ABSTRACT

DARWIN, ROBERT W. Asymmetric Responses of Break-Even Inflation Rates and the Stock-Bond Correlation to Macroeconomic Announcements. (Under the direction of Dr. Douglas Pearce).

Accounting for three types of asymmetry (state, sign, and proportion), I examine movements in fixed-income and equity markets in response to surprise components of macroeconomic announcements. I find evidence for both price and real variables that markets respond more to news in recessions than expansions. No consistent evidence is present, however, to point to sign asymmetry by which positive and negative shocks would have different magnitude of effects.

Asymmetric Responses of Break-Even Inflation Rates and the Stock-Bond Correlation to Macroeconomic Announcements

by

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Chapter 1

Overview of Inflation-Indexed Bonds

The emergence of inflation-indexed bonds has created a new set of financial instruments for practitioners to use and academicians to study. Garcia and Rixtel (2007) provide a comprehensive background on their history, as well as summarizing the rationale for their issuance. While inflation-indexed securities have a long history of thought and attempted application, their widespread usage has been limited until recent years. Now, however, many countries issue these bonds and their liquidity is increasing. The gains to issuers of inflation-adjusted debt are acquired through the inflation risk premia of holders of this debt. Purchasers of this type of debt would like to reduce potential losses accruing to rising inflation, and are willing to pay a premium for this insurance. Debt issuers could face losses, however, in the face of illiquid markets, as debt holders would require a liquidity premium as compensation. In general, once markets are well-established, any liquidity premium should be small as the holders of inflation-indexed securities likely do not demand highly liquid markets (they are long-term investors such as pension funds). Inflation-indexed securities also can match government revenues with obligations, as both are now subjected to the same inflation risk, and governments that issue inflation-indexed debt ensure that they will have a market for debt even when future inflation is uncertain.

Garcia and Rixtel (2007) also describe the informational content contained in the markets of nominal and inflation-adjusted bonds, defining the break-even inflation rate (BEIR) as "the spread between the yields of a conventional nominal bond and an inflation-linked bond of the same maturity." Inflation expectations are a major component of break-even inflation rates, though other information (such as an inflation risk premium and a liquidity premium) is contained in this spread as well. Specifically, the break-even inflation rate can be decomposed as:

$$\text{BEIR} = \text{Expected Inflation} + \text{Inflation Risk Premium - Liquidity Premium}$$

As the inflation risk premium increases, investors are willing to pay more to insure themselves against inflation-influenced losses, demanding more inflation-indexed bonds and pushing real yields down. In contrast, in the face of illiquid markets for inflation-indexed bonds, investors' demand for inflation-indexed bonds falls and real yields rise. Once markets for inflation-indexed debt are sufficiently liquid, however, the liquidity premium should subside and stabilize, leaving only inflation expectations and risk premia as the components of BEIR. Specifically, when examining daily differences in break-even inflation rates, the liquidity premium component will be eliminated due to this constancy. Thus, changes in break-even inflation rates can be thought of as a sum of changes in expected inflation and the inflation risk premium.

$$\Delta\ \text{BEIR} = \Delta\ \text{Expected Inflation} + \Delta\ \text{Inflation Risk Premium}$$

The use of break-even inflation rates of forward yields (also called forward inflation compensation) can help determine how these various components behave at a fixed point in the future in response to news today.

In the United States, the market for Treasury Inflation-Protected Securities (TIPS) formed in 1997, initially offering inflation-indexed bonds with maturities of five and ten years. Thirty-year bonds were subsequently introduced and phased out, while twenty-year bonds are also now actively traded. The five-year bond was phased out for a brief time, then reintroduced. Figures 1.1 and 1.2, taken from the United States Department of the Treasury, illustrate the history of issuance and liquidity of TIPS, showing that transaction volume appears to level off around 2005.

Armed with zero-coupon yield curves for nominal and inflation-indexed securities, I can compute break-even inflation and forward inflation compensation rates across a term structure, examining their evolution over time and in response to macroeconomic announcements. Gürkaynak et al. (2008) provide a blueprint for modelling these yield curves in the U.S., and I review their set-up and results. Defining the main difference between nominal and inflation-indexed bonds, they note that nominal bonds are characterized by fixed payments including bi-annual coupons and the principal at the point of maturity, while TIPS' payments are indexed by ratios of reference CPI realizations. Specifically,

> "if the maturity or issue date d_t of a month with d_n days, then the reference CPI is
>
> $$\text{CPI(-2)}\frac{d_t-1}{d_n} + \text{CPI(-3)}\frac{d_n-d_t+1}{d_n}$$
>
> where CPI(-2) and CPI(-3) denote the non-seasonally adjusted U.S. City Average All Items Consumer Price Index for the second and third months prior to the month in which the maturity or issue date falls, respectively."

The lag in the CPI indexing corresponds to release-date delay of this information, and basically embeds a two-and-a-half month lag in TIPS. So for short-run issuances, this lag means that part of the break-even inflation rates will be based on realized inflation, not just inflation expectations. Examining longer-term forward inflation compensations remedies this problem.

Moving on to modelling the zero-coupon term structures of nominal and inflation-indexed bonds, Gürkaynak et al. (2008) first define the prices of these securities as $P_t^{nom}(n)$ and $P_t^{real}(n)$. Continuously compounded yields are represented as $y_t^{nom}(n) = -\ln(P_t^{nom}(n))/n$ and $y_t^{real}(n) = -\ln(P_t^{real}(n))/n$. First modelling the yield curves in terms of forward rates, they follow a functional form outlined by Svensson (1994), an extension of the Nelson-Siegel (1987) framework. Specifically, where $f_t(n)$ denotes an instantaneous forward rate in n periods, they model for nominal and real yields:

$$f_t(n) = \beta_0 + \beta_1 exp(-\frac{n}{\tau_1}) + \beta_2(\frac{n}{\tau_1})exp(-\frac{n}{\tau_1}) + \beta_3(\frac{n}{\tau_2})exp(-\frac{n}{\tau_2}) \tag{1.1}$$

Integrating (1), they find that zero-coupon yields follow:

$$\begin{aligned} y_t(n) = \beta_0 + \beta_1\frac{1-exp(-\frac{n}{\tau_1})}{\frac{n}{\tau_1}} &+ \beta_2\left[\frac{1-exp(-\frac{n}{\tau_1})}{\frac{n}{\tau_1}} - exp(-\frac{n}{\tau_1})\right] \\ &+\beta_3\left[\frac{1-exp(-\frac{n}{\tau_2})}{\frac{n}{\tau_2}} - exp(-\frac{n}{\tau_2})\right] \end{aligned} \tag{1.2}$$

This specification allows well-defined end points with the possibility of two humps between them (which the authors find is an important provision), whereas a simple Nelson-Siegel

(1987) form without the Svensson (1994) extension only allows one hump. Additionally, Gürkaynak et al. (2008) point out that the Svensson (1994) specification smooths through potential short-term seasonality effects of CPI on TIPS and is quite successful at fitting the TIPS market.

Gürkaynak et al. (2008) provide detailed updates of zero-coupon TIPS yields and forward rates, as well as break-even and forward inflation compensation rates online at

[http://www.federalreserve.gov/econresdata/researchdata.htm].

Using their data, Figure 1.3 illustrates term structures of zero-coupon and forward yields for nominal, TIPS, and and break-even inflation rates on December 31, 2008, as well as indicating zero-coupon and forward inflation compensation on the same date. The nominal zero-coupon yield curve exhibits normal upward-sloping convexity, while zero-coupon TIPS are characterized by an inverted yield curve on this data. Zero-coupon inflation compensations evolve according to a standard upward-sloping convex curve. Nominal forward rates are upward-sloping until about the nine-year point, then decereas through the twenty-year maturity. Forward rates of TIPS yields are upward-sloping until about the twelve-year point, then level off or decrease through the twenty-year maturity. Break-even inflation forward rates are upward sloping until about the ten-year point, then decrease through the twenty-year maturity.

Figure 1.4 provides a historical view of five and ten year zero-coupon nominal yields and forward rates from 1999-2008. Nominal five-year zero-coupon yields fall through around 2003, rebounding until early 2007, then falling through the end of 2008. Ten-year zero-coupon yields are more stable, falling from 2000 to 2003, but generally holding steady until late 2007. Five and ten-year forward rates show drops from 2000-2005, then a levelling off until mid 2008.

Additionally, Figure 1.5 shows the evolution of five and ten year zero-coupon TIPS yields and forward rates. As can be seen, five and ten year zero-coupon TIPS yields fall steadily from 2000-2005, rebounding slightly from 2005-2007, and then become very volatile from 2007-2009. Five and ten year forward rates experience similar directional trends, but move over smaller ranges.

Finally, Figure 1.6 shows the evolution of inflation compensations, both zero-coupon and forward rates at five and ten year horizons. Note that all measures appear to be consistently higher from 2004-2007 than from 1999-2003, presumably owing, at least in part, to the improved liquidity in the TIPS market as seen in Figure 1.2. Recent turmoil increases volatility and drives down inflation compensations, with five year zero-coupon yields even becoming negative.

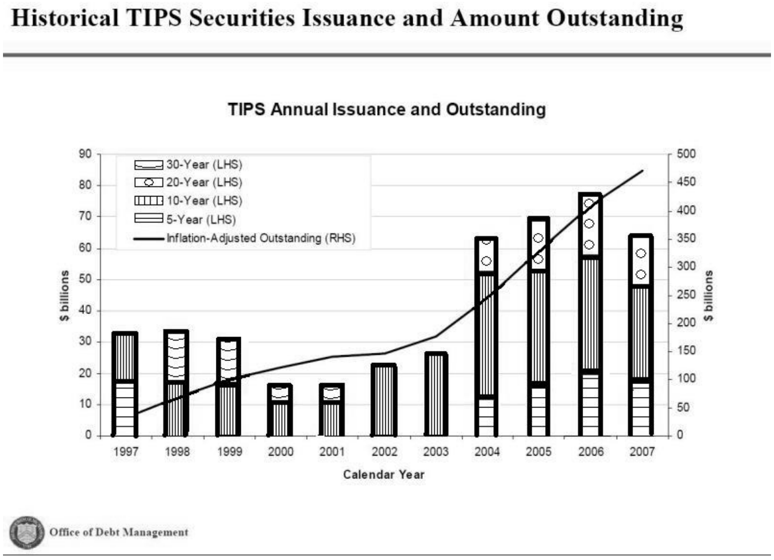


Figure 1.1: Historical TIPS Issuances

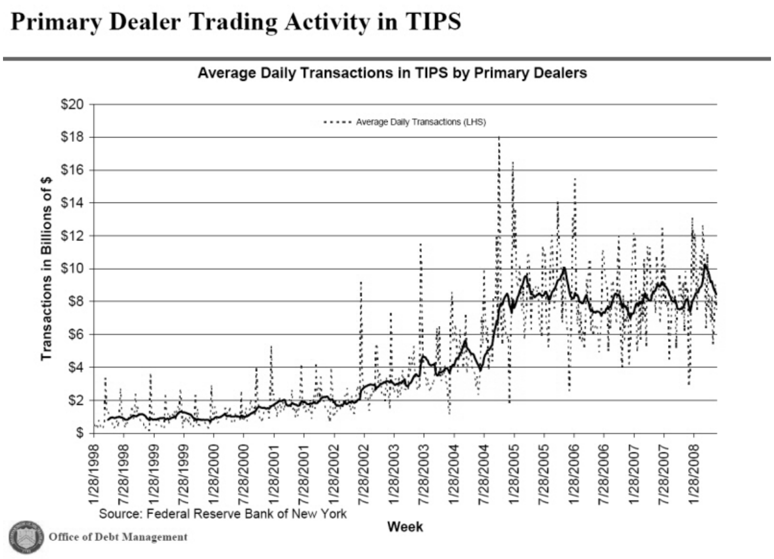


Figure 1.2: Primary Dealer Trading Activity in TIPS

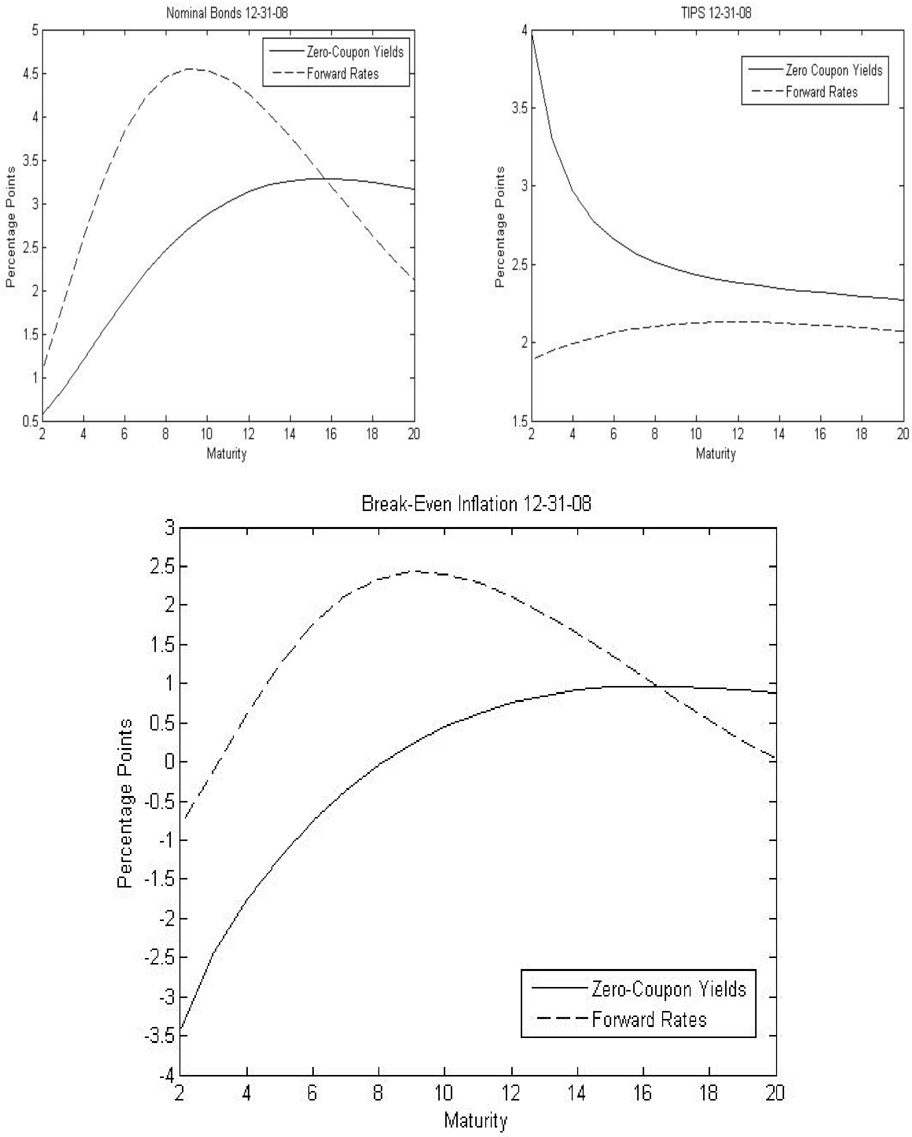


Figure 1.3: Zero-Coupon and Forward Rates on December 31, 2008

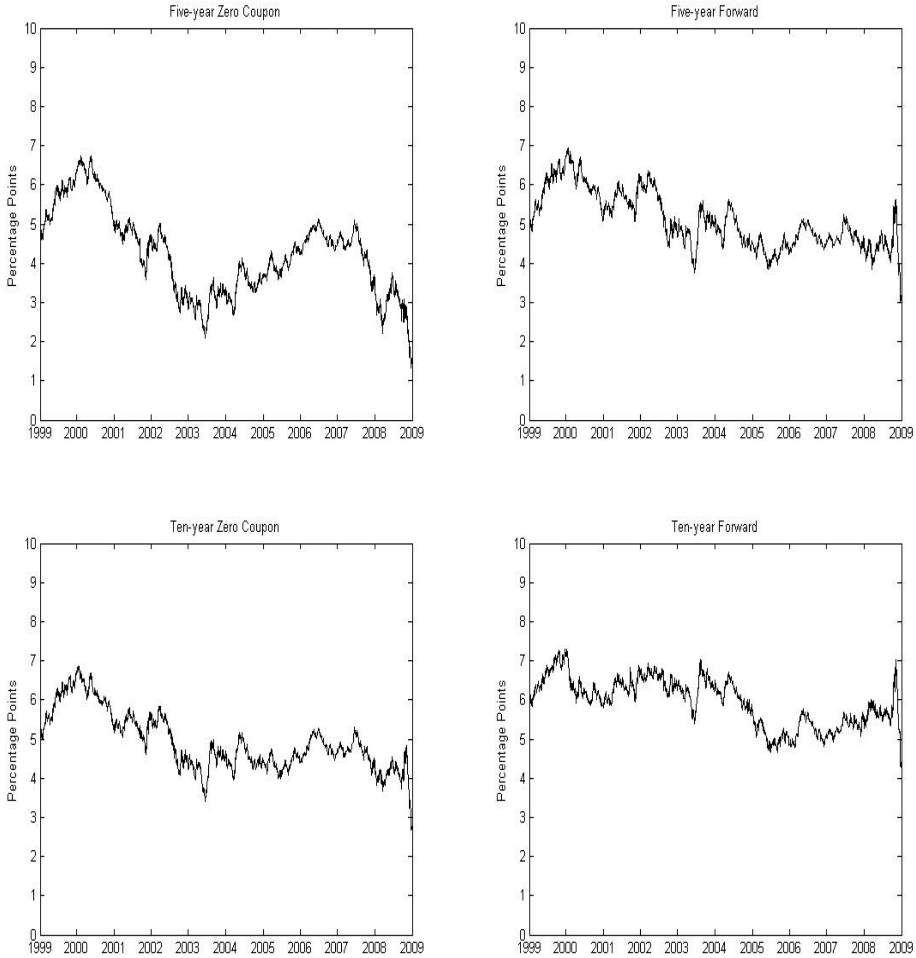


Figure 1.4: Nominal Yields

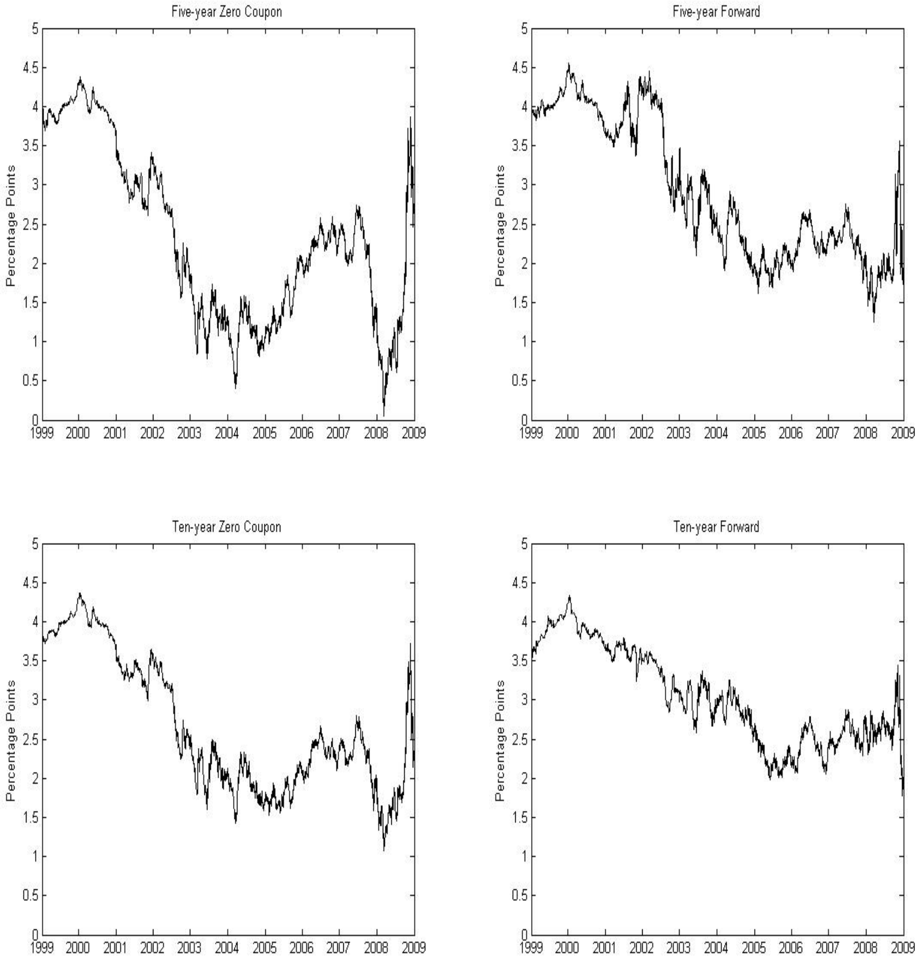


Figure 1.5: TIPS Yields

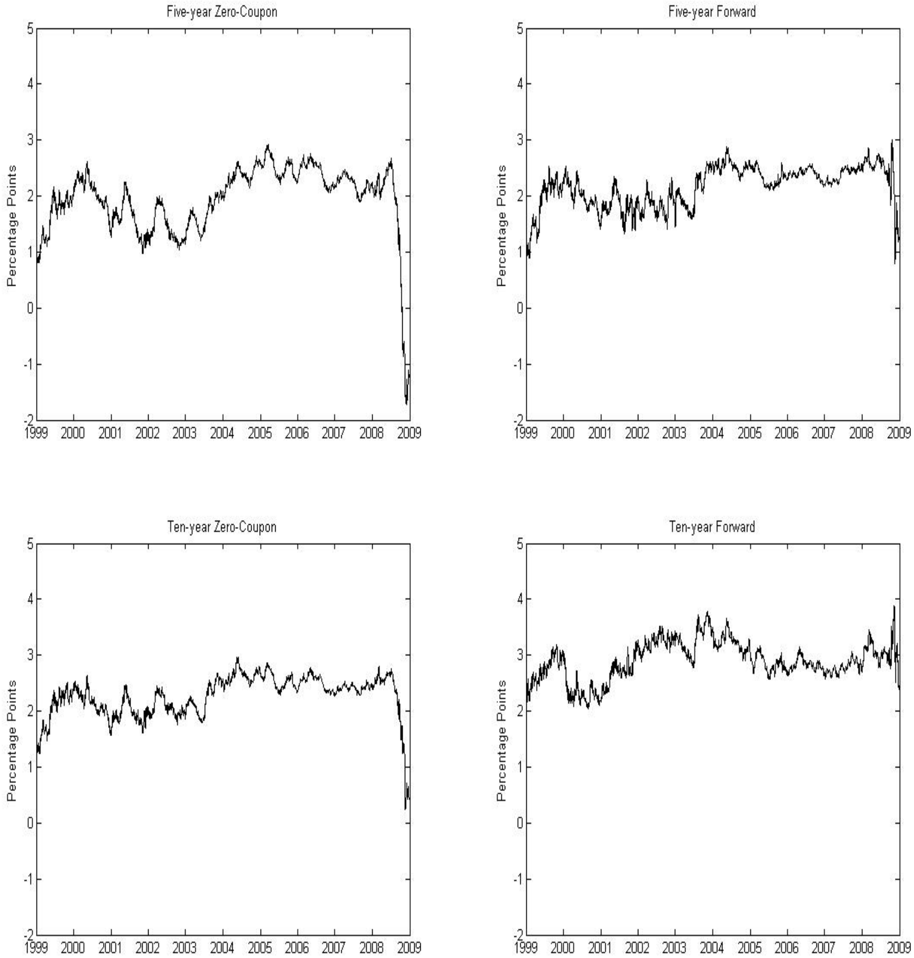


Figure 1.6: Inflation Compensation

Chapter 2

Literature Review

My first goal is to examine reactions of nominal, real, and break-even inflation rates to macroeconomic announcements, accounting for three types of asymmetry: state, sign, and proportion. I also study movements in stock prices and the stock-bond correlation in response to these announcements. This section provides a review of literature relevant to these pursuits, detailing important issues I encounter. Specifically, I review estimates of the magnitude and time-variability of the inflation risk premium while documenting and describing three types of asymmetry commonly discussed in economic literature. Additionally, I provide a survey of prior work studying the effect of macroeconomic announcements on nominal and inflation-indexed securities, and finally I conclude with an examination of factors influencing the stock-bond correlation.

2.1 Inflation Risk Premium

As a reminder, in studying the reaction of break-even inflation rates to macroeconomic announcements, changes in break-even inflation rates can be represented as:

$$\Delta \text{ BEIR} = \Delta \text{ Expected Inflation} + \Delta \text{ Inflation Risk Premium}$$

Since the development of the TIPS market in 1997, a number of authors have attempted to estimate the magnitude and variability of the inflation risk premium with inconsistent results. Some examples include D'Amico et al. (2008) who use a three-factor affine model of nominal rates, real rates, and inflation expectations from 1990-2007 before backing out the inflation risk premium. They find time variability in the inflation risk premium, with the 1 year premium generally ranging from 0-50 basis points and the 10 year premium from 50-100 basis points. Durham (2006) takes a related approach, using forward rates to recover term premia and then inflation risk premia from three-factor affine models of nominal and real rates from 2000 to mid-2006. He finds ten year instantaneous premia to vary from 27 to 105 basis points, averaging 61 basis points and seven year instantaneous premia to vary from -23 to 73 basis points, averaging 13 basis points. Ang et al. (2008) also use a three-factor affine term structure model, but incorporate regime switching from 1952-2004. They find high levels of inflation risk premia in three of four regimes and overall their results indicate variation across time of premia. Chen et al. (2005) use a two-factor model for real rates and inflation from 1998 to 2004, finding the inflation risk premium to exhibit little time variation across a steep term structure, with small premia at short horizons and large (over 130 basis points) premia at longer (ten year) horizons.

Moving away from affine term structure models, Boraschi and Jiltsov (2005) build a structural economic model, accounting for taxes and monetary policy, to solve for inflation risk premia. They find a one month premium of around 15 basis points and a ten year premium of around 70 basis points. These premia vary through time and across the business cycle. Hördahl (2008) models rates and risk premia according to macroeconomic variables (output gap, inflation, monetary policy) from 1999 to mid-2008. Contrary to models discussed above, he finds inflation risk premia are generally stable across time and across maturity. Specifically, the ten year inflation risk premium is small and near zero.

The general lack of consistent methodology and concrete estimates of inflation risk premia impedes my ability to remove the inflation risk premium from break-even inflation rates with any confidence. Additionally, the fact that many studies find evidence of (in some cases extensive) time-variation in risk premia prevents me from assuming that taking daily first differences of break-even inflation rates will only leave changes in inflation expectations. Therefore, in looking at changes in break-even inflation rates, I note that they reflect the sum of changes in inflation expectations and changes in inflation risk premia, but leave further decomposition to future studies.

2.2 Asymmetries Across Announcements and the Business Cycle

Asymmetries in prices and real variables are generally thought of as resulting from upward variable rigidities or learning asymmetries. I define and discuss three types of asymmetry:

1. State Asymmetry: Asymmetry in responses across the business cycle (expansions vs. recessions)

2. Sign Asymmetry: Asymmetry in responses to positive and negative shocks

3. Proportion Asymmetry: Asymmetry in responses to the magnitude of shocks

2.2.1 State Asymmetry

After defining the three types of asymmetry, I focus first on explaining state asymmetries, reviewing three types of business cycle asymmetries considered in the literature. Sichel (1993) introduces the concepts of steepness and deepness, while McQueen and Thorley (1993) define sharpness. Steepness asymmetry refers to the idea that the rates of movement to expansionary peaks and recessionary troughs differ, while deepness asymmetry occurs when peaks and troughs deviate from trend at different magnitudes. Finally, sharpness asymmetry represents the idea that probabilities of transition to and from one state of the economy to another at peaks and troughs are not identical. Clements and Krolzig (2002) summarize these authors' arguments and subsequent findings, mathematically defining the three types of asymmetry as:

1. Steepness: $E[(x_t - \mu_t)^3] \neq 0$

2. Deepness: $E[(\Delta x_t)^3] \neq 0$

3. Sharpness: $p_{m1} \neq p_{mM}$ and $p_{1m} \neq p_{Mm}$

Note: p_{xy} indicates the transition probabilities between states x and y. M is the number of possible states, and $1 < m < M$.
Sichel (1993) finds evidence of deepness in unemployment, industrial production, and (to a lesser extent) GNP, while also seeing steepness present in GNP. McQueen and Thorley

(1993) find that both industrial production and unemployment exhibit sharpness around recessionary troughs and roundness around expansionary peaks.

Chalkley and Lee (1998) hypothesize that business cycle steepness can be explained by agents who are risk-averse in terms of work effort. In their model, agents want to exert high (low) effort in periods of high (low) productivity, but are biased towards selecting low effort if the state probabilities are equal. In this case, when a downturn starts, the belief of impending low productivity causes a domino effect of workers shifting to low effort. However, because of their risk aversion, upswings are more gradual since workers require stronger signals to shift to high effort.

Adding to this steepness argument, Van Nieuwerburgh and Veldkamp (2006) attribute asymmetries across business cycles to differences in learning about true states of macroeconomic indicators. Under this view, periods of high production produce clear economic signals, leading to the immediate recognition of a coming contraction. In contrast, low production in recessions clouds information and signals, implying more gradual recoveries. The authors find evidence of this steepness in output, industrial production, fixed investment, and hours worked.

Ishikawa (2002) also discusses a "learning" argument for explaining asymmetries, arguing that positive technological shocks lead to initial steep and deep declines in real variables due to learning that must occur before their implementation. Otherwise-productive resources must be allocated to the learning process, causing the initial quick and severe downturn. After learning occurs, the new technology is gradually implemented, productivity improves, and an economic recovery occurs gradually. This explanation accounts for both steepness and deepness seen across business cycles.

Gilchrist and Williams (2000) present a model that explains steepness and deepness asymmetries via capacity constraints. In this model, short-run expansionary activity is restrained by these constraints, leading to gradual booms as new productivity and technology are slowly accommodated. Recessionary activity, however, faces no such limitations, leading to steeper and deeper declines in real variables.

2.2.2 Sign Asymmetry

First, examining sign asymmetry, Ball and Mankiw (1994) show that in a positive-trend inflationary environment, firms that want to lower prices can allow inflation to perform some or all of this task rather than paying potentially sizeable menu costs, but firms that need to raise prices must incur these costs. In other words, prices are sticky downwards but flexible upwards (firms immediately raise them upwards when needed, but lag in lowering them). This implies that positive shocks that require upward price movement have zero or minimal real effects, while negative shocks that require downward price movement have non-zero and potentially significant real effects. Additionally, the authors underscore the importance of examining sectoral shocks that imply price increases for some firms and decreases for others. Due to the downward rigidity of prices, the price increases will be felt at a greater magnitude than the decreases, leading to above-trend inflation.

Expounding upon Ball and Mankiw (1994), Cover (1992) provides an argument that downward stickiness and upward flexibility of wages and prices are responsible for sign asymmetries in the responses of prices and output to monetary policy shocks. Increases in the money supply are accommodated with rises in wages, but downward wage rigidity prevents a full accommodation of money supply contractions leading to a reduction in employment and output. Additionally, sticky prices prevent output from responding to positive money supply shocks. Assuming a vertical supply curve at the maximum output level, supply cannot accommodate a positive money supply shock, but a surprise reduction in demand can accommodate a negative money supply shock.

Consistent with Cover's argument, Devereaux and Siu (2007) outline a rationale for why real variables and prices respond to monetary policy differently across types of shocks, finding that real variables respond more to negative money supply shocks than positive shocks. Focusing on marginal costs, they argue that positive money supply shocks (resulting in higher input costs) will be fully accompanied by rises in firm-level prices, leaving real variables unchanged. In a case of near-perfect competition, if a firm raises prices to the new marginal cost level, its profits go to zero. However, if it does not adjust prices while others do, its demand curve becomes the industry-level demand curve and profits become large and negative due to price being beneath marginal costs. This phenomenon generates large incentives for firms to respond to positive marginal cost shocks by raising prices. In the case of falling marginal costs, however, the incentives for full adjustment are not as strong. If a firm lowers its prices to the new marginal cost level, profits go to zero. However, with no adjustment, firm-level demand falls and profits also go to zero. There is less impetus for firms to adjust prices in response to the negative supply shock, leading to greater real effects than for a similarly-sized positive shock.

2.2.3 Proportion Asymmetry

Moving from sign asymmetry to proportion asymmetry, Ravn and Sola (2004) find that menu costs imply large monetary policy shocks are reflected in price adjustments, leaving real variables unchanged, while small monetary policy shocks do not lead to adjustment, thus affecting real variables. The rationale behind this argument is that the size of a shock must be large enough to make the benefits of changing prices outweigh the menu costs involved. It is not hard to generalize this argument to more than just monetary policy shocks, as large implied price movements due to any shock should be realized, while small movements should not.

2.3 Effects of Macroeconomic Announcements on Fixed-Income Markets

Though the literature is relatively young, I provide a brief review of work examining how macroeconomic announcements affect nominal and inflation-indexed securities. Gürkaynak et al. (2006) investigate long-term nominal and inflation-indexed bond forward rates in three countries, contrasting monetary policy regimes. If expected inflation is contained in the spread of nominal minus real yields, movements in expected inflation should be reflected in movements of this spread. Specifically the authors examine how long-run inflation expectations change with macroeconomic announcements or monetary policy changes in countries with varying policy objectives. In Sweden and recently in the U.K., central banks have operated under a strict inflation-targeting regime as opposed to the U.S. which tends to follow a dual mandate of stabilizing inflation and output, similar to the rule outlined by Taylor (1993). The authors find that inflation-targeting countries tend to have more stable long-term yields and forward inflation compensations that are less affected by macroeconomic announcements or short-run monetary policy. Their model takes the form:

$$\Delta y_t = \alpha + \beta X_t + \epsilon_t$$

where y_t represents either a long-term forward rate or forward inflation compensation, and X_t is the set of independent variables which are measured as surprises to macroeconomic announcements, constructed by subtracting the median of a survey of forecasters from the actual announcement realization, then standardizing by the standard deviation of these forecast errors:

$$s_{j,t} = \frac{A_{j,t} - E_{j,t}}{\sigma(A_{j,t} - E_{j,t})}$$

While the literature examining the effect of macroeconomic announcements on inflation compensation and real yields is still evolving, Beechey and Wright (2008) provide further examination of the subject. Using intra-daily data measured at five-minute intervals, they estimate a regression of the form:

$$\Delta y_t(h) = \sum_{j=1}^{J} \beta_j(h) s_{j,t} + \epsilon_t$$

The variable y_t represents forward nominal yields, real yields, or inflation compensation, with 'h' denoting the length in time in minutes after an announcement is made. This time length, 'h' ranges from five to sixty minutes. Note that $s_{j,t}$ is the measure of announcement surprise commonly used in the literature and defined above.

The specification of Beechey and Wright (2008) estimates coefficients on surprise elements of announcements, but ignores all three types of asymmetry (state, sign, proportion). Decomposing changes in nominal rates into real and inflation compensation movements, they find that price surprises significantly affect break-even inflation rates, while real shocks such as GDP impact real rates. Positive (negative) price surprises cause break-even inflation rates to rise (fall) and positive (negative) real shocks cause real rates to rise (fall). Additionally, monetary policy shocks affect both real rates and inflation compensation, as tightening (loosening) causes real rates to rise (fall) and break-even inflation rates to fall (rise). Beechey et al. (2007) conduct similar analysis, using daily data to contrast responses in the United States to the ECB.

Ezer et al. (2008) expand upon the work of Beechey and Wright (2008) by studying the reaction of the term structure of TIPS to macroeconomic surprises. Specifically, they "find that TIPS breakevens respond consistently across the maturity structure to core CPI surprises, employment surprises and to surprises reflected in oil futures." No other surprises produce significant reactions. They run regressions similar to Beechey and Wright (2008), but like these authors they do not estimate positive and negative surprises separately, abstract from possible proportional asymmetries, and do not explicitly consider the cases of expansions and recessions. Interestingly, they do find structural breaks in their results in 2004 and 2008, pointing to the possibility of state-dependent reaction functions.

Finally, they conclude that daily frequency of data on break-even inflation rates is sufficient for capturing appropriate responses.

Although the model of Beechey and Wright (2008) provides an excellent introduction to the study of the effect of macroeconomic announcements on real rates and break-even inflation rates, it does leave room for further study and improvement. Namely, the authors estimate a model in which responses are symmetric around positive and negative surprises, around recessions and expansions, as well as around magnitudes of shocks. However, as outlined earlier, a variety of compelling arguments point to the need for considering all three types of asymmetry.

While Gürkaynak et al. (2006), Beechey and Wright (2008), and Ezer et al. (2008) present studies of the effect of macroeconomic announcements on inflation-adjusted securities, other authors have examined nominal securities in the same context and investigated asymmetric reactions. Andersen et al. (2003) examine the foreign exchange market and find that bad news is more important than good news in moving asset prices. Beber and Brandt (200?) compare the impact of macroeconomic announcements on nominal bond returns and volatility, separating data into expansions and recessions using the XRI-C rubric developed by Stock and Watson (1989). They find specifically that "bad news is what matters in good times and, to a slightly lesser extent, good news is what matters in bad times."

To summarize, my contribution to the literature is to provide an analysis of movements in real rates and break-even inflation rates across three types of asymmetry (state, sign, and proportion).

2.4 Stock-Bond Correlation

Practitioners have an interest in monitoring movements in the correlation between equity and bond prices because this interaction can determine proper portfolio design (Ilmanen 2003). Boyd et al. (2005) and Ilmanen (2003) document three elements that move the stock-bond correlation. First is the discount factor. As nominal rates rise, equity and bond prices fall. Secondly, as expectations of economic growth rise, equity prices rise and bond prices fall. Finally, as equity volatility/risk premium rises, equity prices fall and bond prices rise. This is commonly referred to as "flight to quality" in the literature.

Since a major subset of macroeconomic announcements concerns overall price levels, it is important to consider the effect of inflation on equity and bond prices (and thus yields). The relationship between inflation and equity prices is complex and has received much attention in economics literature throughout history. The original view, outlined by Fisher (1930), stated that equity holdings hedged against inflation risk, thus increasing demand and prices of equities in the face of high inflation. Higher inflation, he argued, would lead to higher overall cash flows and nominal returns, leaving real returns from equities unchanged. However, as outlined in Sharpe (1999), evidence from the late 1970s showed that high inflation negatively impacted stock values. The main rebuttal to the Fisher argument is enumerated by Fama (1981), who introduced the "proxy hypothesis," where increasing inflation predicts a decline in real variables to which the stock market ultimately responds. Specifically, he writes, "money demand theory says that a fall in anticipated real activity lowers the demand for real money, which, given nominal money and the rate of interest, is accommodated by a rise in the price level." Digging deeper, Hess and Lee (1997) decompose economic surprises into supply and demand shocks, categorizing supply shocks as resulting from surprises to real output (e.g. technological innovations) and demand shocks as mostly due to monetary surprises. They find supply shocks move equity prices and inflation in opposite directions, while demand shocks move them in the same direction. In the postwar U.S. the supply effect dominates, leading to an overall negative relationship between equities and inflation, consistent with Fama's (1981) hypothesis. Additionally, to the extent that movements in inflation indicates future expected interest rate movements, this result can be thought of as being consistent with the discount effect.

So, if the "proxy hypothesis" is correct and equity prices are negatively correlated with inflation, what does this imply for the relationship between equities and bonds? Ilmanen (2003) points out that high levels of inflation reduce bond prices due to increasing risk premia and the expectations of higher future discount rates, and thus the correlation between inflation and nominal bond prices is also negative. Combining these results, announcements that move break-even inflation rates should increase the correlation between stocks and nominal bonds. Yang et al. (2009) also show that movements in inflation increase the stock-bond correlation, and Li (2002) shows that as expected inflation becomes less stable stock-bond correlation increases. In terms of the three factors, they find when it comes to inflation the discount rate effect dominates.

In addition to providing information on price levels, macroeconomic announcements also indicate movements of real variables. Boyd et al. (2005) examine the impact of unemployment news on stock-bond correlation, trying to separate information contained in announcements into that on the discount factor, growth factor, and equity premium. In recessionary or expansionary periods, bad news about unemployment ("bad news" meaning higher unemployment than expected) negatively impacts growth expectations with the effect more pronounced in recessions. Additionally, negative employment shocks raise the equity premium in expansions, but do not affect it in recessions. Overall, they find that stocks and bonds respond negatively to unemployment shocks in expansions, while stocks respond positively to unemployment shocks in recessions with bonds remaining unchanged. These findings agree with the discount effect dominating in expansions and the growth effect dominating in recessions and imply that stock-bond correlation increases with news in expansions and decreases with news in contractions.

Additional work studying stock-bond correlation includes Connolly et al. (2007) who show that high levels or first differences of implied volatility in equity markets decrease stock-bond correlation, while low levels or first differences increase stock-bond correlation. This is consistent with a main finding in Ilmanen (2003). Andersen et al. (2007) show that the stock-bond correlation is small and positive in expansions, and large (in absolute value) and negative in recessions. In expansions, stocks respond negatively to real or inflationary shocks. Stocks respond positively to real shocks in recessions, while bonds respond negatively to real or inflationary shocks regardless of the state of the economy. The signs of these correlations are consistent with the findings in Boyd et al. (2005) that the discount effect dominates during expansions while the growth effect dominates during recessions.

My contribution to the literature is to examine movements in correlation for each announcement across states of the economy and across types of news. Comparing these results to those obtained on changes in real rates or break-even inflation rates quantifies whether the announcement's real or inflationary effects are driving the stock-bond correlation.

Chapter 3

Theoretical Model of the Effect of Macroeconomic Announcements on Securities

3.1 Fixed-Income

Initially I estimate a model designed to test the overall effects of surprise macroeconomic announcements, without focusing on asymmetric responses (similar to the analyses conducted by Gürkaynak et al (2006), Beechey and Wright (2008) and Ezer et al (2008)). For each announcement tested, these regressions take the form:

$$y_{t,t-1} = \alpha + \beta X_t + \epsilon_t$$

The left-hand side variable y denotes either instantaneous forward nominal rates, real rates, or the break-even inflation rates implied by the TIPS data and X represents the surprise component of a given macroeconomic announcement. In this specification, if no announcement occurs at time t, $X_t = 0$. Thus 'zero' magnitude surprises are assumed for days where no announcement is made. While this specification has been studied, I replicate its results to provide a base of comparison for my asymmetric model. Data on instantaneous forward rates are available for horizons of 2-20 years, and specifically I examine the horizons of 2, 5, 10, 15, and 20 years.

Incorporating the approaches of Beechey and Wright (2008) and Beber and Brandt

(200?), I first investigate the responses of forward nominal rates, real rates, and break-even inflation rates across maturities where data are present, accounting for asymmetries in sign, state, and proportion. Initially I run two regressions for each announcement considered. The first is a simple linear specification, represented as:

$$\begin{aligned} y_{t,t-1} = \alpha &+ \beta_{Gexp,k,fo}(CFNAI_t)S_{kt}G_{kt} + \beta_{Bexp,k,fo}(CFNAI_t)S_{kt}B_{kt} + \\ &\beta_{Grec,k,fo}(1-CFNAI_t)S_{kt}G_{kt} + \beta_{Brec,k,fo}(1-CFNAI_t)S_{kt}B_{kt} + \epsilon_t \end{aligned} \tag{3.1}$$

The second includes second-order terms according to:

$$\begin{aligned} y_{t,t-1} = \alpha &+ \beta_{Gexp,k,fo}(CFNAI_t)S_{kt}G_{kt} + \beta_{Gexp,k,so}(CFNAI_t)S_{kt}^2G_{kt} + \\ &\beta_{Bexp,k,fo}(CFNAI_t)S_{kt}B_{kt} + \beta_{Bexp,k,so}(CFNAI_t)S_{kt}^2B_{kt} + \\ &\beta_{Grec,k,fo}(1-CFNAI_t)S_{kt}G_{kt} + \beta_{Grec,k,so}(1-CFNAI_t)S_{kt}^2G_{kt} + \\ &\beta_{Brec,k,fo}(1-CFNAI_t)S_{kt}B_{kt} + \beta_{Brec,k,so}(1-CFNAI_t)S_{kt}^2B_{kt} + \epsilon_t \end{aligned} \tag{3.2}$$

which is based loosely on equation (3) of Beber and Brandt (200?). Note that $y_{t,t-1}$ represents either the real rate or the break-even inflation rate from time t-1 to time t, $CFNAI_t$ is the probability of the economy being in an expansion at time t using the Chicago Fed National Activity Index, G and B are dummy variables representing whether an announcement is good or bad news, and subscripts 'fo' and 'so' indicate coefficients on first-order or second-order terms, respectively. S_{kt} is taken as a measure of surprise of announcement k at time t, defined throughout the literature and this paper, and rooted in Balduzzi et al. (2001). Similar to my earlier analysis, I run these regressions for instantaneous forward nominal, real, and break-even inflation rates of maturities 2, 5, 10, 15, and 20 years. After analyzing individual announcements, I select those which show the most significance and run a combined regression including all of these variables as a robustness check.

The specifications in 3.1 and 3.2 address sign, proportion, and state asymmetry. I test sign asymmetry by examining whether the varying coefficients for the type (good or bad) of news are equal. If good and bad news have equal effects (no asymmetry), then the magnitude of all corresponding β_G and β_B terms should be statistically indistinguishable. The CFNAI terms account for the possible presence of state asymmetry. If no state asymmetry is present, the coefficients β_{exp} and β_{rec} should be statistically indistinguishable. Finally, the inclusion of quadratic surprise terms in 3.2 allows me to test for proportion asymmetry. Under the hypothesis that small surprises have greater real effects than large surprises (firms only find it profitable to incur menu costs to adjust prices to large shocks), coefficients on the quadratic terms should be non-zero. If no proportion asymmetry is present, the quadratic coefficients should be statistically indistinguishable from zero.

If my results are consistent with Beechey and Wright (2008), Ravn and Sola (2004), and Beber and Brandt (200?), I expect to see the following:

1. Surprises to price variables move inflation compensation, with the most significant results occurring for negative surprises in expansions and positive surprises in recessions.

2. Surprises to real variables move real rates, with the most significant results occurring for small negative surprises in expansions and small positive surprises in recessions.

In terms of the variables in our model, I can form the following hypotheses (note that the bad news is naturally negatively signed, so a positive coefficient implies bad news lowers rates):

1. $\beta_{Gexp,k,fo} > 0$

2. $\beta_{Grec,k,fo} > 0$

3. $\beta_{Bexp,k,fo} > 0$

4. $\beta_{Brec,k,fo} > 0$

5. $|\beta_{Gexp,k,fo}| < |\beta_{Bexp,k,fo}|$

6. $|\beta_{Grec,k,fo}| > |\beta_{Brec,k,fo}|$

7. $\beta_{Gexp,k,so} < 0$ for real rates

8. $\beta_{Grec,k,so} < 0$ for real rates

9. $\beta_{Bexp,k,so} > 0$ for real rates

10. $\beta_{Brec,k,so} > 0$ for real rates

3.2 Equities

3.2.1 Stock Prices

I perform similar analysis for movements in stock prices as I do for fixed-income security yields. Initially, I run a basic regression that does not account for any types of asymmetry:

$$p_{t,t-1} = \alpha + \beta X_t + \epsilon_t$$

After obtaining these baseline results, I rewrite equations 3.1 and 3.2 in terms of stock prices.

$$\begin{aligned} p_{t,t-1} = \alpha + {} & \beta_{Gexp,k,fo}(CFNAI_t)S_{kt}G_{kt} + \\ & \beta_{Bexp,k,fo}(CFNAI_t)S_{kt}B_{kt} + \\ & \beta_{Grec,k,fo}(1 - CFNAI_t)S_{kt}G_{kt} + \\ & \beta_{Brec,k,fo}(1 - CFNAI_t)S_{kt}B_{kt}\epsilon_t \end{aligned} \tag{3.3}$$

$$\begin{aligned} p_{t,t-1} = \alpha + {} & \beta_{Gexp,k,fo}(CFNAI_t)S_{kt}G_{kt} + \beta_{Gexp,k,so}(CFNAI_t)S_{kt}^2G_{kt} + \\ & \beta_{Bexp,k,fo}(CFNAI_t)S_{kt}B_{kt} + \beta_{Bexp,k,so}(CFNAI_t)S_{kt}^2B_{kt} + \\ & \beta_{Grec,k,fo}(1 - CFNAI_t)S_{kt}G_{kt} + \beta_{Grec,k,so}(1 - CFNAI_t)S_{kt}^2G_{kt} + \\ & \beta_{Brec,k,fo}(1 - CFNAI_t)S_{kt}B_{kt} + \beta_{Brec,k,so}(1 - CFNAI_t)S_{kt}^2B_{kt} + \epsilon_t \end{aligned} \tag{3.4}$$

Assuming the "proxy hypothesis" is correct, I can form the following hypotheses for price variables:

1. $\beta_{Gexp,k,fo} < 0$
2. $\beta_{Grec,k,fo} < 0$
3. $\beta_{Bexp,k,fo} < 0$
4. $\beta_{Brec,k,fo} < 0$

If real variables mainly represent signs of economic growth or information about levels of risk premia, I can form the following hypotheses for real variables:

1. $\beta_{Gexp,k,fo} > 0$
2. $\beta_{Grec,k,fo} > 0$

3. $\beta_{Bexp,k,fo} > 0$

4. $\beta_{Brec,k,fo} > 0$

3.2.2 Stock-Bond Correlation

I model correlation movements in a similar way to the way I model fixed-income yields or stock prices, allowing for state, sign, and proportion asymmetries for each announcement. I model:

$$\begin{aligned} r_{e:t,t-1}r_{b:t,t-1} = \alpha + \beta_{Gexp,fo}(CFNAI_t)S_{kt}G_{kt}\beta_{Bexp,fo}(CFNAI_t)S_{kt}B_{kt}+ \\ \beta_{Grec,fo}(1-CFNAI_t)S_{kt}G_{kt} + \beta_{Brec,k,fo}(1-CFNAI_t)S_{kt}B_{kt} + \epsilon_t \end{aligned} \tag{3.5}$$

$$\begin{aligned} r_{e:t,t-1}r_{b:t,t-1} = \alpha + \beta_{Gexp,fo}(CFNAI_t)S_{kt}G_{kt} + \beta_{Gexp,so}(CFNAI_t)S_{kt}^2G_{kt}+ \\ \beta_{Bexp,fo}(CFNAI_t)S_{kt}B_{kt} + \beta_{Bexp,so}(CFNAI_t)S_{kt}^2B_{kt}+ \quad (3.6) \\ \beta_{Grec,fo}(1-CFNAI_t)S_{kt}G_{kt} + \beta_{Grec,so}(1-CFNAI_t)S_{kt}^2G_{kt}+ \\ \beta_{Brec,k,fo}(1-CFNAI_t)S_{kt}B_{kt} + \beta_{Brec,k,so}(1-CFNAI_t)S_{kt}^2B_{kt} + \epsilon_t \end{aligned}$$

In equation 3.5, $r_{e:t,t-1}$ and $r_{b:t,t-1}$ refer to daily log returns in equity and bond markets, respectively, and their product is a measure of correlation change over time. Macroeconomic announcements that move equity and bond markets in the same direction increase this product, and announcements that move these markets in opposite directions decrease the product. Therefore, equation 3.5 can be used to gauge the effect of macroeconomic surprises on the stock-bond correlation accounting for the state and sign asymmetry, while the inclusion of quadratic terms in equation 3.6 allows me to test for the presence of proportion asymmetry. Comparing these results to those found in the previous sections, I see the relationship between movements in real rates/expected inflation and changes in the stock-bond correlation.

Chapter 4

Data

4.1 Fixed-Income and Equity Markets

In examining how macroeconomic surprises move TIPS yields and break-even inflation rates, I need term structures for these variables. As discussed earlier, Gürkaynak et al. (2008) calculate zero-coupon term structures for TIPS, nominal bonds, and break-even inflation rates, providing daily estimates available at

http://www.federalreserve.gov/econresdata/researchdata.htm.

Due to the relative youth of the TIPS market in the United States, I start my sample at the beginning of 2005 when, according to Figure 2, liquidity began to stabilize. From 1/4/05-12/31/08 I obtain daily first-differences of nominal rates, TIPS rates, and break-even inflation rates to form my dependent variables to regress on surprises to macroeconomic variables.

In examining movements in the stock-bond correlation, I need price returns from equity and bond indices. For equity markets, I use daily log returns on the S & P 500 as reported by the University of Chicago's Center for Research in Security Prices[1]. In examining bond markets, I use daily log returns on a four-week Treasury bond, after obtaining yields from the federal reserve[2].

In order to get price returns on this bond, I extract a crude measure of price as

[1]Source: CRSP, Center for Research in Security Prices. Graduate School of Business, The University of Chicago (2004). Used with permission. All rights reserved. www.crsp.uchicago.edu

[2]http://www.federalreserve.gov/releases/h15/data/Business_ day/H15_ TB_ WK4.txt

follows:

$$P_{4wk,t} = [100 - y_t * \frac{30}{360}]$$

Figures 4.1 and 4.2 show historical stock and bond price returns for the period 2005-2008. As the graphs indicate, stock volatility begins to increase near the end of 2008, while bond volatility picks dramatically around the third quarter of 2007.

4.2 Macroeconomic Announcements

Following Ezer et al. (2008), I study surprises to the following economic variables:

Fed Funds Futures	Durable Goods
Gasoline Futures	Employment
Oil Futures	GDP
Capacity Utilization	Industrial Production
Consumer Confidence	ISM Manufacturing Survey
CPI	Leading Indicators
Core CPI	New Home Sales
PPI	Retail Sales
Core PPI	Unemployment Rate
Employment Cost Index	

Ignoring the futures data momentarily, I obtain survey data on forecasts of all announcements from Bloomberg. For each macroeconomic variable considered, Bloomberg provides specific data on individual forecasts of future realizations, which I then compare to the actual announcement and construct surprise measures using the standardized measure discussed throughout this paper and the literature. Variables are treated such that positive surprises represent “good” news, requiring a reversal on realizations of unemployment shocks. For gasoline and oil futures I use first generic contracts and following Ezer et al. (2008), I treat surprises as non-normalized first differences in daily realizations of futures prices.

Forming surprises to federal funds futures is trickier. Ezer et al.(2008) follow methodology outlined by Kuttner (2001) for dates of rate announcements and reproduced here. The settlement of a monthly federal funds futures contract is for the average fund rate for the given month. So, denoting the spot futures contract on day n as f_n^0, the number

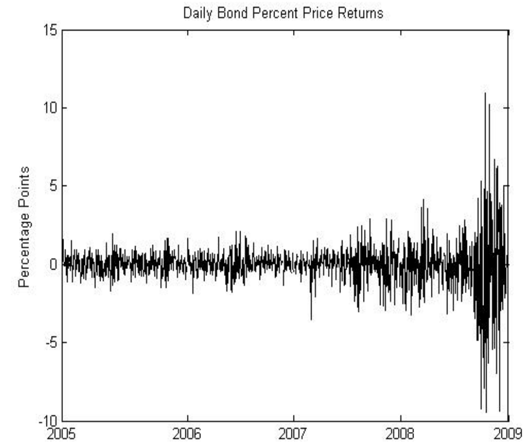


Figure 4.1: Stock Price Returns

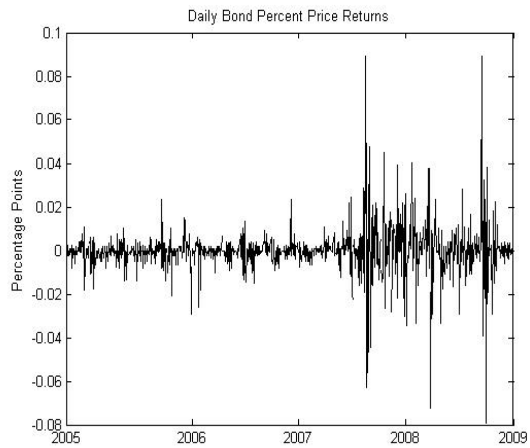


Figure 4.2: Bond Price Returns

of days in the current month as N, and the daily federal funds rate as r, we have [3] :

$$f_n^0 = E_n \frac{1}{N} \sum_{i=1}^{N} r_i + \mu_n$$

where μ_n accounts for deviations of the effective rate from the target rate. Kuttner then backs out a measure of the surprise to the federal funds rate assuming $\mu_n = 0$. Let h_n denote the daily surprise:

$$h_n = \frac{N}{N-n+1}(f_n^0 - f_{n-1}^0)$$

For an announcement on the first day of the month, I use the previous day's month-ahead contract, constructing the surprise as:

$$h_n = \frac{N}{N-n+1}(f_n^0 - f_{n-1}^1)$$

As Kuttner and Hamilton both note, however, this measure is problematic due to potentially non-zero values of μ_n occurring at the end of months. The multiplier term that accounts for the time averaging also scales μ_n, potentially skewing the magnitude of $(f_n^0 - f_{n-1}^0)$ by large amounts as n approaches N. Thus, if there is an announcement within the last 3 days of a given month, I use the change in one-month futures rates:

$$h_n = (f_n^1 - f_{n-1}^1)$$

The dates on which surprises may occur are all scheduled FOMC meetings and unscheduled meetings in which rate changes occur. For a scheduled meeting, even if a rate change does not occur, this news potentially could be a surprise if the market expected rates to move. However, I do not include unscheduled meetings in which rates do not move, as no movement was anticipated for the given day.

I obtain data on fed funds futures and all forecasts from Bloomberg, and all surprises are treated such that positive values indicate good news and negative values indicate bad news. I obtain news of FOMC meetings from the federal reserve [4].

In measuring the state of the economy, I use the Chicago Fed National Activity Index (CFNAI), updated monthly. I run models using monthly realizations of the CFNAI

[3]Notation and equations follow Kuttner (2001) and Hamilton (2008

[4]http://www.federalreserve.gov/monetarypolicy/fomccalendars.htm

as well as three-month moving averages. Evans (2002) provides a summary of the features of the CFNAI. Similar to the XRI-C index constructed by Stock and Watson (1989) but subsequently discontinued, this index uses eighty-five macroeconomic indicators to characterize current states of the economy. The index is formed to have a mean of zero and a standard deviation of one, with the mean representing trend growth. Using the cumulative distribution function of a normal distribution, I obtain expansion probabilities from the CFNAI. This is used in my model to identify any asymmetric effects across states of the economy. Figure 4.3 indicates historical values of the CFNAI index, showing both series of monthly realizations and 3-month moving averages, and Figure 4.4 transforms these values into time-series plots of expansionary probabilities.

Figure ?? graphs movements in macroeconomic variables throughout our sample, plotting survey means as well as their maxima and minima. In each announcement graph, white lines represent actual realizations of variables, green lines represent survey means, blue lines represent the highest survey values, and yellow lines represent the lowest survey values. Finally, Table 4.2 shows monetary policy announcements over the course of our sample.

Table 4.1 contains descriptions of all variables and forecasts used.

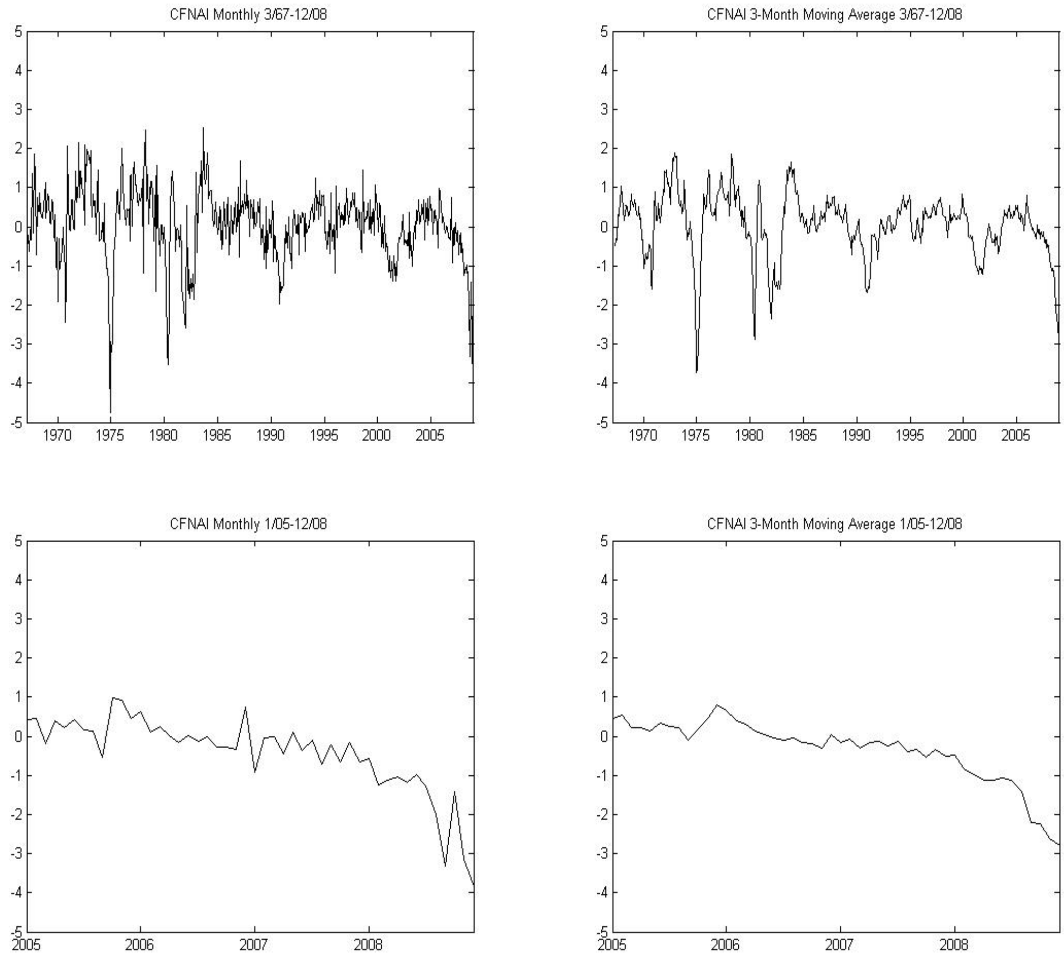


Figure 4.3: Historical CFNAI

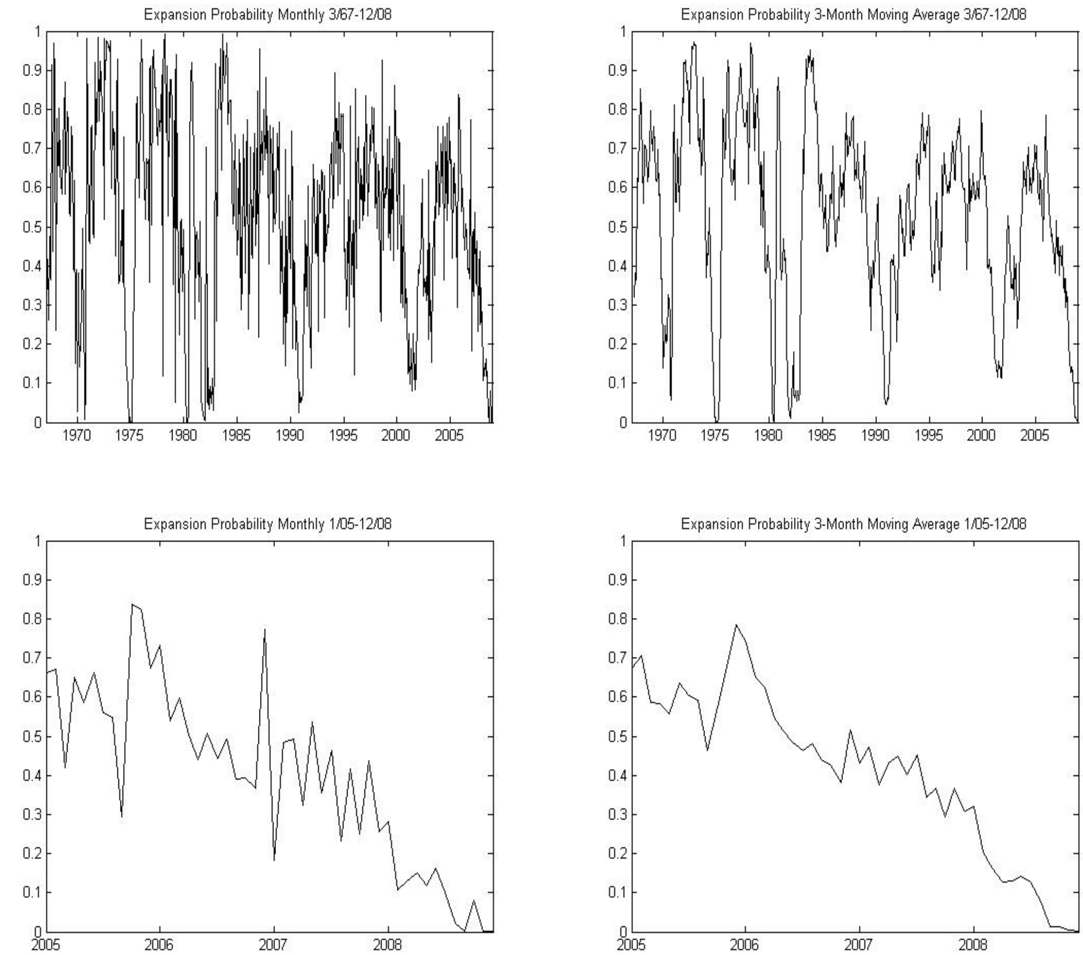
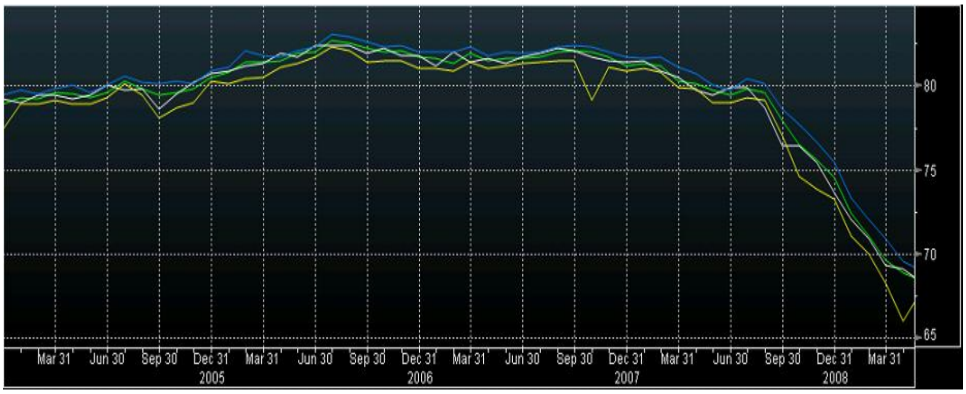


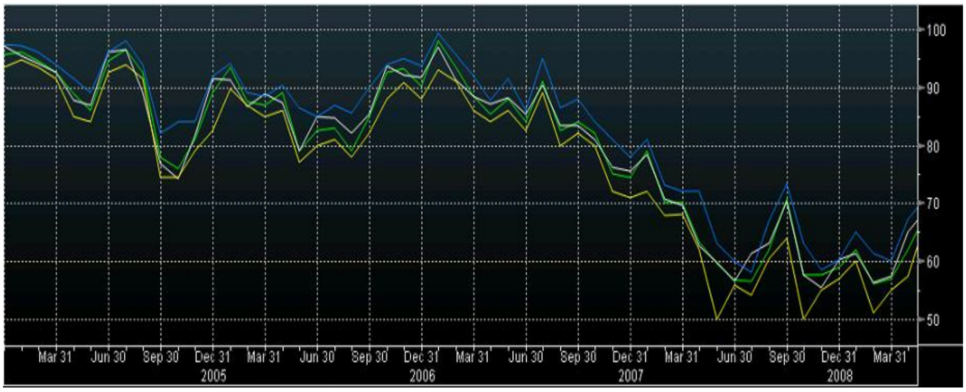
Figure 4.4: Historical Expansion Probabilities

Table 4.1: Data Series Descriptions

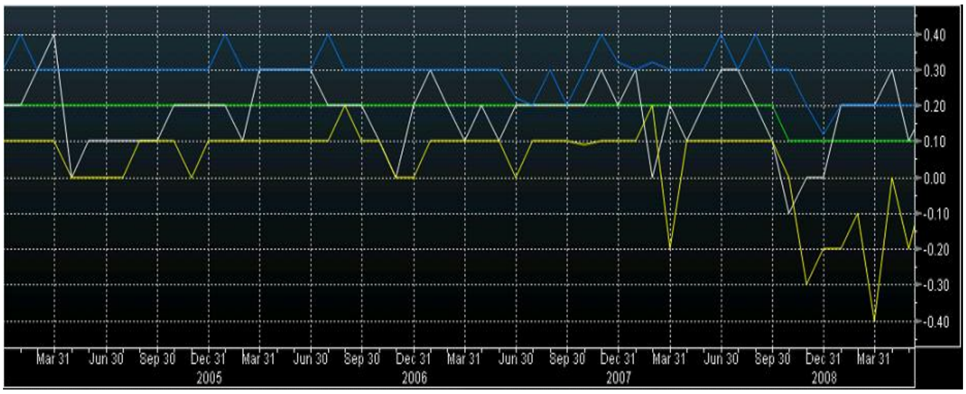
Variable	Description	Frequency	Observations	Average Number of Forecasts
Capacity Utilization	% of Total Capacity SA	Monthly	48	63.08
Consumer Confidence	University of Michigan Survey of Consumer Confidence Sentiment	Biweekly	96	57.63
Core CPI	CPI Urban Consumers Less Food and Energy MoM SA	Monthly	47	73.32
Core PPI	PPI By Processing Stage Finished Goods Except Food and Energy MoM SA	Monthly	48	68.88
CPI	Urban Consumers MoM SA	Monthly	48	74.23
Durable Goods	New Orders Industries MoM SA	Monthly	48	69.52
Employment Cost Index	BLS Employment Cost Civilian Workers QoQ SA	Quarterly	16	51.63
Fed Funds Futures	Futures on Federal Funds Rate	Daily	1005	-
GDP	GDP Chained 2000 Dollars QoQ SAAR	Monthly	48	73.25
Industrial Production	Industrial Production MoM 2002 = 100 SA	Monthly	48	71.27
ISM Manufacturing Survey	ISM Manufacturing PMI SA	Monthly	48	71.25
Leading Indicators	Conference Board Leading Index MoM	Monthly	48	54.77
Natural Gas Futures	Futures on Natural Gas	Daily	1006	-
New Home Sales	New One Family Houses Sold Annual Total SAAR	Monthly	48	64.52
Oil Futures	Futures on Oil	Daily	1007	-
PPI	PPI By Processing Stage Finished Goods Total MoM SA	Monthly	48	71.06
Retail Sales	Adjusted Retail and Food Services Sales SA Total Monthly % Change	Monthly	48	73.46
Unemployment Rate	Unemployment Rate Total in Labor Force SA	Monthly	48	74.48



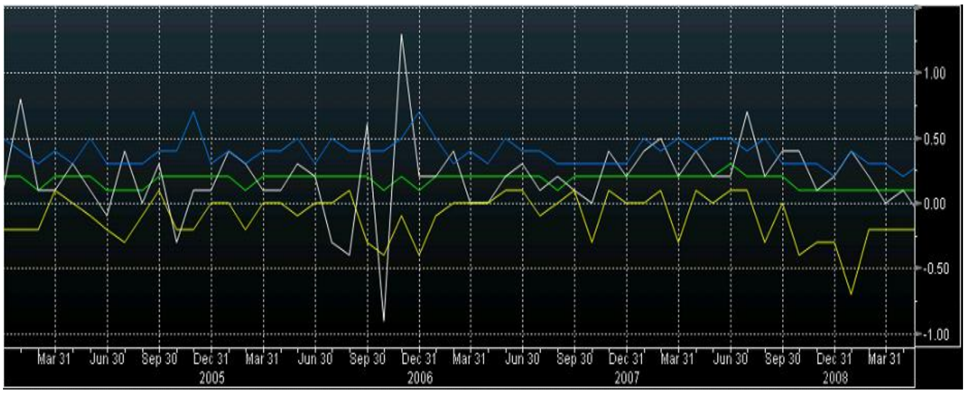
(a) Capacity Utilization



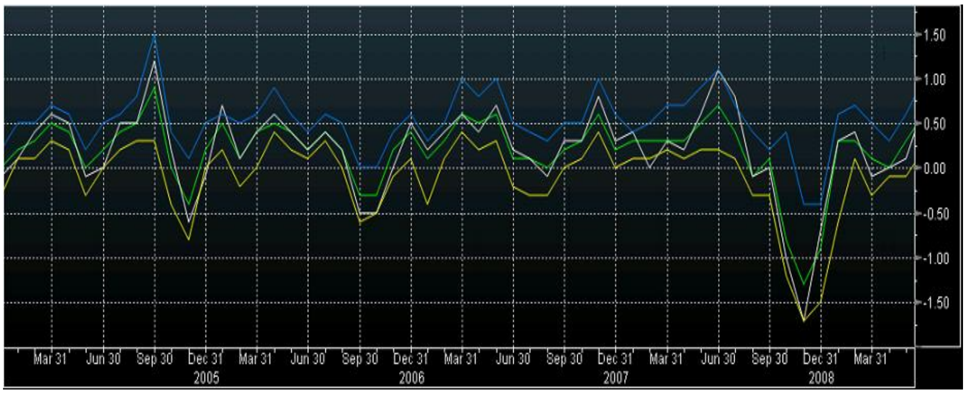
(b) Consumer Confidence



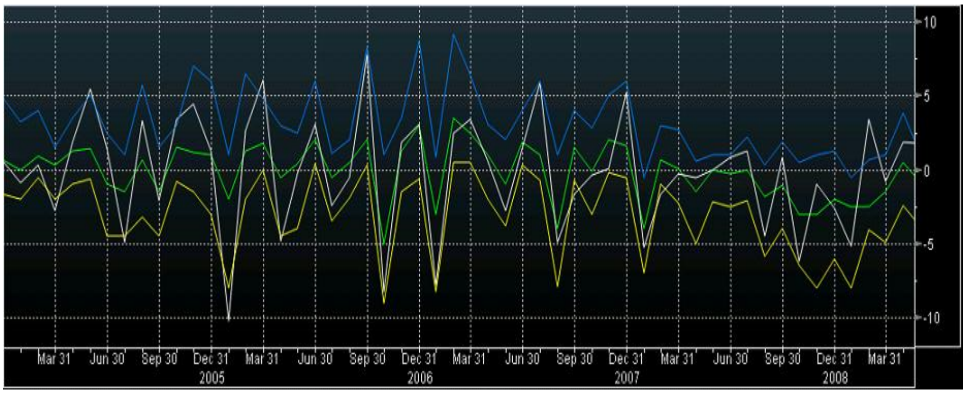
(c) Core CPI



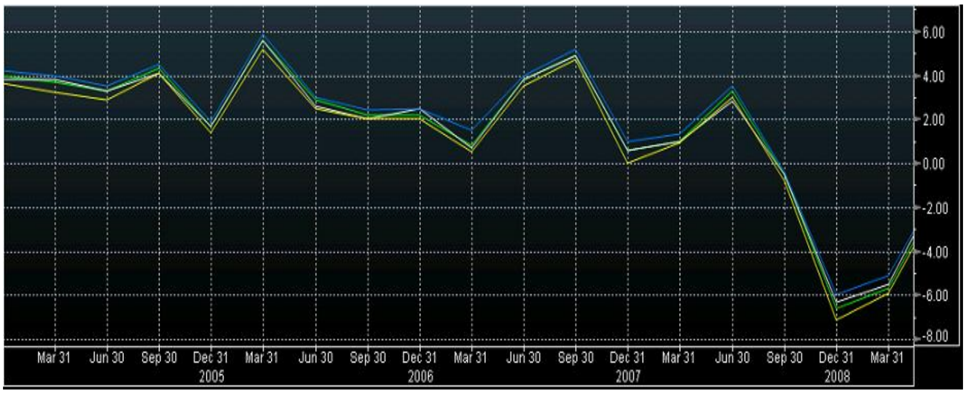
(a) Core PPI



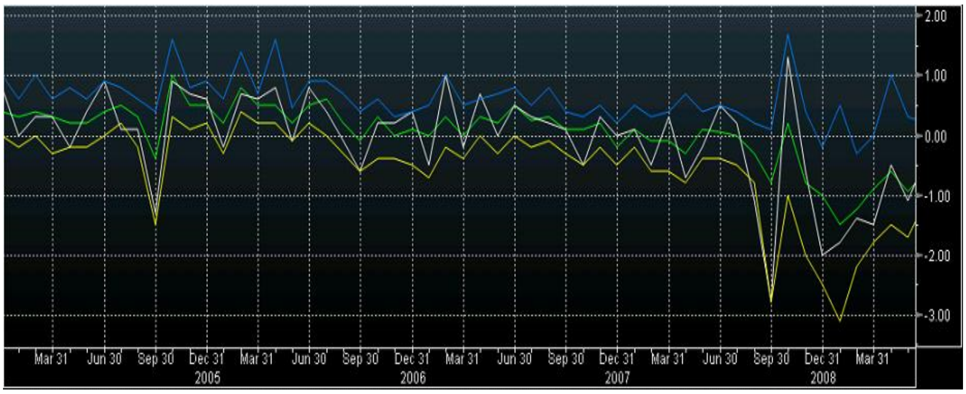
(b) CPI



(c) Durable Goods



(d) GDP



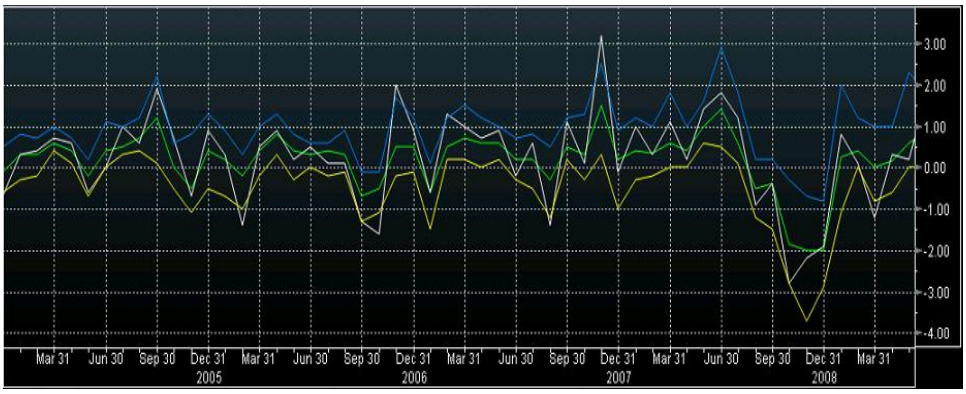
(e) Industrial Production

(f) ISM Manufacturing

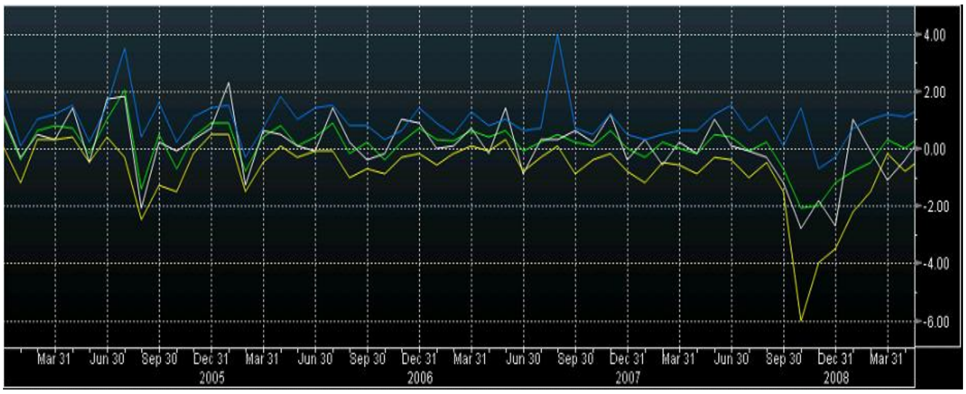
(g) Leading Indicators

(h) New Home Sales

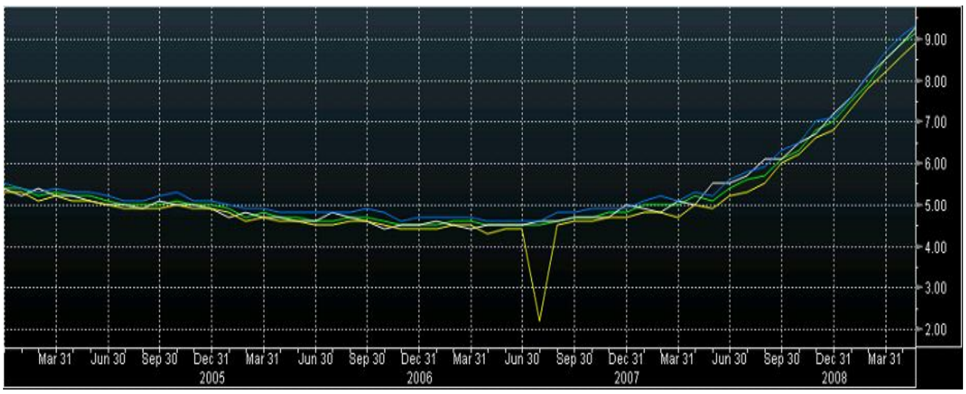
(i) Change in Nonfarm Payrolls



(a) PPI



(b) Retail Sales



(c) Unemployment

Date	Old Target	New Target	Change	Surprise
2/2/2005	2.25	2.50	0.25	0
3/22/2005	2.50	2.75	0.25	0
5/3/2005	2.75	3.00	0.25	0
6/30/2005	3.00	3.25	0.25	0
8/9/2005	3.25	3.50	0.25	0
9/20/2005	3.50	3.75	0.25	-0.0136
11/1/2005	3.75	4.00	0.25	0
12/13/2005	4.00	4.25	0.25	0
1/31/2006	4.25	4.50	0.25	0
3/28/2006	4.50	4.75	0.25	-0.0050
5/10/2006	4.75	5.00	0.25	0.0070
6/29/2006	5.00	5.25	0.25	0.015
8/8/2006	5.25	5.25	0.00	0.0388
9/20/2006	5.25	5.25	0.00	0
10/25/2006	5.25	5.25	0.00	0
12/12/2006	5.25	5.25	0.00	0
1/31/2007	5.25	5.25	0.00	0
3/21/2007	5.25	5.25	0.00	0
5/9/2007	5.25	5.25	0.00	0
6/28/2007	5.25	5.25	0.00	0
8/7/2007	5.25	5.25	0.00	-0.0248
9/18/2007	5.25	4.75	-0.5	0.1385
10/31/2007	4.75	4.50	-0.25	0.02
12/11/2007	4.50	4.25	-0.25	-0.0074
1/22/2008	4.25	3.50	-0.75	0.6665
1/30/2008	3.50	2.00	-0.50	0.0950
3/18/2008	3.00	2.25	-0.75	-0.1550
4/30/2008	2.25	2.00	-0.25	0.0550
6/25/2008	2.00	2.00	0.00	0.0250
8/5/2008	2.00	2.00	0.00	0.0057
9/16/2008	2.00	2.00	0.00	-0.0550
10/8/2008	2.00	1.50	-0.50	0.1356
10/29/2008	1.50	1.00	-0.50	0.0600
12/16/2008	1.00	0.00:0.25	(-0.75):(-1.00)	0.1114

Table 4.2: Monetary Policy Announcements

Chapter 5

Results

Initially I run the basic model of Gürkaynak et al (2006), Beechey and Wright (2008), and Ezer et al (2008):

$$y_{t,t-1} = \alpha + \beta X_t + \epsilon_t$$

I examine this specification for nominal, real, and break-even inflation rates, as well as for stock prices and the stock-bond correlation. Tables 5.1, 5.2, 5.3, 5.4, 5.5 document these initial results.

Looking at price variables, core CPI, core PPI, and oil futures are all positively correlated with movements in nominal yields, while core CPI and oil futures are also positively correlated with movements in break-even inflation rates. Price variables, as expected, affect nominal and break-even inflation rates consistently across maturities, but have no effect on real rates. Additionally, oil future movements are positively correlated with stock price returns.

At various horizons, movements in nominal rates are positively correlated with surprises to real variables such as capacity utilization (2 year and 5 year), consumer confidence (5 year), industrial production (2 year), ISM (2 year, 10 year, 15 year), new home sales (10 year), and the unemployment rate (2 year). Additionally, real rate movements are positively correlated with surprises to consumer confidence (5 year, 15 year, 20 year), industrial production (5 year), and ISM (2 year). Results for break-even inflation rates are similarly scattered, exhibiting positive correlations with real variable surprises for capacity utilization (2 year), industrial production (2 year), ISM (10 year), and new home sales (10 year), and showing negative correlations with surprises to consumer confidence (20 year) and ISM (20 year). Finally, changes in the stock-bond correlation co-move positively with capacity utilization and industrial production. In terms of real variables, the most consistent relationships occur for capacity utilization and industrial production, with only scattered results for other variables.

Monetary policy movements affect nominal rates negatively (2 year), real rates positively (20 year), break-even inflation rates positively (20 year), stock prices positively (10 year), and the stock-bond correlation negatively. The sparse and inconsistent results offer little insight into any true effect of monetary policy surprises, though the short-term stock-bond correlation results contradict the traditional discount hypothesis that rate changes increase the stock-bond correlation.

When ignoring potential asymmetries, it appears that movements in price variables have the most significant and consistent affect on rates and returns (excepting real rates, of course). Real variables tend to affect rates and returns sporadically over various maturities, offering little true insight into their overall importance. Similarly, analyzing monetary policy shocks yields little insight.

After establishing my baseline results, I allow for state and sign asymmetry, running regressions of movements in nominal rates, real rates, or break-even inflation rates on macroeconomic surprises according to:

$$\begin{aligned} y_{t,t-1} = \alpha + \beta_{Gexp,k,fo}(CFNAI_t)S_{kt}G_{kt} + \beta_{Bexp,k,fo}(CFNAI_t)S_{kt}B_{kt} + \\ \beta_{Grec,k,fo}(1 - CFNAI_t)S_{kt}G_{kt} + \beta_{Brec,k,fo}(1 - CFNAI_t)S_{kt}B_{kt} + \epsilon_t \end{aligned} \tag{3.1}$$

I also run a similar regression for stock prices and the stock-bond correlation, with the stock-bond correlation regression taking the form:

$$\begin{aligned} r_{e:t,t-1}r_{b:t,t-1} = \alpha + \beta_{Gexp,fo}(CFNAI_t)S_{kt}G_{kt}\beta_{Bexp,fo}(CFNAI_t)S_{kt}B_{kt} + \\ \beta_{Grec,fo}(1 - CFNAI_t)S_{kt}G_{kt} + \beta_{Brec,k,fo}(1 - CFNAI_t)S_{kt}B_{kt} + \epsilon_t \end{aligned} \tag{3.5}$$

Table 5.6 indicates the directions nominal instantaneous forward rates move in response to surprise components of macroeconomic announcements. For horizons of 2, 5, 10, 15, and 20 years, I indicate with a '+', '-', or '0' as to whether instantaneous forward rates rise, fall, or remain unchanged in response to four types of news: good news in expansions, bad news in expansions, good news in recessions, and bad news in recessions. Tables 5.7 and

5.8 provide similar analysis for instantaneous forward TIPS and break-even inflation rates. Additionally, Table 5.10 shows the movement in the correlation between stock prices and the price of a four-week nominal bond.

5.1 Price Variables

The most significant results for price variables (Core CPI, Core PPI, CPI PPI, Oil Futures, Natural Gas Futures) occur for bad news (lower than expected realizations) in recessions. Lower than expected values of price variables such as Core CPI, CPI, or Oil futures generally lower nominal rates from 2-20 year horizons, leave real rates unaffected, lower break-even inflation rates, lower equity prices, and lower the stock-bond correlation. Lower than expected values of PPI in recessions generally do not have any statistically significant effects on rates, though negative shocks to natural gas futures tend to result in lower break-even inflation rates across the selected horizons. The announcement of lower than expected inflation does not affect real rates, but markets expect nominal rates to decline and thus break-even inflation rates fall. The decline in equity prices contradicts the “proxy hypothesis” which predicts that falling inflation signals real variables are about to rise as well as discrediting the discount effect, by which falling interest rates would lead to higher bond and equity prices. Instead, what must be occurring is a “flight to quality” substitution between equities and bonds in the face of higher uncertainty/risk premia during recessions. The decreasing stock-bond correlation lends further support to this conclusion.

Evidence on the effect of good news (higher realizations than expected) in recessions is less strong, with no statistically significant results to report on core CPI, core PPI, or PPI, with the exception that positive shocks to core PPI raise the stock-bond correlation. Higher than expected realizations of PPI raise nominal rates at 10 and 15 year horizons, but have no significant effects on real or break-even inflation rates, stock prices, or the stock-bond correlation. Positive shocks to oil futures raise nominal rates from 5 to 20 year horizons, raise TIPS rates from 10 to 15 year horizons, raise break-even inflation rates from 2 to 5 year horizons, and reduce the stock-bond correlation. Also, positive shocks to natural gas futures only affect real rates and break-even inflation rates, though movement directions differ across time. The limited results are generally consistent with nominal rates rising in the face of higher price news without a statistically significant movement in stock prices.

Statistically significant results are also hard to find for lower price news than expected in expansions. Negative shocks to CPI actually raise 5 year nominal rates, and negative shocks to PPI raise 5 year break-even inflation rates. No other statistically significant results are present at any horizons for these variables, however. Decreases in oil futures prices raise nominal and real rates across time horizons, leaving break-even inflation unchanged. Additionally, in the face of negative expansionary shocks to oil futures, stock prices fall and the stock-bond correlation rises. If oil futures are a good proxy for overall price levels, the stock price movements again contradict the "proxy hypothesis" that lower price levels would signal impending good economic times. The fact that stock and bond prices are moving in the same direction refutes a "flight to quality" argument and instead supports the dominance of the discount effect. Interestingly, though, if oil futures are proxies for overall price levels, we should expect to see rates fall in the face of lower prices, not rise.

Statistically significant results are even harder to find when analyzing positive price shocks in expansions. No announcements provide consistent results across time horizons, though the stock-bond correlation increases in the face of oil futures price rises.

5.2 Real Variables

Once again, the most significant results occur when analyzing negative shocks in recessions. In general, bad news in recessions about real variables (capacity utilization, industrial production, ISM) lowers nominal and real rates with notable exception being news about new home sales which raises both real and nominal rates. Break-even inflation rates tend to fall, implying that the drop in nominal rates outpaces the drop in real rates. Stock prices are generally unaffected, though do fall with bad news about retail sales, while the stock-bond correlation falls following bad news about real variables capacity utilization and industrial production. The discount effect cannot be dominant, as it would predict a rise in equity prices following nominal rate decreases. Two factors are possibly at work. First, as in the case of the effects of bad news about price variables, a "flight to quality" effect could be occurring in which, due to increased risk premia, investors shift from stocks to bonds. Additionally, downward revisions of growth expectations could be driving equity prices and bond prices in different directions.

When examining the effect of positive shocks to real variables in recessions, consistent results emerge that higher than expected announcements of real variables tend to raise nominal and real rates (for statistically significant movements), with the strongest results occurring for consumer confidence and employment cost index announcements. The only announcement which statistically moves equities is for leading indicators, which raises stock prices and reduces the stock-bond correlation. These results are consistent with either a growth effect or a "flight to quality" effect dominating in this situation. Positive shocks to real variables could increase forecasts of economic growth, leading to higher nominal and real rates, as well as higher stock prices. Additionally, the good news could reduce risk premia, inducing a shift from bonds to equities.

The effects of negative shocks to real variables in expansions are less clear, with only some occasionally significant results. Negative shocks to capacity utilization raise 2 year nominal rates and increase the stock-bond correlation. Consumer confidence shocks mostly raise real rates, lower break-even inflation rates, and have no effect on stocks or the stock-bond correlation. Lower than expected reports on industrial production raise nominal and break-even inflation rates at a 2 year horizon, as well as increasing the stock-bond correlation. Negative shocks to leading indicators raise nominal and break-even inflation rates from 10 to 15 year horizons, but do not affect equities. Bad news about new home sales lowers both nominal and real 2 year rates without moving equities. Lower than expected numbers on retail sales lower 10 year real rates and raise equity prices. The overall results for bad news in expansions are generally lacking in consistency, though the fact that the few results present point to rising rates in the face of bad news is not intuitive.

Similar to the lacking results for the effects of bad news in expansions, little conclusive evidence is present on the effects of good news in expansions. Good news about ISM raises nominal rates at 2 and 10 year horizons, raises real rates at a 10 year horizon, raises 2 year break-even inflation and lowers 20 year break-even inflation rates. Long-term nominal rates fall in response to good news about unemployment, while better than expected news about the employment cost index tends to decrease nominal and/or real rates at horizons of at least 5 years, with break-even inflation rates rising. Additionally, good news about leading indicators drops stock prices and increases the stock-bond correlation. While the results for ISM support the common view of rates rising in the face of good news, the results for unemployment and the employment cost index are counterintuitive.

5.3 Monetary Policy

Reactions of rates to federal funds futures surprises are mixed. Nominal rates show no consistent movements, while real rates fall at 2 and 5 year horizons for higher than expected news in expansions and rise at a 2 year horizon for higher than expected news in recessions. Finally, break-even inflation rates rise at 15 year horizon after good news in expansions, rise at 2 and 5 year horizons after bad news in expansions, and fall at a 15 year horizon after good news in recessions. These inconsistent results leave me unable to form any conclusions about the role of monetary policy in moving nominal, real, and break-even inflation rates.

5.4 Asymmetries

The first-order results underscore the need to test for asymmetries in the responses of nominal, real, and break-even inflation rates to macroeconomic surprises. Recessionary shocks appear to affect rates and equities through either an economic growth or a "flight to quality" mechanism, while limited evidence in expansions points to the prominence of a discount effect which moves equity and fixed-income prices in the same direction.

5.4.1 State Asymmetry

To test for state asymmetry, I perform the following hypothesis tests (note that the tests on the coefficients on bad news take into account that the same signs on good and bad news coefficient imply different directional movements for the left-hand side variable):

1. $\beta_{Gexp} - \beta_{Grec} = 0$

2. $-1 * \beta_{Bexp} + \beta_{Brec} = 0$

Price Variables

Good News

Low evidence points to state asymmetry for higher than expected realizations of price variables (core CPI, core PPI, CPI, PPI, oil futures, natural gas futures). However, PPI shows evidence of state asymmetry for higher than expected realizations at the 10 and 15 year horizons, with rates rising more in recessions than expansions, and natural gas futures exhibit state asymmetry in TIPS and break-even inflation rates at 15 and 20 year horizons, with real (break-even inflation) rates rising more (less) in recessions than expansions. Additionally, the stock-bond correlation rises more following good news about oil futures in expansions than recessions.

Bad News

Table 5.11 indicates the extent of state asymmetry in price variables. Moderate results are present that at various points along the instantaneous forward nominal yield curve state asymmetry occurs for reactions to lower than expected news about core CPI, CPI, oil futures, and natural gas futures. Rates tend to fall more with negative shocks in recessions than expansions. Lower than expected oil futures prices show state asymmetry in TIPS rates at various horizons, with rates falling more in recessions than expansions. Additionally, negative shocks to CPI and natural gas futures appear to exhibit similar state asymmetry for break-even inflation rates, as rates drop more in recessions than expansions. Oil and natural gas futures both induce asymmetric reactions in stock prices, with prices falling more in recessions than expansions. Additionally, for oil futures, the stock-bond correlation falls more in recessions than expansions.

Real Variables

Good News

For the most part, the state asymmetry present, while lacking in consistency across horizons, points to higher than expected realizations of variables (consumer confidence, employment cost index, industrial production, and the unemployment rate) raising nominal rates more in recessions than expansions. Additionally, real rates also rise more in recessions than expansions for some variables(consumer confidence, employment cost index). Break-even inflation rates rise at various horizons more in recessions than expansions for consumer confidence (20 year), employment cost index (5 and 20 year), ISM (2 year), New Home Sales (2 and 15 year), while rising more in expansions than recessions for the unemployment rate (10 year). Leading indicators exhibit state asymmetry for movements in stock prices and the stock-bond correlation, with positive shocks raising prices more in recessions than expansions (though they actually decrease in expansions) and decreasing the stock-bond correlation less in expansions than recessions. In general, the state asymmetry present for higher than expected realizations of variables points to more significant reactions in recessions than expansions.

Bad News

The state asymmetry present for lower than expected realizations of real variables points to greater drops in nominal rates in recessions than expansions for capacity utilization (2 year), industrial production (2 and 5 year), ISM (15 and 20 year), and leading indicators (10 and 15 year). Additionally real rates drop more in recessions for negative shocks to capacity utilization (5 year), consumer confidence (5 year), industrial production (5 year), while dropping more in expansions to negative shocks to new home sales (2 year) and retail sales (10 year). The implications for asymmetry in break-even inflation rates are unclear. Results indicate greater responses in recessions for capacity utilization (2 year), durable goods (15 year), industrial production (2 year), and leading indicators (5-20 year), and greater responses in expansions for consumer confidence (5, 15, 20 year) and industrial production (10 year). Despite the mixed results for real and break-even inflation rates, the evidence present suggests that lower than expected announcements affect nominal rates more in recessions than expansions. Examining equities, negative shocks to retail sales lower stock prices more in recessions than expansions and negative shocks to industrial production lower the stock-bond correlation more in recessions than expansions.

Monetary Policy

The overall results for the effects of surprises to federal funds futures on rates across states are mixed, as are the results for testing for asymmetry.

Good News

Higher than expected federal funds futures prices raise nominal rates more in recessions at 2 and 5 year horizons, while raising nominal rates more in expansions for 20 year horizons. Real rates rise more in recessions at a 2 year horizon and break-even inflation rates rise more in expansions at 15 year horizons.

Bad News

Nominal and real rates exhibit no state asymmetry in response to lower than expected realization of federal funds futures prices, though break-even inflation rates falls more in recessions/ rises less in expansions.

Summary

While little evidence is present for state asymmetry in responses to positive shocks to price variables, consistent moderate results indicate state asymmetry for negative shocks to price variables, with greater reactions occurring in recessions than expansions. Unlike in the case positive shocks to price variables, some evidence is present that higher than expected realizations of real variables tend to have greater effects in recessions than expansions. Additionally, negative shocks to real variables also appear to have greater effects in recessions than expansions. Overall, the results suggest that, in general, markets respond more to news (bad or good) in recessions than expansions.

5.4.2 Sign Asymmetry

In addition to state asymmetry, sign asymmetry may be present, with the magnitude of effects due to good or bad shocks differing. Under the assumption that good news and bad news move variables in opposite directions, I test for sign asymmetry:

1. $|\beta_{Gexp}| - |\beta_{Bexp}| = 0$
2. $|\beta_{Grec}| - |\beta_{Brec}| = 0$

Price Variables

Expansions

For the most part, price variables (core CPI, core PPI, CPI, PPI, oil futures, natural gas futures) show no sign asymmetry in expansions. The only exception is that negative shocks to oil futures in expansions affect nominal rates more than positive shocks at 2, 15, and 20 year horizons.

Recessions

Just as in expansions, strong and consistent evidence is lacking that price variables exhibit sign asymmetry in recessions. Lower than expected realizations of core PPI and CPI affect nominal rates more that higher values at 5 year horizons and lower than expected realizations of CPI (2 year), oil futures (5 year), and natural gas futures (2 year) affect break-even inflation rates more than higher than expected news. Finally, lower oil futures prices affect stock prices more than higher prices in recessions.

Real Variables

Expansions

In expansions, good news about the employment cost index affects nominal rates more than bad news at 10 and 15 year horizons, with similar results holding for real rates at 5-20 year horizons and break-even inflation rates at 5 and 20 year horizons. Sign asymmetry is also present in break-even inflation rates for consumer confidence (5 and 15 year) and leading indicators (10 year) with bad news having greater effects than good news. Additionally, bad news about capacity utilization and industrial production moves the stock-bond correlation more than good news about these variables. Overall, the only significant, consistent results point to sign asymmetry in responses to the employment cost index, with good news being more important than bad news.

Recessions

In recessions, once again sign asymmetry is present in the employment cost index, with good news more important than bad in moving nominal rates (10 and 15 year), real rates (5-20 year), and break-even inflation rates (5 and 20 year). Additionally, good news about the unemployment rate is more important than bad news in moving nominal rates (2 and 10 year), bad news about capacity utilization is more important than good news in moving nominal and break-even inflation rates (2 year), and bad news about industrial production has greater impact than good news on nominal rates (2 year), break-even inflation rates (2 year), and the stock-bond correlation. Bad news about capacity utilization and good news about leading indicators have more effect on the stock-bond correlation than their counterparts. Real rates and break-even inflation rates respond more to bad news on consumer confidence (5 and 20 year), while bad news on leading indicators (10 and 15 year) and good news on new home sales (2 year) affect break-even inflation rates more than their counterparts. These results do not offer strong, noticeable patterns, with the exception that responses to the employment cost index continue to exhibit sign asymmetry.

Monetary Policy

The only sign asymmetry in response to federal funds futures occurs with reactions to break-even inflation rates, with lower values more important than higher values.

Summary

Unlike in the case of state asymmetry, little evidence is present to point to consistent sign asymmetry. One exception is for the responses to the real variable employment cost index, as good news has more significant effects than bad news.

Table 5.1: Correlation Between Surprises and Nominal Rates with no Asymmetries

Announcement	2y	5y	10y	15y	20y
Capacity Utilization	+	+	0	0	0
Consumer Confidence	0	+	0	0	0
Core CPI	+	+	+	+	0
Core PPI	0	+	+	+	0
CPI	0	0	0	0	0
Durable Goods	0	0	0	0	0
Employment Cost Index	0	0	0	0	0
GDP	0	0	0	0	0
Industrial Production	+	0	0	0	0
ISM	+	0	+	+	0
Leading Indicators	0	0	0	0	0
New Home Sales	0	0	+	0	0
PPI	0	0	0	0	0
Retail Sales	0	0	0	0	0
Unemployment Rate	+	0	0	0	0
Fed Funds Rate	-	0	0	0	0
Oil Futures	+	+	+	+	+
Natural Gas Futures	0	0	0	0	0

Table 5.2: Correlation Between Surprises and TIPS Rates with no Asymmetries

Announcement	2y	5y	10y	15y	20y
Capacity Utilization	0	0	0	0	0
Consumer Confidence	0	+	0	+	+
Core CPI	0	0	0	0	0
Core PPI	0	0	0	0	0
CPI	0	0	0	0	0
Durable Goods	0	0	0	0	0
Employment Cost Index	0	0	0	0	0
GDP	0	0	0	0	0
Industrial Production	0	+	0	0	0
ISM	+	0	0	0	0
Leading Indicators	0	0	0	0	0
New Home Sales	0	0	0	0	0
PPI	0	0	0	0	0
Retail Sales	0	0	0	0	0
Unemployment Rate	0	0	0	0	0
Fed Funds Rate	0	0	0	0	+
Oil Futures	-	0	+	0	0
Natural Gas Futures	-	0	0	0	0

Table 5.3: Correlation Between Surprises and Break-Even Inflation Rates with no Asymmetries

Announcement	2y	5y	10y	15y	20y
Capacity Utilization	+	0	0	0	0
Consumer Confidence	0	0	0	0	-
Core CPI	+	+	+	+	0
Core PPI	0	0	0	0	0
CPI	+	0	0	0	0
Durable Goods	0	0	0	0	0
Employment Cost Index	0	0	0	0	0
GDP	0	0	0	0	0
Industrial Production	+	0	0	0	0
ISM	0	0	+	0	-
Leading Indicators	0	0	0	0	0
New Home Sales	0	0	+	0	0
PPI	0	0	0	0	0
Retail Sales	0	0	0	0	0
Unemployment Rate	0	0	0	0	0
Fed Funds Rate	0	0	+	0	0
Oil Futures	+	+	+	+	+
Natural Gas Futures	+	+	0	0	0

Table 5.4: Correlation Between Surprises and Stock Prices with no Asymmetries

Announcement	Correlation
Capacity Utilization	0
Consumer Confidence	0
Core CPI	0
Core PPI	0
CPI	0
Durable Goods	0
Employment Cost Index	0
GDP	0
Industrial Production	0
ISM	0
Leading Indicators	0
New Home Sales	0
PPI	0
Retail Sales	0
Unemployment Rate	0
Fed Funds Futures	0
Oil Futures	+
Natural Gas Futures	0

Table 5.5: Correlation Between Surprises and the Stock-Bond Correlation with no Asymmetries

Announcement	Correlation
Capacity Utilization	+
Consumer Confidence	0
Core CPI	0
Core PPI	0
CPI	0
Durable Goods	0
Employment Cost Index	0
GDP	0
Industrial Production	+
ISM	0
Leading Indicators	0
New Home Sales	0
PPI	0
Retail Sales	0
Unemployment Rate	0
Fed Funds Futures	-
Oil Futures	0
Natural Gas Futures	0

Table 5.6: Effects of Surprises on Nominal Rates

	Good News, Exp					**Bad News, Exp**					**Good News, Rec**					**Bad News, Rec**				
Announcement	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y
Capacity Utilization	0	0	0	0	0	+	0	0	0	0	0	0	+	0	0	-	-	0	0	0
Consumer Confidence	0	0	0	0	0	0	0	0	0	0	0	+	+	+	0	0	0	0	0	0
Core CPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0	-	-
Core PPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CPI	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	-	-	0	0	-
Durable Goods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Employment Cost Index	0	0	-	-	0	0	0	0	0	0	0	0	+	+	0	0	0	0	0	0
GDP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial Production	0	0	0	0	0	+	0	0	0	0	0	0	0	+	+	-	-	0	0	0
ISM	+	0	+	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	-	0
Leading Indicators	0	0	0	0	0	0	0	+	+	0	0	0	0	0	0	0	0	-	-	0
New Home Sales	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	+	0	0	0	0
PPI	0	0	0	-	0	0	0	0	0	0	0	0	+	+	0	0	0	0	0	+
Retail Sales	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	+	0	0
Unemployment Rate	0	0	0	-	-	0	0	0	0	0	+	0	+	+	0	0	0	0	0	0
Fed Funds Futures	0	-	0	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil Futures	0	0	0	0	0	+	+	+	+	+	0	+	+	+	+	-	-	-	-	-
Natural Gas Futures	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-

Table 5.7: Effects of Surprises on TIPS Rates

	Good News, Exp					Bad News, Exp					Good News, Rec					Bad News, Rec				
Announcement	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y
Capacity Utilization	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0
Consumer Confidence	0	0	0	-	-	0	+	0	0	+	+	+	+	+	+	0	-	0	-	-
Core CPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Core PPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Durable Goods	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Employment Cost Index	0	-	-	-	-	0	0	0	0	0	0	+	+	+	+	0	0	0	0	0
GDP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial Production	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0
ISM	0	0	+	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0
Leading Indicators	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0
New Home Sales	-	0	0	0	0	-	0	0	0	0	+	0	0	0	0	+	0	0	0	0
PPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retail Sales	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	+	0	0
Unemployment Rate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0
Fed Funds Futures	-	-	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0
Oil Futures	0	0	0	0	0	+	0	+	+	+	0	0	+	+	0	0	0	-	-	0
Natural Gas Futures	0	0	0	-	0	0	0	0	0	0	0	-	0	+	+	0	0	0	0	+

Table 5.8: Effects of Surprises on Break-Even Inflation Rates

	Good News, Exp					**Bad News, Exp**					**Good News, Rec**					**Bad News, Rec**				
Announcement	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y
Capacity Utilization	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Consumer Confidence	0	0	0	0	0	0	-	0	-	-	0	0	0	0	-	0	+	0	+	+
Core CPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0
Core PPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0
Durable Goods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0
Employment Cost Index	0	+	0	0	+	0	0	0	0	0	0	-	0	0	-	0	0	0	0	0
GDP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial Production	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0	-	0	+	0	0
ISM	+	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	0	-	-	0
Leading Indicators	0	0	0	0	0	0	0	+	+	0	0	0	0	0	0	0	-	-	-	-
New Home Sales	+	0	0	+	0	0	0	0	0	0	-	0	0	-	-	0	0	0	-	0
PPI	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0	-	0	0	0
Retail Sales	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unemployment Rate	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0
Fed Funds Futures	0	0	0	+	0	+	+	0	0	0	0	0	0	-	0	0	0	0	0	0
Oil Futures	+	0	0	0	0	0	0	0	0	0	+	+	0	0	0	-	-	0	-	-
Natural Gas Futures	0	0	0	+	0	0	+	0	0	0	0	+	0	-	-	-	-	0	-	-

Table 5.9: Effects of Surprises on Stock Prices

Announcement	**Good News, Exp**	**Bad News, Exp**	**Good News, Rec**	**Bad News, Rec**
Capacity Utilization	0	0	0	0
Consumer Confidence	0	0	0	0
Core CPI	0	0	0	-
Core PPI	0	0	0	0
CPI	0	0	0	0
Durable Goods	0	0	0	0
Employment Cost Index	0	0	0	0
GDP	0	0	0	0
Industrial Production	0	0	0	0
ISM	0	0	0	0
Leading Indicators	-	0	+	0
New Home Sales	0	0	0	0
PPI	0	0	0	0
Retail Sales	0	+	0	-
Unemployment Rate	0	0	0	0
Fed Funds Futures	0	0	0	0
Oil Futures	0	+	0	-
Natural Gas Futures	0	0	0	-

Table 5.10: Effects of Surprises on the Stock-Bond Correlation

Announcement	**Good News, Exp**	**Bad News, Exp**	**Good News, Rec**	**Bad News, Rec**
Capacity Utilization	0	+	0	-
Consumer Confidence	0	0	0	0
Core CPI	0	0	0	0
Core PPI	0	0	+	0
CPI	0	0	0	-
Durable Goods	0	0	0	0
Employment Cost Index	0	0	0	0
GDP	0	0	0	0
Industrial Production	0	+	0	-
ISM	0	0	0	0
Leading Indicators	0	0	-	-
New Home Sales	0	0	0	0
PPI	0	0	0	0
Retail Sales	0	0	0	0
Unemployment Rate	0	0	0	0
Fed Funds Futures	0	0	0	0
Oil Futures	+	+	+	-
Natural Gas Futures	0	0	0	0

Table 5.11: State Asymmetry in Nominal Rates

	$\beta_{Gexp} - \beta_{Grec}$					$-1 * \beta_{Bexp} + \beta_{Brec}$				
Announcement	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y
Capacity Utilization	0	+	0	0	0	+	0	0	0	0
Consumer Confidence	0	0	-	-	0	0	0	0	0	0
Core CPI	0	0	0	0	0	0	+	0	0	+
Core PPI	0	0	0	0	0	0	0	0	0	0
CPI	0	0	0	0	0	+	+	0	0	0
Durable Goods	0	0	0	0	0	0	0	0	0	0
Employment Cost Index	0	0	-	-	0	0	0	0	0	0
GDP	0	0	0	0	0	0	0	0	0	0
Industrial Production	0	0	0	-	-	+	+	0	0	0
ISM	+	0	0	0	0	0	0	0	+	+
Leading Indicators	0	0	0	0	0	0	0	+	+	0
New Home Sales	0	0	0	0	0	-	0	0	0	0
PPI	0	0	-	-	0	0	0	0	0	-
Retail Sales	0	0	0	0	0	0	0	0	0	0
Unemployment Rate	-	0	-	-	0	0	0	0	0	0
Fed Funds Futures	-	-	0	0	+	0	0	0	0	0
Oil Futures	0	0	0	0	0	+	+	+	+	+
Natural Gas Futures	0	0	0	0	0	0	0	0	+	+

Table 5.12: State Asymmetry in TIPS Rates

	$\beta_{Gexp} - \beta_{Grec}$					$-1 * \beta_{Bexp} + \beta_{Brec}$				
Announcement	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y
Capacity Utilization	0	0	0	0	0	0	+	0	0	0
Consumer Confidence	0	0	-	-	-	0	+	0	0	+
Core CPI	0	0	0	0	0	0	0	0	0	0
Core PPI	0	0	0	0	0	0	0	0	0	0
CPI	0	0	0	0	0	0	0	0	0	+
Durable Goods	0	0	0	-	0	0	0	0	0	0
Employment Cost Index	0	-	-	-	-	0	0	0	0	0
GDP	0	0	0	0	0	0	0	0	0	0
Industrial Production	0	0	0	0	0	0	+	0	0	0
ISM	0	0	0	0	0	0	0	0	0	0
Leading Indicators	0	0	0	0	0	0	0	0	0	0
New Home Sales	-	0	0	0	0	-	0	0	0	0
PPI	0	0	0	0	0	0	0	0	0	0
Retail Sales	0	0	0	0	0	0	0	-	0	0
Unemployment Rate	0	0	0	0	0	0	0	0	0	0
Fed Funds Futures	-	0	0	0	0	0	0	0	0	0
Oil Futures	0	0	0	0	0	+	0	+	0	+
Natural Gas Futures	0	0	0	-	-	0	0	0	0	0

Table 5.13: State Asymmetry in BEIR Rates

	$\beta_{Gexp} - \beta_{Grec}$					$-1 * \beta_{Bexp} + \beta_{Brec}$				
Announcement	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y
Capacity Utilization	0	0	0	0	0	+	0	0	0	0
Consumer Confidence	0	0	0	0	+	0	-	0	-	-
Core CPI	0	0	0	0	0	0	0	0	0	0
Core PPI	0	0	0	0	0	0	0	0	0	0
CPI	0	0	0	0	0	+	+	0	0	0
Durable Goods	0	0	0	0	0	0	0	0	+	0
Employment Cost Index	0	+	0	0	+	0	0	0	0	0
GDP	0	0	0	0	0	0	0	0	0	0
Industrial Production	0	0	0	0	0	+	0	-	0	0
ISM	+	0	0	0	0	0	0	0	+	0
Leading Indicators	0	0	0	0	0	0	+	+	+	+
New Home Sales	+	0	0	+	0	0	0	0	0	0
PPI	0	0	0	0	0	0	+	0	0	0
Retail Sales	0	0	0	0	0	0	0	0	0	0
Unemployment Rate	0	0	-	0	0	0	0	0	0	0
Fed Funds Futures	0	0	0	+	0	+	+	0	0	0
Oil Futures	0	0	0	0	0	0	+	0	0	0
Natural Gas Futures	0	0	0	+	+	+	+	0	+	+

Table 5.14: State Asymmetry in Stock Prices

Announcement	$\beta_{Gexp} - \beta_{Grec}$	$-1 * \beta_{Bexp} + \beta_{Brec}$
Capacity Utilization	0	0
Consumer Confidence	0	0
Core CPI	0	0
Core PPI	0	0
CPI	0	0
Durable Goods	0	0
Employment Cost Index	0	0
GDP	0	0
Industrial Production	0	0
ISM	0	0
Leading Indicators	-	0
New Home Sales	0	0
PPI	0	0
Retail Sales	0	+
Unemployment Rate	0	0
Fed Funds Futures	0	0
Oil Futures	0	+
Natural Gas Futures	0	+

Table 5.15: State Asymmetry in Stock-Bond Correlation

Announcement	$\beta_{Gexp} - \beta_{Grec}$	$-1 * \beta_{Bexp} + \beta_{Brec}$
Capacity Utilization	0	+
Consumer Confidence	0	0
Core CPI	0	0
Core PPI	0	0
CPI	0	0
Durable Goods	0	0
Employment Cost Index	0	0
GDP	0	0
Industrial Production	0	+
ISM	0	0
Leading Indicators	+	0
New Home Sales	0	0
PPI	0	0
Retail Sales	0	0
Unemployment Rate	0	0
Fed Funds Futures	0	0
Oil Futures	+	+
Natural Gas Futures	0	0

Table 5.16: Sign Asymmetry in Nominal Rates

	$\|\beta_{Gexp}\| - \|\beta_{Bexp}\|$					$—\beta_{Grec}\| - \beta_{Brec}\|$				
Announcement	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y
Capacity Utilization	0	0	0	0	0	-	0	0	0	0
Consumer Confidence	0	0	0	0	0	0	0	0	0	0
Core CPI	0	0	0	0	0	0	0	0	0	0
Core PPI	0	0	0	0	0	0	-	0	0	0
CPI	0	0	0	0	0	0	-	0	0	0
Durable Goods	0	0	0	0	0	0	0	0	0	0
Employment Cost Index	0	0	+	+	0	0	0	+	+	0
GDP	0	0	0	0	0	0	0	0	0	0
Industrial Production	0	0	0	0	0	-	0	0	0	0
ISM	0	0	0	0	0	0	0	0	0	0
Leading Indicators	0	0	0	0	0	0	0	0	0	0
New Home Sales	0	0	0	0	0	0	0	0	0	0
PPI	0	0	0	0	0	0	0	0	0	0
Retail Sales	0	0	0	0	0	0	0	0	0	0
Unemployment Rate	0	0	0	0	0	+	0	+	0	0
Fed Funds Futures	0	0	0	0	0	0	0	0	0	0
Oil Futures	-	0	0	-	-	0	0	0	0	0
Natural Gas Futures	0	0	0	0	0	0	0	0	0	0

Table 5.17: Sign Asymmetry in TIPS Rates

	$\|\beta_{Gexp}\| - \|\beta_{Bexp}\|$					$—\beta_{Grec}\| - \beta_{Brec}\|$				
Announcement	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y
Capacity Utilization	0	0	0	0	0	0	0	0	0	0
Consumer Confidence	0	0	0	0	0	0	-	0	0	-
Core CPI	0	0	0	0	0	0	0	0	0	0
Core PPI	0	0	0	0	0	0	0	0	0	0
CPI	0	0	0	0	0	0	0	0	0	0
Durable Goods	0	0	0	0	0	0	0	0	0	0
Employment Cost Index	0	+	+	+	+	0	+	+	+	+
GDP	0	0	0	0	0	0	0	0	0	0
Industrial Production	0	0	0	0	0	0	0	0	0	0
ISM	0	0	0	0	0	0	0	0	0	0
Leading Indicators	0	0	0	0	0	0	0	0	0	0
New Home Sales	0	0	0	0	0	0	0	0	0	0
PPI	0	0	0	0	0	0	0	0	0	0
Retail Sales	0	0	0	0	0	0	0	0	0	0
Unemployment Rate	0	0	0	0	0	0	0	0	0	0
Fed Funds Futures	0	0	0	0	0	0	0	0	0	0
Oil Futures	0	0	0	0	0	0	0	0	0	0
Natural Gas Futures	0	0	0	0	0	0	0	0	0	0

Table 5.18: Sign Asymmetry in BEIR Rates

	$\vert\beta_{Gexp}\vert - \vert\beta_{Bexp}\vert$					$—\beta_{Grec}\vert - \beta_{Brec}\vert$				
Announcement	2y	5y	10y	15y	20y	2y	5y	10y	15y	20y
Capacity Utilization	0	0	0	0	0	-	0	0	0	0
Consumer Confidence	0	-	0	-	0	0	-	0	0	-
Core CPI	0	0	0	0	0	0	0	0	0	0
Core PPI	0	0	0	0	0	0	0	0	0	0
CPI	0	0	0	0	0	-	0	0	0	0
Durable Goods	0	0	0	0	0	0	0	0	0	0
Employment Cost Index	0	+	0	0	+	0	+	0	0	+
GDP	0	0	0	0	0	0	0	0	0	0
Industrial Production	0	0	0	0	0	-	0	0	0	0
ISM	0	0	0	0	0	0	0	0	0	0
Leading Indicators	0	0	-	0	0	0	0	-	-	0
New Home Sales	0	0	0	0	0	+	0	0	0	0
PPI	0	0	0	0	0	0	0	0	0	0
Retail Sales	0	0	0	0	0	0	0	0	0	0
Unemployment Rate	0	0	0	0	0	0	0	0	0	0
Fed Funds Futures	-	-	0	0	0	0	0	0	0	0
Oil Futures	0	0	0	0	0	0	-	0	0	0
Natural Gas Futures	0	0	0	0	0	-	0	0	0	0

Chapter 6

Conclusions

After analyzing responses of fixed-income and equity markets to macroeconomic announcements from 2005-2008, I find the most significant results occur for negative shocks in recessions. In recessions, negative shocks to price variables tend to lower nominal and break-even inflation rates, while real rates remain unchanged. Additionally, stock prices and the stock-bond correlation falls in response to these lower-than-expected realizations. Negative recessionary shocks to real variables (the most important being capacity utilization, industrial production, and ISM) tend to lower nominal, real, and break-even inflation rates. The stock-bond correlation also falls for some negative shocks, pointing to the presence of a "flight-to-quality" or economic growth effect driving market movements for bad news in recessions. Positive shocks to some real variables (the most important being consumer confidence and the employment cost index) in recessions raise nominal and real rates, while break-even inflation rates mainly remain unchanged or drop. Stocks and the stock-bond correlation are generally unaffected, except in the case of leading indicators, where positive shocks raise stock prices and reduce the stock-bond correlation, also consistent with a "flight-to-quality" or economic growth effect in recessions.

When examining three types of asymmetry (state, sign, and proportion), I find evidence of state asymmetry for negative shocks to price and for positive and negative shocks to some real variables. For price variables, negative shocks lower nominal and break-even inflation rates more in recessions than expansions. Additionally, lower values of oil and natural gas futures lower equity prices more in recessions and lower values of oil futures lower the stock-bond correlation more in recessions than expansions. For statistically significant movements, positive shocks to real variables raise nominal and real rates more in recessions than expansions. Additionally, negative shocks lower nominal rates more in recessions, with negative shocks to retail sales lowering stock prices more in recessions than expansions and negative shocks to industrial production lowering the stock-bond correlation more in recessions than expansions.

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