis, the reduced volatility of inflationary expectations has restricted the yield curve's movement. If long-term rates tend to remain fairly

stable, then the only changes to the curve derive from short-term rates. As we know, short-term rates are controlled primarily by Federal Reserve Bank decisions. Therefore, the yield curve operates primarily as a metric for testing the accuracy and efficacy of the Fed's policy actions as opposed to economic variables.

The glut of savings describes the recent situation in which much of the global economy is over-saving and under-investing, and can also be used as a possible explanation for the results of this analysis. Bernanke first discussed the global savings glut in 2005. He cites a number of reasons for this situation including aging populations, war chests, artificially low exchange rates in order to promote an export-based economy, rising oil price and a "dearth of economic opportunities (Bernanke 2005). He claims that this leads to global current account imbalances, rising asset prices and lower rates of interest (Bernanke 2005). Lower rates of interest leads to a flatter yield curve as investors seek the highest returns in long-term bonds. Thus the yield curve does not accurately depict the larger part of the economy.

The implications of this analysis are important for theoretical reasons. A strong connection between the corporate spread is important because it can potentially allow investors and policy-makers alike to more accurately and successfully determine forecasts of different economic variables. The corporate spread had been a tool that has seen little discussion until recently. The results of this analysis suggest that a focus on the corporate spread as opposed to the yield curve is more useful when conducting monetary policy and investing strategies.

However, I do recognize the issues regarding corporate spreads as a predictor, and agree that there are concerns when evaluating the corporate spread as forecasting tool. Duca (1999) determined that the spread has given false signals when the financial markets are under considerate strain when he criticized Gertler and Lown (1999). Particularly, Duca points to the

long-term capital management crisis as an example of its poor predictive nature. Nevertheless, the period to which he refers was not excluded in the dataset, and my analysis showed that the corporate spread was still informative. It is therefore my conclusion that despite its potential shortcomings, it can still be a useful tool in determining policy.

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EDUCATION

The Pennsylvania State University, Smeal College of Business — University Park, PA
The Schreyer Honors College — Class of 2010
B.S. Economics, with a concentration in Money and Banking, Minor in International Business
Courses: 34 credits in Math/Analytical fields such as Accounting, Econometrics, Calculus, Statistics

The Institute at Palazzo Rucellai — Florence, Italy
- Study Abroad — Summer 2008

HONORS

Sapphire Program
- Accelerated business program for exceptional students offering early entrance to major, study abroad and advanced level courses

Beta Gamma Sigma
- Top 10% of class, inducted early as sophomore