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Economic News and the Yield Curve: Evidence from the U.S. Treasury Market

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Abstract

This paper examines newly-available intra-day data from the inter-dealer government bond market to investigate the effects of economic-news announcements on prices, trading volume, and bid-ask spreads. The use of intra-day price data together with data on market expectations allows us to obtain new and different results relative to previous studies. We find a total of seventeen economic announcements to have a significant impact on the price of at least one of the following instruments: a three-month bill, a two- and ten-year note, and a thirty-year bond. Ten of them significantly affect all note and bond prices. For announcements that have a significant impact on prices, the impact occurs within one minute after the announcement. Interestingly, only three announcements affect the bill price. This suggests that at least two factors of uncertainty are needed to model the yield curve. For the ten-year note we find a strong association between announcements and trading volume. Economic announcements have less effect on trading volume for the three-month bill, although changes in monetary policy lead to an average trading volume up to nine times higher than at non-announcement times. Bid-ask spreads widen immediately after most economic announcements, but then return to normal levels within 5 to 15 minutes. For almost all announcements, volatility is significantly higher after the release, especially for the announcements that significantly affect prices.

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1. Introduction

The secondary market for U.S. Treasury securities is the largest and most active single financial market in the world. As of December 1994, private investors and institutions held $2,754 billion worth of U.S. Treasury securities.[1] Average daily trading is in the order of $100 billion per day. Hence, understanding the determinants of this market is of crucial importance for academics, policy-makers, and practitioners.

It is a well-established paradigm in finance that asset prices are affected by the arrival of "news." Unanticipated changes in underlying variables can affect the cash-flows provided by an asset as well as the discount factors used to value the cash-flows. In the case of U.S. government debt, the variables likely to be relevant for pricing are those that characterize the general macroeconomic environment. In fact, unlike stocks and corporate bonds, there is little, if any, asset-specific information concerning Treasury securities.

Thus far, the lack of available data on the *intra-day* behavior of prices in the secondary market for U.S. government debt has made it difficult to study the impact of economic news on interest rates. Normally, several announcements and other news reach the market during any given day, making it hard to attribute price behavior to any one of them using daily return data. Consider, for example, a situation where a second announcement is always released on the same day as the announcement under scrutiny, but at a different time. Based on daily data, one cannot attribute price behavior to one announcement or the other. Indeed, when we regress price changes on announcements, as the time window around the announcement widens, the variability of the residual term in the regression also increases. This reduces R-squared estimates and the precision of the slope-coefficient estimates. As a result, changes in the time period under scrutiny and/or the method of analysis have led to very different results. For example, the producer price index (PPI) is found to have an impact on interest rates in Dwyer and Hafer (1989), Hardouvelis (1988), McQueen and Roley (1993), and Urich and Wachtel (1984), but not Roley and Troll (1983). McQueen and Roley (1993) and Roley and Troll (1983) do find evidence in favor of the industrial production index impacting rates, but Hardouvelis (1988) and Dwyer and Hafer (1989) do not. Hardouvelis (1988) finds significant effects for the consumer price index (CPI), the trade balance, and the unemployment rate, but none of the other studies that look at these variables find them strongly significant. Hardouvelis (1988) also uncovers

evidence that durable goods orders, personal income, and retail sales impact interest rates; while McQueen and Roley (1993) find significant effects for the unemployment rate, nonfarm payroll, CPI, and M1 announcements.

The studies that have looked at the futures market to use intra-day price information, focus on price volatility only. Ederington and Lee (1993), for example, examine the impact of economic announcements on the volatility of Treasury bond, Eurodollar, and deutsche-mark futures prices. They find that employment, PPI, CPI, and durable goods orders have the largest volatility effect for interest rate futures prices. Also, Harvey and Huang (1993) perform a similar exercise and find that the volatility effect is related to the absolute size of the surprise component of the announcements.

Taking advantage of a newly-available data set, we study the intra-day effects of economic announcements on the secondary market for U.S. Treasury securities.[2] With this new data set we can address a variety of issues that could not be studied before. The first of these is the differential impact of an announcement on instruments of different maturity. Specifically, we consider the most-recently issued three-month bills, two-year notes, ten-year notes, and thirty-year bonds. These maturities were selected for two reasons. First, at least the first three of these instruments are very liquid.[3] Second, modern bond-pricing models describe interest rates as functions of one, two, or three factors, and the rates that we study are those normally used in testing these models. For example, a single factor is typically identified with the short-term rate as in the traditional one-factor models of Cox, Ingersoll, and Ross (1985) and Vasicek (1977). A second factor has been identified with the long-term rate as in Brennan and Schwartz (1979), the spread between the short and the long-term rate as in Elton, Gruber, and Mei (1996) and Schaefer and Schwartz (1984), or a time-varying central tendency of the short-term rate, which in turn is proxied by a linear combination of two intermediate-maturity yields as in Balduzzi, Das, and Foresi (1996).

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[1] *Treasury Bulletin*, December 1994.

[2] A recent paper by Fleming and Remolona (1996) analyzes the volatility effects of announcements using the same source of data. Our study differs in that we use expectational data to measure surprises. This allows us to analyze the impact of announcements on prices and separate the effects of concurrent announcements.

[3] We intentionally left out the five-year note, which is the single most actively traded Treasury instruments. The exceptional liquidity of this instrument translates into occasional odd price behavior associated with its going "on special" in the repo market. Duffie (1996) provides a useful discussion of the specialness feature and its impact on bond prices.

We use intra-day price information, together with data on economic announcements and expectations, to differentiate between contemporaneous announcements and to determine which announcements significantly affect prices, the size and sign of the price response, as well as how quickly the new information is incorporated into Treasury prices. In addition to price data, our data set contains information on trading volume and bid-ask spreads, enabling us to also investigate the patterns in trading activity in response to the different announcements.

According to a classical decomposition, nominal interest rates can be viewed as the sum of a real risk-free rate, an inflation premium, and expected inflation. Standard theories of interest-rate determination tie real interest rates to intertemporal marginal rates of substitution, and hence to expected growth rates in per-capita consumption. Production-based models tie real interest rates to intertemporal marginal rates of transformation, and hence to expected growth rates in output [e.g. Breeden (1979, 1986) and Cochrane (1991)]. Liquidity-preference models, on the other hand, emphasize the role of the Federal Reserve in controlling nominal and real rates. Moreover, the traditional quantity theory ties inflation to money supply growth and the business cycle; while the alternative, Phillips-curve view also ties inflation to the business cycle. Hence, our analysis focuses on announcements related to the business cycle, Federal Reserve policy, monetary aggregates, and inflation. Since we do not know ex ante which variables affect market's expectations, we consider a large number of economic announcements to ensure we include all relevant information. Indeed, we consider a more comprehensive set of economic announcements than any other existing study.

There are at least two aspects of this study that are different and new relative to the existing literature that looks at intra-day price data. First, we utilize expectations data to calculate surprises in the economic announcements.[4] This allows us to relate price *reactions* to the surprise component of the announcement, and assess the different impact of announcements which occur *simultaneously*. This differentiates us from the studies of intra-day price behavior by Ederington and Lee (1993), Harvey and Huang (1993), and Fleming and Remolona (1996), which focus on price *volatility* and use *dummy variables* as regressors. These dummies take a value of one when a given economic variable is

[4] There is ample evidence that unanticipated information moves asset prices, since anticipated news is already incorporated into prices. The original study demonstrating this behavior for common equity is Elton, and Gruber (1972). This has been followed by nearly 500 other studies in the common equity area; see the I/B/E/S research bibliography by Brown (1996) and the associated overview for a history of these studies.

announced. If two or more economic variables are always released at the same time (Civilian Unemployment Rate and Nonfarm Payrolls, for example), the corresponding dummies are perfectly correlated, and it is impossible to separate the effects of the different announcements. Second, we utilize data from the inter-dealer or *inner* market. These data have several advantages relative to data from the futures market: i) futures contracts have delivery options which complicate the analysis; ii) U.S. Treasury dealers are much more active in the secondary market than in the futures market; iii) futures-market data do not contain bid-ask and trade volume information; and iv) the inner market trades *around-the-clock*, and hence we are able to consider the effects of announcements that take place when the futures markets are closed.

The main findings of our analysis can be summarized as follows. First, we that find several economic surprises have a significant impact on the price of the two and ten-year note and the thirty-year bond. Surprises also explain a substantial portion of price volatility around announcement times (up to 67%). Specifically, the price of the two-year note reacts to 15 announcements, the price of the ten-year note reacts to 16 announcements, while the price of the thirty-year bond reacts to ten announcements. The three-month bill price, on the other hand, is significantly affected only by three announcements. This difference in behavior is consistent with common wisdom among traders, who view the short end of the yield curve as being "anchored" by current monetary policy, while they view the long end of the yield curve as being "speculative" and sensitive to economic announcements. It is also consistent with current efforts of modeling the yield curve as being driven by at least two factors of uncertainty. Second, the Nonfarm Payroll component of the employment announcement is by far the most important announcement. Also, surprises in procyclical indicators (*e.g.* Nonfarm Payrolls) affect bond prices negatively, while surprises in counter-cyclical indicators (*e.g.* Initial Jobless Claims) affect bond prices positively. Third, the adjustment of prices to news is extremely quick. In the case of the ten-year note (which is representative of the behavior of intermediate- and long-term bonds), only three announcements (out of 16) induce a significant price reaction beyond one minute after the release. Fourth, for the ten-year note we also find a strong association between news releases and trading volume. This effect is not nearly as strong for the three-month bill, although trading in this instrument is exceptionally high in response to changes in monetary policy. Fifth, bid-ask spreads on the three-month bill and the ten-year note widen at the time of the announcement, but then revert to

their usual magnitude immediately after. This effect is especially strong for the bill around changes in monetary policy. Finally, for almost all announcements that significantly affect prices, the volatility of the three-month bill and the ten-year note prices is significantly higher after the announcement. Again, this effect is especially strong for the bill after monetary policy changes.

The paper is organized as follows: Section 2 describes the data set. Section 3 studies the effects of announcements on prices. Section 4 studies the effects of announcements on trading activity: trading volume, bid-ask spreads, and price volatility. Section 5 concludes.

2 The Data

This section describes the data set used in the empirical analysis: the GovPX bond price data and the MMS forecast survey data. We also perform some tests to assess the properties of the MMS survey data.

2.1 Bond Prices

Our primary data set contains bid and ask quotes, trade prices, and trading volume for Treasury bills, notes, and bonds in the inter-dealer broker market. The data set covers the period from July 1, 1991 to September 29, 1995.

According to the *Federal Reserve Bulletin* (September 1993), roughly 62% of the March-May 1993 Treasury security transactions in the secondary market occurred between dealers; that is, within the inner market. Treasury dealers trade with one another mainly through intermediaries, called inter-dealer brokers. Dealers use intermediaries, rather than trading directly with each other, in order to maintain anonymity. Six of the seven main inter-dealer brokers[5] provide price information to the firm GovPX (the notable exception is Cantor Fitzgerald). In turn, GovPx provides price information to Treasury bond dealers and other traders through financial news providers, such as Bloomberg.

Dealers leave *firm* quotes with the brokers, along with the largest size that they are willing to trade. Thus, the posted quotes are also the prices at which actual trading takes place. Unlike other sources, GovPX provides information on the maximum amounts that dealers are willing to trade at the

[5] Garban, EJV, Fundamental, Liberty, RMJ, and Hilliard Farber.

posted quotes. At a minimum, these quotes are good for one million dollars, and normal units are in millions of dollars.

In addition to continuously updating price quotes, the GovPX screen reports the last trade, as well as the cumulative daily volume for each instrument. Daily trading volume in the most recently issued securities, "on-the-run" or "active" issues,[6] is measured in the billions of dollars, and the number of transactions in the active issues recorded by GovPX is in the order of three to seven hundred a day. Bid-ask spreads are also very narrow for all securities: 5.3 cents for 100 dollars of price. The volume recorded by GovPX, reflects most, but not all, the trading in the inter-dealer market. For Instance, Cantor Fitzgerald, which does not participate in GovPX, covers approximately 25% of the inter-dealer trading, mainly in the thirty-year bond.

It is important to note that the GovPX data reports continuously the best price quotes collected by the major brokers among *all* the primary dealers, where the quotes are binding. All other sources currently available only report end-of-day prices and collect data from a smaller pool of dealers. For example, the CRSP data consists of the quotes from one dealer only, Salomon Brothers, until 1962. After 1962, CRSP uses the data collected by the Federal Reserve Bank of New York, which, in turn, are an average of the price quotes from five primary dealers. The *Wall Street Journal*, on the other hand, reports the quotes posted by one of the brokers only, Cantor Fitzgerald, which are collected through a Dow Jones subsidiary, Telerate. Hence, the price data collected by GovPX provide a better representation of the market for U.S. Treasury securities than the data provided by these other sources.

GovPX distributes its information through on-line vendors, by sending out a digital ticker feed. We were given digital backup copies of the feed. The data provides a precise history of the tick-by-tick information sent to traders. Since the purpose of the digital feed is to refresh vendors' screens, the data must be processed before it can be effectively analyzed. GovPX's digital ticker feed contains a time stamp which is the actual time, rounded to the closest second, when the message reaches the computer terminals. It is the arrival of the information to the screen that determines the time stamping. The messages typically reach screens every 60 seconds. Hence, we have $60 \times 24 = 1440$ messages

[6] In general, GovPX lists a newly-issued security as the new active after 6:00p.m. on the day of the auction. The "active" status belongs both to securities that are issued for the first time, and to securities whose issue is being "reopened." In this second case, the security is the active for a maturity which is shorter than that of the original issue.

each day, although some of the messages are simply "refreshers" and do not change any of the existing information on the screen.

In our analysis, we consider the price and trading volume information for the following active instruments: three-month bill, two-year note, ten-year note, and thirty-year bond. The availability of data for different maturities allows us to evaluate the impact of news announcements on prices at several different points in the yield curve. Also, we can estimate the effects of announcements on bid-ask spreads and trading volume.

This type of analysis would not be possible using data on interest-rate futures contracts, since intra-day information on bid-ask spreads and trading volume is not available for the futures markets. For example, the data provided by the Chicago Board of Trade is tick-by-tick data: transaction prices which are recorded separately only if there was a change in price. Bid-ask quotes, successive trades at the same price, and trade volume are not recorded. Moreover, in the market for U.S. Treasury instruments, transaction volume is far greater in the cash than in the futures market. For example, during the March-May 1993 period, dealers transactions in futures and forward contracts were worth only about 18% of the transactions in the cash market (*Federal Reserve Bulletin*, September 1993). Also, futures contracts have delivery options that make it hard to determine exactly the maturity of the instrument to be traded at a forward date. This is especially true for the bond futures contract, that has bonds with maturities ranging from 15 to 30 years as the deliverable instrument. Finally, the GovPX data provides *around-the-clock* price and trade volume information. This makes it possible to study the effects of announcements that take place after the Chicago futures exchanges close at 3:30p.m.

2.2 Survey and Announcement Data

The data on economic announcements and expectations are from Money Market Services (MMS), a San Francisco-based corporation which has conducted telephone surveys since late 1977. The MMS data are the most commonly used data in studies of economic announcements. Edison (1996), Hakkio and Pearce (1985), Ito and Roley (1987), Hardouvelis (1988), McQueen and Roley (1993), and Urich and Wachtel (1984) are some of the many previous studies that have used the MMS data to calculate the surprise component in economic announcements.

MMS conducts a survey of about forty money market managers on the Friday of the week before the release of each variable under consideration. MMS reports the median forecast from the survey.[7] The announcement of a given economic variable typically occurs on the same day of the week. For example, the employment figure is always released on a Friday; the PPI figure is usually released on Thursday or Friday; and the Index of Leading Indicators figure is mainly announced on Wednesdays or Fridays. Thus, the distance in days between the time of the MMS survey and the announcement of the corresponding economic variable does not vary much; the standard deviation of this distance ranges from a minimum of 0.85 days for Consumer Confidence to a maximum of 1.69 days for Construction Spending. Moreover, these news releases tend to be concentrated in the last two days of the week. So, the distance between survey and announcement also tends to be the same across announcements. For 21 of the 27 announcements, the average number of days between survey and release is between five and six.

The 27 economic news announcements that we consider are shown in Table 1.[8] This is a more comprehensive set of economic announcements than in any existing study. As shown in Table 1, twelve of the announcements occur at 8:30a.m., two at 9:15a.m., eight at 10a.m., one at 2p.m., one at 3p.m., and three at 4:30p.m.[9] Most of the announcements are made monthly, although M1, M2, M3 and Initial Jobless Claims figures are announced weekly. Table 1 also shows the number of times an announcement coincided with another announcement. For example, Nonfarm Payrolls and the Civilian Unemployment rate are always announced at the same time. Table 1 also reports the units used to measure the announced figures. Levels are reported as units, dollars, or as percentages. Changes are reported as either absolute in units or dollars, or as a percentage change from the previous observation.

While we would expect economic announcements to be especially influential at the intermediate and long end of the yield curve, academics and market participants alike attach particular

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[7] Unfortunately, MMS provides no information on the distribution of the forecasts.

[8] For most monthly announcements, we have 51 observations. We lose one observation in the case of the Index of Leading Indicators, and Personal Consumption and Personal Income, because of the timing of the releases. We also lose two observations (219 rather than 221) for a weekly announcement, Initial Jobless Claims, since the Labor Department started releasing this figure beginning July 18, 1991.

[9] The dates of the announcements reported by MMS were checked against the dates recorded by Salomon Brothers. The few discrepancies were then verified against the information from *Business Week*, in "The Week Ahead" section, which confirmed the information from Salomon Brothers. The times of the announcements are those recorded by Salomon Brothers.

significance to the stance of monetary policy when assessing the outlook for short-term interest rates. In fact, the recent papers by Balduzzi, Bertola, and Foresi (1996) and Rudebusch (1995) show that interest rate targeting is especially influential on the overnight fed funds rate and other money-market rates.[10] Hence, we also examine the possible impact of changes in monetary policy, as they are summarized by changes in the fed funds rate target: the rate targeted by the trading desk of the Federal Reserve Bank of New York (or "indications of the fed funds rate expected to be consistent with the degree of reserve pressure specified by the Federal Open Market Committee;" Federal Reserve Bank of New York). Until 1994, these changes were mainly implemented in response to the employment announcement, within a few days after the announcement (Cook and Korn, 1991). The implementation of the change in policy was not explicitly announced, although the market was able to infer it from the desk's trades, which are implemented during "Fed time:" from 11:30a.m. to 12:00p.m.[11] Hence, for the 1991-1993 period, we take the time of the announcement of a change in policy to be 11:30a.m.. Beginning with February 4, 1994, explicit announcements were made to the public, on the same day of the meeting of the Federal Open Market Committee (FOMC). This recent institutional feature allows us to identify for the 1994-1995 period both nonzero and *zero* target changes. Zero target changes occur when, on the day of an FOMC meeting, the Board announces that no change in monetary policy was decided. With two exceptions, all announcements were made within one or two minutes of 2:15p.m. Summary statistics of target changes with dates and times are presented in Table 2. The expectations for potential target changes are based on MMS surveys of expected average overnight fed funds rates for the subsequent bank reserves' maintenance period.

2.3 Properties of the MMS Survey Data

We had two main concerns regarding the MMS data. First, although these data have been widely used, we would like to provide some direct evidence of their accuracy. Second, new information may reach the market between the time of the survey and the release, and this information may affect expectations.[12]

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[10] See also Balduzzi, Bertola, Foresi, and Klapper (1997).

[11] See Harvey and Huang (1994) for an analysis of the effect of open market operations on futures prices.

[12] This concern is somewhat lessened by the short time interval between survey and release, and by the fact that related variables tend to be announced at the same time. For example, if the unemployment rate were announced a few

Table 3 reports the results of a regression of the actual announcement, A_i,[13] on the median forecast of the MMS survey, F_i, and the change in the ten-year note yield from the time of the survey to the time of the announcement, Δy:[14]

$$A_{it} = \alpha_{0i} + \alpha_{1i} F_{it} + \alpha_{2i} \Delta y_t + e_{it} \quad (1)$$

In order to make the predictive regression meaningful, the series that are announced in levels and hence are very persistent, such as the Civilian Unemployment Rate, have been transformed to percentage changes relative to the previous announcement.

The regression model in equation (1) allows us to test several hypotheses. First, if there is information content in the MMS survey data, we would expect the coefficient estimates α_{1i} to be positive and significant. Second, if the survey information is unbiased, we would expect the α_{0i} coefficient estimates to be zero, and the intercept terms α_{1i} to be one. Finally, if expectations are revised between the survey and the announcement, there should be a price change at the time of the revision, and we should see a relationship between the change in yield and the announcement.

Now consider the regression results reported in Table 3. The adjusted R-squared is higher than 50% in the majority of the regressions. In all but two cases, the α_{1i} coefficient estimate is significantly different from zero.[15] Moreover, the intercept terms are insignificantly different from zero in 22 out of 27 regressions.[16] Also, we cannot reject the hypothesis that the survey enters with a coefficient of unity in 18 out of 27 regressions. This is strong evidence that the survey data that we use contains real information about the variable being forecasted, and in most cases this is an unbiased forecast.

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days before the nonfarm payroll figure, rather than at the same time, this could lead to a substantial revision of expectations regarding the latter announcement.

[13] It is worth noting that the announcement A_i that we use may differ from the figure actually released, if the series was revised after the announcement. In fact, MMS reports the revised figures for a series as opposed to those originally announced. This is actually an advantage for our analysis, because the market anticipates the actual series value, as opposed to a released value that may only be a noisy signal.

[14] We used the ten-year yield, rather than a shorter maturity rate, because we found that short-term rates do not respond significantly to economic announcements.

[15] Here, and in the remaining of the paper, a coefficient is denoted significant if its t-statistic differs from zero in a two-tailed test at the 5% level. Since in all regressions there are at least 30 observations, the corresponding critical values can be read off the table for the normal distribution, and they equal ± 1.96. Moreover, all regression t-statistics use White's standard error estimates to correct for heteroskedasticity of unknown form.

[16] We did not perform this exercise for the fed funds rate target changes because we only have 24 observations for this announcement.

Moreover, in 21 of 27 cases, the estimate of the coefficient on the yield change is insignificant. And even when the yield change is significant, in four of seven cases we later show that the announcement significantly affects all note and bond prices (*e.g.* Nonfarm Payroll). Thus, we may also conclude that the revision of expectations between survey and release is not a major issue.

These results complement the findings of Pearce and Roley (1985) who test the properties of the MMS survey data for money supply, industrial production, unemployment, PPI, and CPI. They find a significant bias only in the industrial production forecasts. They also note that the survey data is more accurate than autoregressive models by virtue of lower mean squared errors.[17]

Regardless of the results above, it is possible that the surprise components in the announcements is measured with error. Since the surprises are then used as regressors in our tests, these errors-in-variables induce a bias towards zero in the coefficients, as well as inflate the standard errors of the estimates. Hence, t-statistics are biased towards zero. This affects the interpretation of our results in the following sense: the actual significance level of the tests may be even higher than what we report.

3. Economic News and Bond Prices

This section explains the methodology used to evaluate the impact of the different announcements on bond prices. We then study which announcements have a significant effect on bond prices, and the speed at which new information is incorporated into prices. We also discuss the size of the effect of the various announcements, and we separately study the role of monetary policy.

3.1 Methodology

Let F_i denote the median of the MMS forecast survey and A_i the released value for announcement i. We measure the surprise in the announcement i as:

$$E_i = A_i - F_i$$

Since units of measurement differ across economic variables, we divide the surprises by their standard deviation across all observations to facilitate interpretation. Our "standardized" surprise measure is:

$$S_i = E_i / \sigma_i$$

Thus, when regressing bond returns on surprises, the regression coefficient is the change in return for a one standard-deviation change in the surprise. Since the standard deviation σ_i is constant across all the observations for a given announcement i, this adjustment does not affect either the significance of the estimates or the fit of the regressions. The only reason for the standardization is that it allows us to compare the size of regression coefficients associated with surprises in different announcements.

To analyze the effect of economic news on bond prices, we follow a long tradition of linear factor models (see Burmeister and McElroy, 1988, Chen, Roll, and Ross, 1986, Ferson and Harvey, 1991, and Fama and French, 1993, among many others) and model asset returns as linear in explicit factors, which are the surprise components in the economic announcements:

$$(P_{30it} - P_{-5it}) / P_{-5it} = \beta_{0i} + \beta_{1i} S_{it} + \sum_{k=1}^{K} \beta_{k+1,i} S_{i_k t} + e_{it} \quad (2)$$

where

1. P_{30i} is the price thirty minutes after announcement i. Prices are measured as the average between the bid and ask quotes.

2. P_{-5i} is the price 5 minutes before the announcement.

3. β_{1i} is the sensitivity of the price to the announcement.

4. k denotes the k-th announcement concurrent with announcement i, and K is the total number of concurrent announcements.

5. S_{i_k} is the standardized surprise in the k-th announcement concurrent with announcement i.

6. $\beta_{k+1,i}$ is the sensitivity of the price to the k-th announcement concurrent with announcement i.

It is worth noting that the surprise in a concurrent announcement can be zero either because the forecast equals the announced value, or because on that particular date the concurrent announcement is not released. We do not differentiate between the two, because in both cases there is absence of news concerning a given economic variable. Also, we estimated regression

[17] McQueen and Roley (1993) perform similar tests for a different sample period, and they also conclude that the survey data generally have smaller mean squared errors than autoregressive models.

models where the effects of positive and negative surprises are allowed to differ. The results are very similar to those of the regression model in equation (2), and hence are not reported. Moreover, we did not attempt to estimate a model where the slope coefficients change according to the phase of the business cycle, as in McQueen and Roley (1993), since our sample (July 91 to September 95) only covers a period of economic expansion.

We also ran identical regressions using price changes from 5 minutes before to 1, 2, 3, 4, 5, 10, 15, 20, and 25 minutes after the announcement. Shortly, we will show that price changes are extremely rapid in this market, with most of the impact in the first minute after the release. We find no additional price change after 25 minutes. Thus our choice of 30 minutes should capture all of the relevant price change.

As an example of the methodology, consider the employment announcement. From Table 1 we know that the Civilian Unemployment Rate and the Nonfarm Payroll figures are always announced at the same time. Moreover, the two announcements concur with the Index of Leading Indicators seven times, and once with Initial Jobless Claims. We include a concurrent announcement in the regression if it occurs at least 10% of the times the announcement under analysis is released. Hence, for the Civilian Unemployment Rate we include two concurrent announcements, $K = 2$, and we run the regression

$$(P_{30t} - P_{-5t}) / P_{-5t} = \beta_{0} + \beta_{1} S_{1t} + \beta_{2} S_{8t} + \beta_{3} S_{5t} + e_{1t} \quad (3)$$

The subscripts 1, 8, and 5, correspond to the announcements as numbered in Table 1; that is, 1 represents the Civilian Unemployment Rate, 8 represents the Nonfarm Payroll, and 5 represents the Index of Leading Indicators. This regression has 51 observations. It is also worth noting that for 44 of the 51 observations, the surprise in the Index of Leading Indicators is zero simply because this announcement is not concurrently released. We do not differentiate this situation from when the Index is announced and its value is exactly what the market expected, since, in both cases, there is no news concerning this economic variable.

We also performed a test to determine whether the MMS survey data contains information in addition to the released values. Namely, we regressed percentage price changes on the announced value A_i and the MMS forecast F_i separately. We then tested whether the two regressors are separately significant. We also tested whether A_i and F_i enter the regression with coefficients that are

equal, but have opposite signs, which is a test of the implicit restriction in equation (2). In general, we find strong evidence that the MMS survey data does add value to the announcement information, and that the specification of the regression model in equation (2) is correct. For example, for the ten-year note we find that for all the announcements whose surprise component is significant, the MMS forecast is also significant. Moreover, the restriction on the coefficients of the announced value and the forecast is rejected for only 8 of the 27 announcements.

We now turn to a detailed analysis of the results.

3.2 Which Economic Announcements Affect Prices?

Table 4 presents the estimation results for the four instruments: three-month bill, two-year note, ten-year note, thirty-year bond, reporting slope coefficients, t-statistics and R-squared estimates. Intercept terms are not reported, since they are rarely significant. For example, in the case of the ten-year note, only three of the 27 intercept terms are significant. To aid the reader, the results are further summarized in Table 5, which reports the significant announcements for the three instruments. The main results are as follows:

First, the three-month bill price reacts significantly to three announcements only. By contrast, the other three instruments react significantly to 15 (two-year note), 16 (ten-year note), and 10 announcements (thirty-year bond), respectively. The three announcements that significantly affect bill prices are Durable Goods Orders, Initial Jobless Claims, and Nonfarm Payrolls. The lack of impact of economic announcements on the three-month bill is consistent with common wisdom among traders, who view the short end of the yield curve as being anchored by the current stance of monetary policy.[18] In contrast, the intermediate and long portions of the yield curve are "speculative," in the sense that they reflect *anticipations of future monetary policy.* Future monetary policy will reflect future economic conditions, and the market tries to forecast them based on current information. It is also worth noting that the evidence described here is inconsistent with the practice of modeling the entire yield curve as a function of one factor of uncertainty only (Cox, Ingersoll, and Ross, 1985, and

[18] The remaining time to maturity of an on-the-run three-month bill is on average 12.5 weeks. In the current "regime" of fed funds rate target changes being decided only at FOMC meetings (about every six weeks), this means that, on average, only two target changes may take place over the remaining life of the bill.

Vasicek, 1977, for example), and of using changes in a short-term rate as proxy for changes in the full yield curve.

Second, the prices of the two- and ten-year note and the thirty-year bond are largely affected by the same announcements. The ten announcements that significantly affect the prices of all three bonds are: CPI, Durable Goods Orders, Housing Starts, Initial Jobless Claims, Nonfarm Payrolls, PPI, Consumer Confidence, NAPM Index, New Home Sales, and M2 Medians.

Third, the R-squared for the significant announcements can be quite high. For instance, in the case of the two-year note, the R-squared for the employment announcement is 67.7%. This indicates that a substantial portion of price volatility around announcement time is explained by the surprises.

Fourth, it is important to note how we have been able to separate the effects of variables announced concurrently by using our surprise data, and how it is the availability of the MMS forecast data that allows us to calculate surprises.[19] Consider, for example, Nonfarm Payrolls and the Civilian Unemployment rate. These announcements are always released together at 8:30a.m. Thus, without knowing the surprise components of the two announcements, there is no way to separate their influence. However, examining Table 4 shows that the surprises in the Civilian Unemployment rate affect prices much less than surprises in Nonfarm Payrolls. What we have shown is that it is the Nonfarm Payroll figure that affects bond prices, while the Civilian Unemployment rate is much less important. Also, consider the National Association of Purchasing Managers (NAPM) Index and Construction Spending. Previous studies (e.g. Ederington and Lee, 1993, and Fleming and Remolona, 1996) have not attempted to distinguish between the effects of the two 10:00a.m. announcements, and therefore find them equally important. Once again, examining Table 1 shows that 43 out of 50 times they are announced at the same time. Using our surprise data, we are able to show that it is the NAPM Index and not Construction Spending that affects prices. In fact, not only are the sensitivities for Construction Spending insignificant across instruments of different maturity, but they vary in sign. Again, this shows the importance of using surprise data in comparing announcement effects. The last variable which we find significant, and often overlaps with other variables, is Weekly Initial Claims.

Fifth, we find that for most announcements the size of the effect increases with the maturity of the instrument. For the Nonfarm Payroll announcement, for example, the surprise coefficient (in

absolute value) increases from 0.013[20] for the three-month bill, to 0.0160 for the two-year note, to 0.416 for the ten-year note, to 0.592 for the thirty-year bond. This is consistent with the notion that longer maturity bond prices are more volatile (duration increases with maturity).

3.3 Some Further Discussion

Of the ten announcements that significantly affect all note and bond prices, two describe the situation in the *labor market* (Initial Jobless Claims and Nonfarm Payrolls), two describe the *inflationary process* (CPI and PPI), one describes the state of *consumer demand* (Durable Goods Orders), two describe the state of the *real estate market* (Housing Starts and New Home Sales), two describe the *perceived state of the economy* (Consumer Confidence and NAPM Index), and one describes the conditions of the *money market* (M2 medians). Of the announcements that significantly affect some, but not all, note and bond prices, one describes the *labor market* (Civilian Unemployment Rate), three describe the *state of the economy* (Retail Sales, Capacity Utilization, and Industrial production), one describes *foreign trade* (U.S. Exports), and one describes the *state of the credit market* (Consumer Credit).[21]

It is also interesting to provide an interpretation for the lack of significance of some of the economic announcements. For example, the reason for the lack of impact of the Index of Leading Indicators may have to do with the fact the Index is a weighted average of 11 components.[22] While the market may find some of the components relevant for pricing, this information might be confused by the other components of the index. The lack of significance of the Merchandise Trade Balance and U.S. Imports may be attributed to the fact that these announcements have implications both for aggregate economic activity and for foreign exchange rates, and thus convey a mixed signal. Personal Consumption regressions are also insignificant. A possible explanation is that the Commerce Department estimates these figures based on the retail sales report, and the market already reacts significantly to the Retail Sales announcement. In addition, the Treasury Budget announcements are

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[19] This would be true even if there were no simultaneous announcements.

[20] This means a negative 0.013% return for a one standard deviation surprise.

[21] Of these announcements, Retail Sales, Capacity Utilization, Industrial Production, and Consumer Credit have a significant impact on the prices of both the two- and ten-year note.

[22] The eleven components of the index are: the average workweek, weekly jobless claims, new orders for consumer goods, vendor performance, contracts and orders for new plant and equipment, building permits,

also not significant, probably because they are related to one component only of total aggregate demand. The reason why the market reacts to M2, but not to M1 and to M3, is that both M1 and M3 are viewed as not having a stable relationship with nominal GNP.[23] Indeed, this result is consistent with the findings of Hallman, Porter, and Small (1991), who document a long-run link between M2 and the price level for the 1955-1988 period.[24]

For the ten announcements that affect significantly the prices of all notes and bond prices, we calculated the average yield changes induced by the announcements for the different maturities.[25] For all announcements, the absolute yield change for one standard deviation of surprise is largest for the two-year note, and smallest for the thirty-year bond. This is consistent with the notion of the short rate being stationary around a long-run mean: in equilibrium, the longer the maturity of the rate, the smaller the variability (see, for example, Cox, Ingersoll, and Ross, 1985). The (absolute) size of the yield changes reflects the price effects documented above. One standard deviation of Nonfarm Payroll Surprise induces the largest change in the ten-year yield, 5.6 basis points, while one standard deviation of M2 Medians induces the smallest change, 0.3 basis points.

We can also compare our findings on bond prices to those of other studies that have looked at the impact of news on foreign exchange rates. In fact, it is an accepted notion that exchange rate movements reflect changes in *real* interest rates (Dornbusch, 1976, and Engle and Frankel, 1984). Hence, if exchange rates react significantly to the same announcements that affect bond prices, we may conclude that *both real and nominal* interest rates are being affected. The recent study by Ederington and Lee (1993), for example, looks at the reaction of exchange rates to economic news using intra-day data for a sample which is close to ours: 1987-1991. They find that the following six announcements significantly affect the volatility of the deutsche-mark futures contract: employment, Merchandise Trade Balance, PPI, Durable Goods Orders, GNP, and Retail Sales, in that order of importance. With

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changes in unfilled durable goods orders, sensitive material prices, stock prices, real money supply (M2), and consumer expectations.

[23] Interestingly, the correlations between surprises in the three monetary aggregates are not very high. In fact, the highest correlation coefficient is between surprises in M2 and M3, 0.7. Hence, the lack of significance of surprises in M1 and M3 cannot be attributed to a problem of multicollinearity.

[24] Interestingly, that study was the result of a request by Alan Greenspan, who suggested the usefulness of M2 per unit of potential real output as an indicator of longer-term price trends.

[25] Note that these yields are not those of zero-coupon instruments, and hence they are only *averages* of zero or spot rates for the different maturities.

the exception of Merchandise Trade Balance and GNP, these are also announcements that we find have a significant impact on all note and bond prices.

It is also interesting to examine how some of our results would differ if daily, rather than intra-day, price data had been used. For this purpose, we also estimated a regression model analogous to that in equation (2), but where the intra-day price change is replaced by the daily one as the dependent variable.[26] Of the ten announcements that we find significant for all note and bond prices, *five* would not be significant if we used daily data: CPI, Initial Jobless Claims, Housing Starts, PPI, and M2 Medians. This is not surprising, since the standard error of the slope estimates increases with the variability of the residual in the regression. As the time window around the announcement widens, the variability of the residual term also increases, because a smaller portion of price variability can be explained by any given announcement. Hence, as we move from intra-day to daily data, the statistical significance of some announcements gets lost.

Perhaps more importantly, when the time window is widened, announcements that are not significant may erroneously show up as significant. Consider the situation where two announcements are often released on the same day, but at different times during the day, and assume that the market reacts significantly only to the first of the two announcements, although the two surprises are correlated. Using daily data, the second announcement may seem to be significant, when in fact it is not. Indeed, in our data set we find that *three* announcements are significant in the daily regressions, but not in the intra-day ones: Index of Leading Indicators, Personal Income, and M1 Medians.

The importance of looking at intra-day data is also supported by the evidence in Section 3.5 below. There, we show that most announcements that significantly affect the price of the ten-year note, do so within one minute of the release, and all but one have no impact after 25 minutes from the release.

3.4 Sign and Size of Response

Commentaries in the financial press explain the reaction of the bond market to economic news mainly in terms of revisions of inflationary expectations, where, in accord with a Phillips-curve view, inflation

[26] The daily price change is defined as the change between 6:00p.m. the day before the announcement and 6:00p.m. on the announcement day.

is perceived to be positively correlated with economic activity. Our results are consistent with this interpretation. Procyclical variables, such as Nonfarm Payrolls, affect bond prices negatively, while counter-cyclical variables, such as Initial Jobless Claims, have a positive impact on prices.

Since the bond market seems to believe in an inflation-output trade-off, it is interesting to verify whether such a trade-off indeed exists in postwar U.S. data. King and Watson (1996), for example, use spectral methods to calculate the correlation between inflation and output at the business cycle frequency (six to 32 quarters) for the period 1949-1992. They find that, while contemporaneous inflation and output growth are negatively correlated (-0.35), current output growth has a strong positive correlation with inflation six to ten quarters ahead (0.2 and 0.45, respectively). Moreover, King and Watson (1994) document a strong and stable *contemporaneous* negative correlation between the unemployment rate and inflation, -0.66, at the business cycle frequencies for the 1954-1987 period. Hence, it appears that during the post-war period there is indeed an inflation-output trade off, where procyclical business cycle indicators anticipate inflation in the same direction, and where employment is contemporaneously positively correlated with inflation. The market's response to economic announcements seems to reflect these features. Moreover, surprises in the inflation rate itself affect bond prices negatively. This is consistent with the well-documented persistence in the inflation rate: an increase in today's inflation rate leads to higher expected inflation tomorrow.

Regarding the size of the price reaction, the following discussion concentrates on the behavior of the price of the ten-year note, which is representative of the behavior of intermediate- and long-term bond prices. The 16 economic announcements that significantly affect the ten-year note have differing impacts in terms of the magnitude of price changes. Per unit of standard deviation of surprise, the most important is Nonfarm Payrolls. To gain some idea of the importance of this announcement, note that the standard deviation of the daily percentage price change for the ten-year note is 0.47%. Thus, a one standard deviation surprise in nonfarm payrolls leads to a price change of about 89% of the normal daily volatility of price changes. Next in importance is PPI. A one standard deviation surprise in PPI leads to a price change of about 39% of the normal daily volatility. CPI, Durable Goods Orders, Retail Sales, NAPM Index, and Consumer Confidence are of roughly equal importance. These announcements induce price changes that range from 25 to 30% of daily volatility. Initial Jobless Claims, Capacity Utilization, Industrial Production, and New Home Sales have effects between 12 and

19% of daily volatility. Finally, Factory Orders, Consumer Credit, and M2 Medians have the smallest effect on bond prices, with effects between four and nine percent of daily volatility.

3.5 Speed of Impact

One interesting issue to investigate, in addition to the size of the response, is how quickly bond prices react to economic news announcements. As in the previous section, we concentrate on the behavior of the price of the ten-year note. Table 6 presents the results of the following regression

$$(P_{30it} - P_{\tau it}) / P_{\tau it} = \gamma_{0i} + \gamma_{1i} S_{it} + \sum_{k=1}^{K} \gamma_{k+1,i} S_{i_k t} + e_{it} \quad (4)$$

where $P_{\tau it}$ is the price τ minutes after the announcement. The regression is performed for the 16 significant announcements identified in Table 4. The endpoint of the horizon used to calculate rates of return is kept constant, while the beginning of the horizon, τ, is changed from -2, two minutes *before* the release, to +25, 25 minutes *after* the announcement. This allows us to identify the lowest value of τ for which the price reaction is not significant any more. This corresponds to the time period needed for the surprise to be fully incorporated into prices.

Of the 16 announcements, only four significantly affect prices on and after $\tau = 1$: U.S. Exports, Capacity Utilization, NAPM Index, and Consumer Credit. The last three of these announcements are continuously significant after the release time for at most 15 minutes. Thus, even for these announcements, information is rapidly incorporated. For some of these announcements we also find significant later effects, but the coefficients are economically small.

The very quick reaction of prices to economic news is suggestive that *jumps* may play an important role in the dynamics of interest rates. Das and Foresi (1996), for instance, model the innovations in the instantaneous riskless rate as the sum of a diffusion and a jump process. This quick reaction is also consistent with the notion of this market being very efficient in incorporating new information from economic announcements. In fact, if prices took a long time to adjust to an announcement, this would translate into a predictability of price changes (conditional on the realization of the surprise) which would be inconsistent with market efficiency.

The high speed of adjustment is also documented by the graphs reported in Figure 1 and Figure 2, which show the average percentage price change of the ten-year note in response to the significant

announcements released at 8:30a.m.. The figures also show that the reaction of prices to positive and negative surprises is roughly symmetric.

3.6 Monetary Policy

We also analyzed the effect of the announcements of changes in the fed funds target rates shown in Table 2. It is worth noting that the fed funds rate target is not a market rate itself, but it is an indication of the policy intentions of the Federal Reserve. In this sense, it is *exogenous* to market interest rates and can be legitimately used as a regressor.

Given the limited number of observations of changes in fed funds target rates (24), and the additional problem that we can precisely determine the release time for only the last 9, it is not surprising that the effect of target changes is statistically insignificant for all four instruments. Because volume, bid-ask spreads, and volatility increase dramatically around fed funds target changes, as we will show, we summarize the effects of these changes in Figure 3. The figure shows that T-bill prices respond negatively to positive unexpected changes in the target and positively to negative unexpected changes. Ten-year bond prices, on the other hand, are positively affected by both positive and negative target surprises.

This evidence further confirms the different behavior at the short and long ends of the yield curve. It is also consistent with the current monetary "regime" and its perception on the part of market participants. In fact, an increase in the fed funds rate target is a signal of the anti-inflationary stance of monetary policy. This typically leads to a downward revision of long-run inflationary expectations, and hence to lower intermediate- and long-term rates. A decrease in the fed funds rate target is, given the anti-inflationary stance of monetary policy, a signal that inflation is under control, and this also drives intermediate- and long-term rates down, and prices up.

4 Economic News and Bond Trading

This section studies the effects on trading volume, bid-ask spread, and price volatility. In this analysis, we focus on the bill and the ten-year note.

4.1 Trading Volume

Table 7 presents the ratio of the average trading volume over different intervals preceding and following announcement times to the average volume over the same interval on days when no announcement took place. Ratios are reported for the ten-year note and the three-month bill.

We also ran regressions of volume against the absolute size of economic surprises, in the same way as we did with bond returns. We found little evidence of a statistically reliable relation between trading volume and the size of the surprises, even for the announcements that significantly affect bond prices. This is not surprising, since volume should reflect disagreement among investors concerning the price adjustment.[27] This disagreement need not be directly related to the size of the surprise. In fact, while a large surprise may induce investors to revise their priors in the same manner, and hence trigger little trade, a small surprise may generate wide disagreement, and hence trigger a large surge in trading activity.

For the ten-year note, we find consistent patterns of volume for each of the announcements which have a significant impact on prices. In the five minutes before the announcement, volume is either not different from or significantly less than trading volume on non-announcement days. Within the first five minutes after the announcement, trading volume grows to about 1.7 times the average volume for that time period on non-announcement days. The volume ratio continues to grow in the following ten minutes, up to almost twice the size of the non-announcement average, but then declines after another 15 minutes, while still remaining above normal.[28]

For the three-month bill, we find that volume is substantially higher around announcements. However, the pattern is erratic, suggesting that the increased volume is not related to the specific announcement, but rather a general increase in trading, possibly as a consequence of the implementation of hedging strategies. One announcement that strongly affects trading volume in the three-month bill is changes in the fed funds target rate. Hence, the effect of changes in the fed funds

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[27] This interpretation dates back to Beaver (1968).

[28] This pattern is strongest for the 8:30a.m. announcements, since trading volume around this time cannot be influenced by announcements released earlier on that day, since there are none. Conversely, trading volume later in the day might be higher than normal even if there are no announcements at that time, because of announcements released earlier that day.

target rate on the three-month bill will be considered in all subsequent tables. In fact, for the three-month bill, volume increases are much larger, reaching 8 to 9 times the normal volume.

It is also interesting to compare the different effects of announcements on trading volume and on prices. First, the effects of announcements on trading volume differ much less than the effects on prices. Consider, for example, the ten-year note. From Table 4 we see that a one standard deviation surprise in Nonfarm Payroll triggers a price change which is more than 20 times larger than the effect of a one standard deviation surprise in M2 Medians. However, the largest increment in trading volume during the interval of 5 to 15 minutes after the announcement (the PPI announcement) is only about twice as big as the smallest increment (Consumer Credit).

Second, the announcements that affect prices most are not those that have the greatest effect on volume. Consider again the ten-year note and trading volume during the interval of 5 to 15 minutes after the announcement. The Nonfarm Payroll-Civilian Unemployment announcement has only the fourth largest effect on volume. From Table 4 we know that the Nonfarm Payroll surprise has, by far, the largest effect on prices. We also found that several of the announcements that exhibit significant increases in volume at some point after their release time are also announcements for which the surprise does not appear to affect prices (these results are not reported in the table).[29]

Third, the effects of announcements on volume persist even beyond 30 minutes after the release, yet we know from Table 6 that for most of the announcements that significantly affect the price of the ten-year note, the impact is exhausted within the first minute after the release.

The discussion above highlights the fact that trading volume behaves somewhat independently of price changes. As in French and Roll (1986), we can distinguish between public information which affects prices with little or no trading, and private information which only affects prices through trading. Hence, the evidence that we collected suggests that public information plays a dominant role in the adjustment of bond prices after economic announcements.

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[29] In a sense, this is not very surprising when we consider the number of times non-significant announcements overlap with announcements that do move prices. Even the observed trading volume after the 9:15a.m. announcements may be affected by important announcements released 45 minutes earlier.

4.2 Bid-Ask Spreads

Table 8 presents the ratio between the average bid-ask spread at different times before and after the announcement and the average bid-ask spread at the same times during non-announcement days for the ten-year note and for the three-month bill.[30] The average spreads are 2.6 cents and 0.26 cents per one hundred dollars price, for the bill and the note, respectively.

For most of the 8:30a.m. and 9:15a.m. announcements, for both the ten-year note and the three-month bill, we find a significant widening of the spread exactly at the time when the announcement is made. The spread then reverts to its normal values after five to fifteen minutes.

There are several theories that predict this response. First there is an asymmetric information argument that predicts a widening of the spread because of the fear on the part of market makers that traders may be better informed (Glosten and Milgrom, 1985, and Glosten, 1987). Since there should be no leakage of information before announcements are made, and since information relevant to the bond market is quickly disseminated in a widespread manner, asymmetry arises not because different information is received by traders, but because traders may have differing ability to process the information. A second argument that suggests bid-ask spreads will widen around announcements relies on the interpretation of bid-ask spreads as an "option to trade" offered by the market maker to traders (Copeland and Galai, 1983, and Ho and Stoll, 1981). The price of the option to trade is the bid-ask spread itself. As volatility increases because of the announcement, the value of the option increases, and this is reflected by a widening of the spread.

As with trading volume, it is interesting to compare the effects of announcements on bid-ask spreads to those on prices and volume. First, the employment announcement induces both the largest price adjustment and the largest widening of the bid-ask spread. This is true for both the ten-year note and the three-month T-bill. Second, in the case of the ten-year note, the quick reversion of bid-ask spreads to normal values mirrors the quick adjustment of prices to news. This is not surprising, since the need on the part of market makers to protect themselves from informed traders should be exhausted as soon as prices have adjusted to their new "equilibrium" values. Third, changes in fed

[30] Once again, we find no relation between the size of the bid-ask spread and the surprise component of the announcement.

funds target rates induce a substantial widening of the bid-ask spread for the three-month bill. This effect is the counterpart to the large increase in trading volume documented in Table 7.

4.3 Price Volatility

We also examine price volatility around announcements. We measure this by the ratio of the mean absolute value of the price changes on announcement days, during the time interval from 0 to 5 minutes after the announcements, over the mean absolute value of price changes on non-announcement days, during the same time interval. The evidence is strongest for the announcements that we find to significantly impact prices, and the relative size of the volatility effects largely reflects the relative size of the price effects documented in Section 3. For example, the largest increases in price volatility are for the employment announcement and for the PPI announcement, with ratios of 10.2 and 6, respectively.

The notable exception again is fed funds target rate changes. In Table 9, we present volatility ratios for the important announcements for the three-month bill and the ten-year note. The magnitude of the volatility increases for fed funds target changes is among the highest of all the announcements we study, and the ratio of mean absolute deviations is much higher for the three-month bill than for the ten-year note. This is further evidence of the overall importance of monetary policy for bond prices, and of its special influence at the short end of the yield curve.

It is interesting to understand how an announcement, such as changes in the fed funds rate target, may induce a significant increase in volatility without significantly affecting prices. There are at least two explanations for this effect. First, it might be that an announcement leads to higher price volatility, but that the mean price tends to stay the same. This would be the case, for example, if there is substantial disagreement concerning the implications of an announcement, and quotes move in opposite directions under the pressure of waves of buyer- and seller-initiated transactions. Second, it might be that the same announcement takes on a different meaning depending on other information available to the market. For example, an increase in the fed funds rate target can be bad news if it is perceived as a passive adjustment to mounting inflation; it can be good news if it represents a commitment on the part of the Fed to actively fight inflation.

5 Conclusions

This paper examines the effect of economic announcements on the price, volume, bid-ask spread and price volatility of Treasury securities. To analyze price effects, we use intra-day data of bid and ask quotes from the inner market for U.S. government bonds. Our database provides a continuous posting of bids and asks, and the trading around announcement times is sufficiently intense that in most cases there are multiple trades every minute. This allows us to measure impact on price at very short intervals. Many announcements are made concurrently. By using a database on forecasts, we are able to measure the surprise component of an announcement. This allows us to separate out the impact of concurrent announcements. While previous researchers have grouped simultaneous announcements together, we find that in several cases of important announcement pairs only one of the two announcements has a significant impact on prices. Because of our ability to separate out the impact of concurrent announcements, and because we analyze intra-day price data, the announcements that we find important differ from what other researchers have found.

We find that most economic announcements are incorporated in bond prices within one minute of the announcement for most significant announcements. This implies that the inner market for U.S. government bonds is highly efficient. We also find a strong impact of announcements on two, ten, and thirty-year rates and almost none on three-month rates. This strongly suggests that at least two factors of uncertainty are needed to model equilibrium bond prices.

We also consider the effects of announcements on transaction volume, bid-ask spreads, and price volatility. We find that the patterns of trading volume are quite different from those in prices, thus suggesting that private information and differences in opinion only play a minor role in the market for U.S. Treasuries. Bid-ask spreads tend to widen significantly immediately after the announcement, and then to quickly revert to their normal values, which is consistent with the quick reaction of prices to news. The behavior of price volatility is also consistent with the price reactions that we document.

Finally, although changes in monetary policy do not trigger significant price changes in any of the instruments, they have a major impact on trading volume, bid-ask spread, and price volatility for the three-month bill. We take this evidence as suggestive that the stance of monetary policy mainly affects the short end of the yield curve.

REFERENCES

Balduzzi, P., Das, S. R., and Foresi, S. (1996). "The Central Tendency: A Second Factor in Bond Yields." forthcoming, *Review of Economics and Statistics*.

Balduzzi, P., Bertola, G., and Foresi, S. (1996). "A Model of Target Changes and the Term Structure of Interest Rates." *Journal of Monetary Economics* 39, 223-249.

Balduzzi, P., Bertola, G., Foresi, S., and Klapper, L. (1997). "Interest Rate Targeting and the Dynamics of Short-term rates." forthcoming, *Journal of Money, Credit, and Banking*.

Beaver, W.H. (1968). "The Information Content of Annual Earnings Announcements." In *Empirical Research in Accounting: Selected Studies*, supplement to *The Journal of Accounting Research*, 67-92.

Brennan, M.J. and Schwartz, E. S. (1979). "A Continuous Time Approach to the Pricing of Bonds." *Journal of Banking and Finance* 3, 133-156.

Breeden, D. T. (1979). "An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities." *Journal of Financial Economics* 7, 265-296.

Breeden, D. T. (1986). "Consumption, Production, Inflation, and Interest Rates: A Synthesis." *Journal of Financial Economics* 16, 3-39.

Burmeister, E., and McElroy, M. B. (1988). "Joint Estimation of Factor Sensitivities and Risk Premia for the Arbitrage Pricing Theory." *Journal of Finance* 43, 721-733.

Brown, L. D. (1996). *I/B/E/S Research Bibliography*, I/B/E/S International Inc., New York.

Chen, N., Roll, R., and Ross, S. A. (1986). "Economic Forces and the Stock Market." *Journal of Business* 59, 383-403.

Cochrane, J. H., (1991). "Production-based Asset Pricing and the link Between Stock returns and Economic Fluctuations." *Journal of Finance* 46, 209-237.

Cook, T., and Korn, S. (1991). "The Reaction of Interest Rates to the Employment Report: The Role of Policy Anticipations." Federal Reserve Bank of Richmond.

Copeland, T. E., and Galai, D. (1983). "Information Effects of the Bid-Ask Spread." *Journal of Finance*, 38, 1457-1469.

Cox, J. C., Ingersoll, J. E., and Ross, S. A. (1985). "A Theory of the Term Structure of Interest Rates." *Econometrica*, 53, 385-407.

Das, S. and Foresi, S. (1996). "Exact Solutions for Bond and Option Prices with Systematic Jump Risk." *Review of Derivatives Research*, 1, 7-24.

Dornbusch, R. (1976). " Expectations and Exchange Rate Dynamics." *Journal of Political Economy* 84, 1161-1176.

Dwyer, G. and Hafer, H.W. (1989). "Interest Rates and Economic Announcements." *Federal Reserve Bank of St. Louis*, 34-36.

Duffie, D. (1996). "Special Repo Rates." *Journal of Finance* 51, 493-526.

Ederington, L. H. and Lee, J. H. (1993). "How Markets Process Information: News Releases and Volatility." *The Journal of Finance*, 48, 1161-1191.

Ederington, L. H. and Lee, J. H. (1995). "The Short-Run Dynamics of the Price Adjustment to New Information." *Journal of Financial and Quantitative Analysis*, 30, 117-134.

Ederington, L. H. and Lee, J. H. (1996). "The Creation and Resolution of Market Uncertainty: The Impact of Information Releases on Implied Volatility." *Journal of Financial and Quantitative Analysis*, 31, 513-539.

Edison, H.J. (1996). "The Reaction of Exchange Rates and Interest Rates to News Releases." International Finance Discussion Paper No. 570, Board of Governors of the Federal Reserve System.

Elton, E. J., Gruber, M. J., and Mei, J. (1996). "Return Generating Process and the Determinants of Risk Premiums." *Journal of Banking and Finance*, 20, 1251-69.

Elton, E. J., and Gruber, M. J. (1972). "Earnings Estimation and the Accuracy of Expectational Data." *Management Science*, 18, Vol. 2, 409-424.

Engle, C., and Frankel, J. (1984). "Why Money Announcements Move Interest Rates: an Answer from the Exchange Rate Market. " *Journal of Monetary Economics* 13, 31-39.

Fama, E. F., French, K. R. (1993). "Common Risk Factors in the Returns on Stocks and Bonds." *Journal of Financial Economics* 33, 3-56.

Ferson, W. E., and Harvey, C. R. (1991). "The Variation of Economic Risk Premia." *Journal of Political Economy* 99, 385-415.

Fleming, M. J., and Remolona, E. M. (1996). "Price Formation and Liquidity in the U.S. Treasuries Market: Evidence from Intra-day Patterns Around Announcements." Federal Reserve Bank of New York Working Paper.

Fleming, M. J., and Remolona, E. M. (1997). "What Moves the Bond Market?" Federal Reserve Bank of New York Working Paper.

French, K., and R. Roll (1986), "Stock Return Variances: The Arrival of Information and the Reaction of Traders." *Journal of Financial Economics*, 17, 5-26.

Federal Reserve Bulletin, September 1993, Board of Governors of the Federal Reserve System, Washington D.C.

Glosten, L. R., and Milgrom, P. R. (1985). "Bid, Ask, and Transaction Prices in a Specialist Market with Heterogeneously Informed Traders." *Journal of Financial Economics*, 14, 71-100.

Glosten, L. R. (1987). "Components of the Bid-ask Spread and the Statistical Properties of Transaction Prices." *Journal of Business* 42, 1293-1307.

Hakkio, C. S., and Pearce D. K. (1985). "The reaction of Exchange Rates to Economic News." *Economic Inquiry* 23, 621-636.

Hallman, J. H., Porter, R. D., and Small, D.H. (1991). "Is the Price Level Tied to the M2 Monetary Aggregate in the Long Run?" *American Economic Review 81*, 841-858.

Hardouvelis, G. A. (1987). "Macroeconomic Information and Stock Prices." *Journal of Economics and Business*, 39, 131-140.

Hardouvelis, G. A. (1988). "Economic News, Exchange Rates and Interest Rates." *Journal of International Money and Finance*, 7, 23-35.

Harvey, C. R. and Huang, R. D. (1993). "Public Information and Fixed Income Volatility." *Mimeo*, Duke University.

Harvey, C. R. and Huang, R. D. (1994). "The Impact of The Federal Reserve Bank's Open Market Operations." NBER Working Paper Series No. 4663.

Ho, T. and Stoll, H. R. (1981). "Optimal Dealer Pricing Under Transactions and Return Uncertainty." *Journal of Financial Economics*, 9, 47-73.

Ito, T., and Roley, V. V. (1987). "News from the U.S. and Japan: Which Moves the Yen/Dollar Exchange Rate?" *Journal of Monetary Economcs* 19, 255-277.

King, R. G., and Watson, M. (1994). "Money, Prices, Interest Rates, and the Business Cycle." *Carnagie-Rochester Conference Series on Public Policy* 41, 157-219.

King, R. G., and Watson, M. (1996). "Money, Prices, Interest Rates, and the Business Cycle." *Review of Economics and Statistics* 78, 35-53.

McQueen, G., and Roley, V.V. (1993). "Stock Prices, News, and Business Conditions." *The Review of Financial Studies*, 6, 683-707.

Pearce, D. K., and Roley, V. V. (1985). "Stock Prices and Economic News." *Journal of Business* 58, 49-67.

Roley, V.V. and Troll, R. (1983). "The Impact of New Economic Information on the Volatility of Short-Term Interest Rates." *Economic Review*, Federal Reserve Bank of Kansas City, February, 3-15.

Rudebusch, G. D. (1995). "Federal Reserve Interest Rate Targeting, Rational Expectations, and the Term Structure." *Journal of Monetary Economics*, 35, 245-274.

Schaefer, S. M. and Schwartz, E. S. (1984). "A Two-Factor Model of the Term Structure: An Approximate Analytical Solution." *Journal of Financial and Quantitative Analysis*, 19, 413-424.

Urich, T., and Wachtel, P. (1984). "The Effects of Inflation and Money Supply Announcements on Interest Rates." *Journal of Finance* 39, 1177-1188.

Vasicek, O. (1977). "An Equilibrium Characterization of the Term Structure." *Journal of Financial Economics*, 5, 177-188.

Treasury Bulletin, December 1994, Treasury Department, Washington D.C.

Table 1

Contemporaneous Announcement Releases

The table contains the number of times each announcement is released concurrently with other announcements. The sample covers 7/1/91 to 9/29/95.

8:30a.m. Announcements

		1	2	3	4	5	6	7	8	9	10	11	12
Civilian Unemployment (% Level)	1	51	0	0	0	7	1	0	51	0	0	0	0
Consumer Price Index (% Change)	2	0	51	0	5	0	11	5	0	0	18	5	4
Durable Goods Orders (% Change)	3	0	0	51	0	0	14	0	0	0	0	0	0
Housing Starts (Millions of Units)	4	0	5	0	51	0	8	0	0	0	0	1	1
Index of Leading Indicators (% Change)	5	7	0	0	0	50	4	0	7	0	0	0	0
Initial Jobless Claims - weekly (Thousands)	6	1	11	14	8	4	219	19	1	18	19	22	22
Merchandise Trade Balances ($ Billions)	7	0	5	0	1	0	22	51	0	0	0	51	51
Nonfarm Payrolls (Change in Thousands)	8	51	0	0	0	7	1	0	51	0	0	0	0
Producer Price Index (% Change)	9	0	0	0	0	0	18	0	0	51	14	0	0
Retail Sales (% Change)	10	0	18	0	0	0	19	0	0	14	51	0	0
U.S. Imports ($ Billions)	11	0	5	0	1	0	22	51	0	0	0	51	51
U.S. Exports ($ Billions)	12	0	5	0	1	0	22	51	0	0	0	51	51

9:15a.m. Announcements

		13	14
Capacity Utilization (% Level)	13	51	51
Industrial Production (% Change)	14	51	51

10:00a.m. Announcements

		15	16	17	18	19	20	21	22
Business Inventories (% Change)	15	51	0	0	0	0	0	0	0
Construction Spending (% Change)	16	0	51	1	0	43	1	5	5
Consumer Confidence (% Level)	17	0	1	51	0	1	10	0	0
Factory Orders (% Change)	18	0	0	0	51	3	0	2	2
NAPM Index (Index Value)	19	0	43	1	3	51	1	5	5
New Home Sales (In Thousands)	20	0	1	10	0	1	51	7	7
Personal Consumption (% Change)	21	0	5	0	2	5	7	50	50
Personal Income (% Change)	22	0	5	0	2	5	7	50	50

2:00p.m. Announcements

Treasury Budget (Change in $ Billions)	23	51

3:00p.m. Announcements

Consumer Credit (Change in $ Billions)	24	51

4:30p.m. Announcements

		25	26	27
M1 Medians - weekly (Change in $ Billions)	25	221	221	221
M2 Medians - weekly (Change in $ Billions)	26	221	221	221
M3 Medians - weekly (Change in $ Billions)	27	221	221	221

Table 2
Changes in the Federal Funds Target Rate

Changes in the Fed Funds Target Rate are reported for the time period 6/17/91 to 9/29/95. After 2/4/94, the Federal Reserve usually announced policy changes at Board meetings. After this date, meeting dates were included when the Fed did not act.

Date	Release Time	New Target Rate	Basis Point Change
8/6/91	11:30	5.50	-25
9/13/91	11:30	5.25	-25
10/31/91	11:30	5.00	-25
11/6/91	11:30	4.75	-25
12/6/91	11:30	4.50	-25
12/20/91	11:30	4.00	-50
4/9/92	11:30	3.75	-25
7/2/92	11:30	3.25	-50
9/4/92	11:30	3.00	-25
2/4/94	11:00	3.25	25
3/22/94	2:15	3.50	25
4/18/94	2:15	3.75	25
5/17/94	2:15	4.25	50
7/6/94	2:15	4.25	0
8/16/94	1:29	4.75	50
9/27/94	2:15	4.75	0
11/15/94	2:15	5.50	75
12/20/94	2:15	5.50	0
2/1/95	2:15	6.00	50
3/28/95	2:15	6.00	0
5/23/95	2:15	6.00	0
7/6/95	2:15	5.75	-25
8/22/95	2:15	5.75	0
9/26/95	2:15	5.75	0

Table 3

Results Regressions of Announcement Values on Survey Values

For each announcement type i, we run the following regression:

$$A_{it} = \alpha_{0i} + \alpha_{1i} F_{it} + \alpha_{2i} \Delta y_{it} + \varepsilon_{it},$$

where A_{it} is the released value of the announcement, S_{it} is the median expectation across a number of market participants survey approximately one week before the announcement, and Δy_i is the change in the closing yield of the ten-year note between the date of the survey and the day before the announcement. The table reports R^2, the coefficients and t-statistics using White's standard errors. The t-statistic for $\alpha_{1i} = 1$ is also reported.

		Constant		Survey	α=0	α=1	Yield Change	
	R^2	Coef.	t-stat.	Coef.	t-stat.	t-stat.	Coef.	t-stat.
1 Civilian Unemployment	0.038	-0.038	-1.451	0.392	1.503	-2.328	0.021	0.145
2 Consumer Price Index	0.051	0.117	1.429	0.451	1.442	-1.752	-0.008	-0.036
3 Durable Goods Orders	0.280	-0.168	-0.387	1.377	4.800	1.314	-1.072	-0.199
4 Housing Starts	0.405	0.002	0.334	1.214	6.950	1.226	0.137	2.104
5 Index of Leading Indicators	0.919	-0.023	-0.985	1.127	21.733	2.452	0.045	0.216
6 Initial Jobless Claims	0.461	0.003	0.799	1.353	9.426	2.458	-0.059	-1.714
7 Merchandise Trade Balances	0.537	0.034	0.748	1.083	12.886	0.982	0.314	0.991
8 Nonfarm Payrolls	0.515	-17.651	-0.712	1.055	6.857	0.360	276.934	2.633
9 Producer Price Index	0.353	-0.151	-2.952	1.269	7.128	1.512	0.139	0.531
10 Retail Sales	0.369	-0.101	-1.007	1.191	5.540	0.887	1.579	2.755
11 U.S. Imports	0.699	0.002	0.488	1.083	13.122	1.004	-0.042	-0.672
12 U.S. Exports	0.655	0.011	3.094	1.049	11.746	0.549	-0.006	-0.141
13 Capacity Utilization	0.645	0.118	2.363	1.197	12.649	2.083	0.238	0.488
14 Industrial Production	0.775	0.020	0.663	1.097	12.177	1.080	-0.335	-1.446
15 Business Inventories	0.562	0.090	2.394	0.915	9.047	-0.839	-0.239	-0.677
16 Construction Spending	0.232	0.009	0.071	0.819	4.039	-0.895	0.953	0.620
17 Consumer Confidence	0.404	-0.012	-0.017	1.325	5.188	1.273	17.724	1.693
18 Factory Orders	0.942	-0.029	-0.406	1.089	29.275	2.401	0.689	1.181
19 NAPM Index	0.537	-0.004	-0.977	1.281	4.962	1.089	0.225	3.267
20 New Home Sales	0.484	0.002	0.183	1.771	7.208	3.138	0.434	2.979
21 Personal Consumption	0.600	-0.024	-0.376	1.135	8.573	1.018	-0.237	-0.673
22 Personal Income	0.505	-0.059	-0.773	1.218	9.058	1.618	0.160	0.329
23 Treasury Budget	0.962	0.266	0.258	1.002	32.185	0.077	-9.320	-1.379
24 Consumer Credit	0.792	0.165	0.473	1.086	13.747	1.084	1.201	0.323
25 M1 Medians	0.464	-0.168	-0.688	1.284	11.757	2.602	4.079	2.138
26 M2 Medians	0.368	-0.708	-1.835	1.281	11.283	2.473	4.030	1.334
27 M3 Medians	0.467	-0.761	-1.565	1.213	12.834	2.255	3.391	0.795
28 Fed Funds Target Rate Ch.	0.602	0.019	0.491	1.208	5.231	0.902	0.801	2.233

Table 4

The Effect of Announcement Surprises at Different Points on the Yield Curve

For each instrument and for each announcement type i, we run the following regression:

$$(P_{30it} - P_{-5it}) / P_{-5it} = \beta_{0i} + \beta_{1i} S_{it} + \sum_{k=1}^{K} \beta_{k+1,i} S_{i_k t} + e_{it},$$

where P_{30it} is the price of the instrument 30 minutes after the announcement i, S_{it} is the standardized surprise for announcement type i, and k denotes other announcements occurring at the same time as announcement i. The table reports the coefficient β_{1i}, and under the coefficient is the t-statistic using White's standard errors. R^2 for the regression is also reported.

	3 Month Bill			2 Year Note			10 Year Note			30 Year Bond		
	Surprise			Surprise			Surprise			Surprise		
	Coef.	t-stat	R-squared	Coef.	t-stat	R-squared	Coef.	t-stat	R-squared	Coef.	t-stat	R-squared
1 Civilian Unemployment	0.003	0.949	0.140	0.053	2.631	0.677	0.112	1.761	0.607	-0.003	-0.028	0.567
2 Consumer Price Index	-0.005	-1.686	0.064	-0.033	-3.345	0.281	-0.142	-3.637	0.374	-0.205	-2.587	0.446
3 Durable Goods Orders	-0.004	-3.079	0.405	-0.056	-5.201	0.552	-0.118	-4.442	0.399	-0.211	-5.622	0.498
4 Housing Starts	0.005	0.735	0.016	-0.031	-4.435	0.453	-0.075	-2.424	0.181	-0.119	-3.298	0.227
5 Index of Leading Indicators	-0.001	-1.048	0.048	-0.006	-0.954	0.772	-0.029	-1.669	0.678	-0.019	-0.449	0.003
6 Initial Jobless Claims	0.003	2.276	0.017	0.020	5.317	0.097	0.057	3.792	0.068	0.051	2.998	0.037
7 Merchandise Trade Balances	0.000	-0.314	0.003	0.005	1.227	0.040	0.031	1.457	0.063	0.093	1.297	0.037
8 Nonfarm Payrolls	-0.013	-2.976	0.140	-0.160	-7.763	0.677	-0.416	-6.189	0.607	-0.592	-5.386	0.567
9 Producer Price Index	0.003	0.737	0.033	-0.044	-5.504	0.448	-0.184	-5.093	0.473	-0.333	-5.825	0.437
10 Retail Sales	-0.002	-0.294	0.009	-0.037	-2.944	0.320	-0.117	-3.080	0.390	-0.122	-1.607	0.175
11 U.S. Imports	0.000	-0.136	0.004	0.001	0.186	0.057	0.031	1.146	0.117	0.024	0.638	0.035
12 U.S. Exports	0.000	-0.258	0.004	-0.008	-1.370	0.057	-0.058	-2.525	0.117	-0.054	-1.862	0.035
13 Capacity Utilization	-0.002	-1.894	0.195	-0.029	-3.599	0.269	-0.070	-2.548	0.232	-0.055	-1.884	0.135
14 Industrial Production	0.000	-0.040	0.195	-0.010	-1.545	0.269	-0.054	-2.804	0.232	-0.053	-1.693	0.135
15 Business Inventories	0.000	-0.017	0.000	0.000	0.053	0.000	0.017	0.705	0.014	0.040	1.131	0.057
16 Construction Spending	0.000	0.000	0.267	0.002	0.332	0.569	0.018	0.614	0.408	-0.002	-0.052	0.432
17 Consumer Confidence	0.000	-0.316	0.015	-0.031	-4.023	0.352	-0.109	-3.968	0.326	-0.088	-2.417	0.239
18 Factory Orders	0.000	-0.594	0.007	-0.007	-1.356	0.026	-0.040	-2.649	0.091	-0.034	-1.286	0.017
19 NAPM Index	0.000	-0.034	0.000	-0.061	-7.248	0.575	-0.147	-4.821	0.392	-0.233	-6.290	0.412
20 New Home Sales	-0.003	-1.662	0.163	-0.031	-4.897	0.352	-0.089	-4.070	0.252	-0.152	-4.039	0.254
21 Personal Consumption	0.000	0.982	0.065	-0.003	-0.327	0.031	-0.017	-0.492	0.062	0.011	0.391	0.006
22 Personal Income	0.001	1.604	0.065	-0.011	-1.038	0.031	-0.047	-1.275	0.062	-0.012	-0.361	0.006
23 Treasury Budget	0.000	-0.734	0.012	0.002	0.526	0.010	-0.002	-0.217	0.000	-0.005	-0.374	0.002
24 Consumer Credit	0.000	-0.943	0.015	-0.007	-2.218	0.087	-0.027	-2.964	0.141	-0.024	-1.752	0.068
25 M1 Medians	-0.003	-0.374	0.026	-0.002	-1.479	0.295	-0.006	-1.524	0.170	-0.011	-1.894	0.114
26 M2 Medians	0.012	1.507	0.026	-0.011	-3.989	0.295	-0.020	-3.138	0.170	-0.028	-2.264	0.114
27 M3 Medians	0.001	0.067	0.026	-0.004	-1.844	0.295	-0.002	-0.414	0.170	0.005	0.568	0.114

Table 5

The Impact of Economic Anouncements on Treasury Prices

Percentage price changes are regressed on announcement surprises. Intra-day price change is measured from five minutes before to 30 minutes after the announcement. The sample period covers 6/17/91 to 9/29/95. "*" denotes an announcement for which the intra-day regression yielded a significant surprise coefficient at the .05 level.

		3 Mo.	2 Yr.	10 Yr.	30 Yr.
		8:30a.m. Announcements			
1	Civilian Unemployment	-	*	-	-
2	Consumer Price Index	-	*	*	*
3	Durable Goods Orders	*	*	*	*
4	Housing Starts	-	*	*	*
5	Index of Leading Indicators	-	-	-	-
6	Initial Jobless Claims	*	*	*	*
7	Merchandise Trade Balances	-	-	-	-
8	Nonfarm Payrolls	*	*	*	*
9	Producer Price Index	-	*	*	*
10	Retail Sales	-	*	*	-
11	U.S. Imports	-	-	-	-
12	U.S. Exports	-	-	*	-
		9:15a.m. Announcements			
13	Capacity Utilization	-	*	*	-
14	Industrial Production	-	-	*	-
		10:30a.m. Announcements			
15	Business Inventories	-	-	-	-
16	Construction Spending	-	-	-	-
17	Consumer Confidence	-	*	*	*
18	Factory Orders	-	-	*	-
19	NAPM Index	-	*	*	*
20	New Home Sales	-	*	*	*
21	Personal Consumption	-	-	-	-
22	Personal Income	-	-	-	-
		2:00p.m. Announcements			
23	Treasury Budget	-	-	-	-
		3:00p.m. Announcements			
24	Consumer Credit	-	*	*	-
		4:30 Announcements			
25	M1 Medians	-	-	-	-
26	M2 Medians	-	*	*	*
27	M3 Medians	-	-	-	-

Table 6

Speed of Adjustment to New Economic Information

For each announcement i, we run the following regression:

$$(P_{30\,it} - P_{\tau it}) / P_{\tau it} = \gamma_{0i} + \gamma_{1i} S_{it} + \Sigma_{k=1}^{K} \gamma_{k+1,i} S_{i_k t} + e_{it},$$

where P_{30it} is the price of the ten year note 30 minutes after announcement i, $P_{\tau i}$ is the price of the ten year note τ minutes after the announcement, S_{it} is the standardized surprise for announcement type i, and k denotes other announcements occurring at the same time as announcement i. A number of different time horizons τ are chosen to measure price changes, with the endpoint of each price change being fixed at 30 minutes after the announcement. The table reports the coefficient γ_{1i} for each time horizon for all announcements found to be significant for the ten-year note. Under each coefficient is the t-statistic using White's standard errors.

	-2	-1	0	1	2	3	4	5	10	15	20	25
2 Consumer Price Index	-0.107	-0.101	-0.011	-0.016	-0.015	-0.005	-0.012	0.002	-0.011	0.008	0.008	0.002
	-2.924	-2.068	-0.306	-0.521	-0.589	-0.173	-0.373	0.060	-0.399	0.411	0.419	0.221
3 Durable Goods Orders	-0.115	-0.126	-0.095	0.013	0.003	-0.003	0.000	-0.005	-0.001	-0.006	-0.002	-0.004
	-4.429	-4.780	-3.852	0.650	0.161	-0.213	0.020	-0.266	-0.117	-1.022	-0.460	-0.644
4 Housing Starts	-0.098	-0.107	-0.051	-0.037	-0.035	-0.034	-0.020	-0.022	-0.007	-0.012	-0.008	0.001
	-4.795	-5.346	-1.694	-1.693	-1.720	-1.695	-1.112	-1.272	-0.484	-0.967	-0.915	0.210
6 Initial Jobless Claims	0.062	0.068	0.027	-0.007	-0.003	0.001	0.006	0.003	0.000	0.000	-0.005	-0.004
	4.731	4.876	2.302	-0.491	-0.280	0.143	0.723	0.387	-0.075	-0.001	-1.272	-1.510
8 Nonfarm Payrolls	-0.365	-0.373	-0.213	-0.126	-0.045	-0.036	-0.021	-0.039	-0.012	0.018	0.049	0.043
	-6.048	-6.878	-3.055	-1.331	-0.853	-0.711	-0.436	-0.964	-0.388	1.066	1.370	1.112
9 Producer Price Index	-0.175	-0.160	-0.052	-0.008	0.016	0.000	-0.001	-0.005	-0.004	-0.004	-0.004	-0.007
	-5.173	-3.748	-1.281	-0.271	0.532	-0.008	-0.084	-0.353	-0.344	-0.196	-0.210	-0.838
10 Retail Sales	-0.119	-0.147	-0.093	-0.024	-0.031	-0.052	-0.039	-0.041	-0.020	0.003	0.001	0.001
	-3.203	-3.689	-2.512	-0.771	-0.966	-1.947	-1.378	-1.843	-0.846	0.174	0.034	0.097
12 U.S. Exports	-0.056	-0.055	-0.039	-0.026	-0.024	-0.031	-0.020	-0.026	-0.027	-0.025	-0.011	-0.008
	-3.417	-2.857	-1.762	-1.932	-1.809	-2.326	-1.362	-1.636	-2.042	-3.678	-1.568	-1.266
13 Capacity Utilization	-0.072	-0.075	-0.046	-0.038	-0.040	-0.051	-0.045	-0.043	-0.022	-0.011	-0.012	-0.015
	-2.620	-2.723	-2.373	-2.076	-2.010	-2.713	-2.212	-2.150	-1.453	-1.059	-1.427	-3.305
14 Industrial Production	-0.058	-0.057	-0.034	-0.010	-0.009	-0.011	-0.008	-0.013	-0.014	-0.011	-0.014	-0.006
	-3.292	-3.252	-1.971	-0.655	-0.505	-0.828	-0.532	-0.915	-0.926	-0.853	-1.415	-0.768
17 Consumer Confidence	-0.098	-0.082	-0.041	0.018	-0.002	-0.001	0.004	0.000	-0.003	0.002	-0.011	-0.012
	-3.537	-3.250	-1.878	0.618	-0.102	-0.037	0.171	0.000	-0.137	0.156	-0.902	-1.297
18 Factory Orders	-0.035	-0.031	-0.023	-0.017	-0.024	-0.022	-0.022	-0.023	-0.018	-0.005	-0.003	-0.003
	-2.416	-1.984	-1.560	-1.268	-1.911	-1.910	-1.959	-1.994	-1.542	-0.610	-0.433	-0.590
19 NAPM Index	-0.150	-0.144	-0.102	-0.105	-0.076	-0.079	-0.066	-0.052	-0.049	-0.028	-0.024	0.000
	-5.472	-5.229	-4.857	-3.512	-3.653	-3.419	-3.104	-2.732	-2.720	-2.614	-1.642	0.091
20 New Home Sales	-0.091	-0.090	-0.071	-0.011	-0.020	-0.026	-0.021	-0.017	0.002	-0.009	-0.004	-0.004
	-4.136	-4.031	-3.051	-0.569	-1.316	-1.661	-1.242	-1.075	0.144	-0.627	-0.460	-0.615
24 Consumer Credit	-0.028	-0.016	-0.015	-0.016	-0.016	-0.017	-0.017	-0.019	-0.016	-0.009	-0.010	-0.005
	-2.569	-2.146	-2.076	-2.120	-2.307	-2.463	-2.498	-2.595	-2.322	-1.900	-2.963	-1.498
26 M2 Medians	-0.016	-0.017	-0.015	-0.007	0.005	0.004	0.001	0.006	0.000	0.004	0.009	0.003
	-2.733	-2.757	-2.295	-1.321	0.548	0.370	0.144	0.623	0.001	1.337	1.118	1.094

Table 7

Mean Trading Volumes on Announcement and Nonannouncement Days

10 Year Note

Mean trading volume is calculated around announcements and compared to the mean trading volume at the same time of day on nonannouncement days. Announcements that are usually released alone are considered in isolation. Announcements that are frequently released at the same time are grouped together. The table reports the ratio of mean volume on announcement days over the mean volume on nonannouncement days. Reported below the ratio is the t-statistic for a test that the two means are equal.

	-30 to -5	-5 to 0	0 to 5	5 to 15	15 to 30	30 to 45	45 to 60
2 Consumer Price Index	1.583	0.850	1.916	2.380	1.890	1.932	1.699
	4.371	-1.183	6.607	11.497	8.611	8.794	6.428
3 Durable Goods Orders	1.048	0.683	1.547	1.713	1.416	1.201	1.114
	0.375	-2.532	4.000	6.198	4.197	2.079	1.115
4 Housing Starts	1.102	0.777	1.571	1.821	1.480	1.446	1.303
	0.806	-1.753	4.325	7.002	4.793	4.479	2.931
6 Initial Jobless Claims	1.121	0.753	1.466	1.741	1.500	1.398	1.279
	1.639	-3.584	5.917	10.165	7.867	6.658	4.597
9 Producer Price Index	1.539	0.885	2.040	2.533	2.063	1.756	1.621
	4.107	-0.894	7.201	12.269	9.730	7.347	5.547
10 Retail Sales	1.540	0.730	1.955	2.391	1.923	1.875	1.551
	4.105	-2.158	6.748	11.523	8.756	8.526	5.263
1 Civilian Unemployment and 8 Nonfarm Payrolls	1.438	0.728	1.615	2.355	2.377	2.127	1.768
	3.298	-2.113	4.414	11.469	13.183	11.151	7.203
7 Merchandise Trade Balances, 11 U.S. Imports, and 12 U.S. Exports	1.295	0.704	1.359	1.764	1.356	1.430	1.348
	2.147	-2.369	2.757	6.466	3.559	4.415	3.301
13 Capacity Utilization and 14 Industrial Production	1.289	1.138	1.771	1.916	1.777	1.458	1.507
	3.048	1.046	4.734	7.113	6.811	4.001	4.615
17 Consumer Confidence	1.058	1.405	1.795	1.767	1.704	1.391	1.240
	0.567	2.665	5.391	6.436	5.837	3.609	2.285
18 Factory Orders	1.324	1.163	1.742	1.706	1.657	1.436	1.324
	3.127	1.103	5.301	5.933	5.330	3.835	2.971
20 New Home Sales	1.190	1.158	1.923	1.923	1.537	1.339	1.396
	1.826	1.044	6.456	7.603	4.482	3.070	3.759
16 Construction Spending and 19 NAPM Index	0.964	1.208	1.665	1.822	1.616	1.468	1.313
	-0.382	1.430	4.929	6.984	5.279	4.377	3.148
24 Consumer Credit	1.196	1.056	1.203	1.212	1.425	1.072	1.196
	1.706	0.377	1.294	1.005	2.800	0.521	1.368
25 M1 Medians, 26 M2 Medians, and 27 M3 Medians	1.291	1.215	1.272	1.549	1.400	1.373	1.383
	3.793	1.631	2.036	4.910	4.149	2.907	0.339

Table 7 (cont.)
Mean Trading Volume on Announcement and Nonannouncement Days
3 Month Bill

Mean Trading Volume is calculated around announcements and compared to the mean trading volume at the same time of day on nonannouncement days. Announcements that are usually released alone are considered in isolation. Announcements that are frequently released at the same time are grouped together. The table reports the ratio of mean volume on announcement days over the mean volume on nonannouncement days. Reported below the ratio is the t-statistic for a test that the two means are equal.

	-30 to -5	-5 to 0	0 to 5	5 to 15	15 to 30	30 to 45	45 to 60
3 Durable Goods Orders	1.029	0.679	2.420	1.657	1.471	1.172	1.358
	0.080	-0.705	2.464	2.176	1.435	0.681	1.254
6 Initial Jobless Claims	0.860	0.971	1.662	1.522	1.283	1.141	1.616
	-0.765	-0.112	2.111	2.534	1.586	1.007	3.476
1 Civilian Unemployment and	1.664	1.391	0.854	1.754	1.271	1.752	1.504
8 Nonfarm Payrolls	1.806	0.775	-0.286	2.265	0.831	2.891	1.794
				11:30 Announcements			
28 Fed Target Changes	1.067	1.954	2.275	8.919	3.383	2.098	1.513
	0.108	1.104	1.145	8.556	3.867	1.733	0.885
				2:15 Announcements			
	1.178	0.562	4.265	8.332	8.485	5.993	6.409
	0.393	-0.568	3.511	8.350	10.573	6.966	7.965

Table 8
Mean Bid-Ask Spreads on Announcement and Nonannouncement Days
10 Year Note

Mean percentage bid-ask spread is calculated around announcements and compared to the mean bid-ask spread volume at the same time of day on nonannouncement days. Announcements that are usually released alone are considered in isolation. Announcements that are frequently released at the same time are grouped together. The table reports the ratio of mean bid-ask spread on announcement days over the mean bid-ask spread on nonannouncement days. Reported below the ratio is the t-statistic for a test that the two means are equal.

	-30	-5	0	5	15	30	45	60
2 Consumer Price Index	0.815	1.020	2.517	0.898	0.885	0.847	1.033	1.087
	-1.783	0.211	8.941	-0.821	-1.050	-1.385	0.324	0.759
3 Durable Goods Orders	0.999	0.886	2.132	1.008	0.842	0.897	1.004	1.089
	-0.006	-1.280	7.624	0.067	-1.457	-0.969	0.038	0.792
4 Housing Starts	0.790	1.177	1.758	1.025	0.854	0.988	0.980	0.909
	-2.063	1.615	6.222	0.208	-1.371	-0.111	-0.201	-0.828
6 Initial Jobless Claims	0.919	1.018	1.853	0.989	0.972	0.894	0.981	1.064
	-1.325	0.322	8.627	-0.159	-0.265	-1.779	-0.341	0.501
9 Producer Price Index	0.947	0.982	2.061	1.331	0.857	1.076	1.084	0.942
	-0.510	-0.189	6.944	2.686	-1.271	0.655	0.818	-0.532
10 Retail Sales	0.832	1.012	2.298	0.932	0.778	1.022	1.147	1.071
	-1.647	0.131	7.433	-0.566	-2.028	0.195	1.425	0.621
1 Civilian Unemployment and	0.842	1.274	5.459	1.937	1.040	1.288	1.527	1.218
8 Nonfarm Payrolls	-1.581	2.516	12.421	6.925	0.364	2.491	4.444	1.925
7 Merchandise Trade Balances,	0.965	1.034	1.672	0.795	1.026	0.929	1.265	0.923
11 U.S. Imports, and	-0.320	0.382	5.094	-1.784	0.236	-0.658	2.478	-0.716
12 U.S. Exports								
13 Capacity Utilization and	0.907	1.034	1.840	1.256	1.027	0.962	1.130	0.907
14 Industrial Production	-0.849	0.326	6.460	2.271	0.244	-0.392	1.332	-0.974
17 Consumer Confidence	0.942	0.906	1.406	0.977	1.184	1.019	1.226	0.900
	-0.535	-0.985	3.385	-0.237	1.836	0.207	2.425	-1.055
18 Factory Orders	0.931	1.060	1.215	0.904	0.812	1.028	0.905	0.883
	-0.632	0.620	2.070	-1.041	-1.994	0.310	-1.092	-1.203
20 New Home Sales	0.751	1.060	1.516	1.375	1.019	1.068	1.170	0.889
	-2.221	0.627	4.279	3.698	0.201	0.767	1.835	-1.150
16 Construction Spending and	0.859	0.904	1.524	0.982	1.029	1.076	1.048	0.822
19 NAPM Index	-1.400	-1.064	4.642	-0.198	0.326	0.904	0.561	-1.965
24 Consumer Credit	0.916	1.094	1.201	1.060	0.921	0.870	1.039	1.011
	-0.874	0.923	1.867	0.616	-0.830	-1.070	0.415	0.115
25 M1 Medians,	1.020	0.903	1.242	1.062	1.116	1.079	0.961	0.814
26 M2 Medians, and	0.358	-1.125	3.140	0.552	1.661	1.027	-0.479	-1.166
27 M3 Medians								

Table 8 (cont.)

Mean Bid-Ask Spread on Announcement and Nonannouncement Days

3 Month Bill

Mean percentage bid-ask spread is calculated around announcements and compared to the mean bid-ask spread volume at the same time of day on nonannouncement days. Announcements that are usually released alone are considered in isolation. Announcements that are frequently released at the same time are grouped together. The table reports the ratio of mean bid-ask spread on announcement days over the mean bid-ask spread on nonannouncement days. Reported below the ratio is the t-statistic for a test that the two means are equal.

	-30	-5	0	5	15	30	45	60
3 Durable Goods Orders	1.007	0.727	2.575	2.618	0.901	1.007	0.922	1.128
	0.021	-1.710	2.464	3.029	-0.609	0.040	-0.535	0.431
6 Initial Jobless Claims	1.111	0.756	1.485	1.026	1.149	0.891	0.966	1.247
	0.507	-3.007	1.423	0.151	0.817	-1.199	-0.402	0.658
1 Civilian Unemployment and	2.447	1.162	3.544	6.381	6.153	3.413	4.625	1.482
8 Nonfarm Payrolls	2.851	0.943	3.727	7.044	5.986	4.111	4.761	1.837
				11:30 Announcements				
28 Fed Target Changes	1.408	1.712	2.769	5.424	1.280	1.504	1.942	1.560
	0.819	2.768	6.477	8.542	0.188	0.337	2.680	1.894
				2:15 Announcements				
	4.019	1.267	1.318	4.575	1.875	2.107	1.017	0.945
	4.555	0.394	0.452	7.952	0.904	2.960	0.012	-0.044

Table 9

Mean Price Deviations on Announcement and Nonannouncement Days

10 Year Note

Mean price deviations are calculated around announcements and compared to the mean price deviation at the same time of day on non-announcement days. Price deviation is defined as the absolute value of the percentage price change measured from the time of the announcement to five minutes after the announcement. Announcements that are usually released alone are considered in isolation. Announcements that are frequently released at the same time are grouped together. The table reports the ratio of price deviation on announcement days over the price deviation on non-announcement days. Reported below the ratio is the t-statistic for a test that the two means are equal.

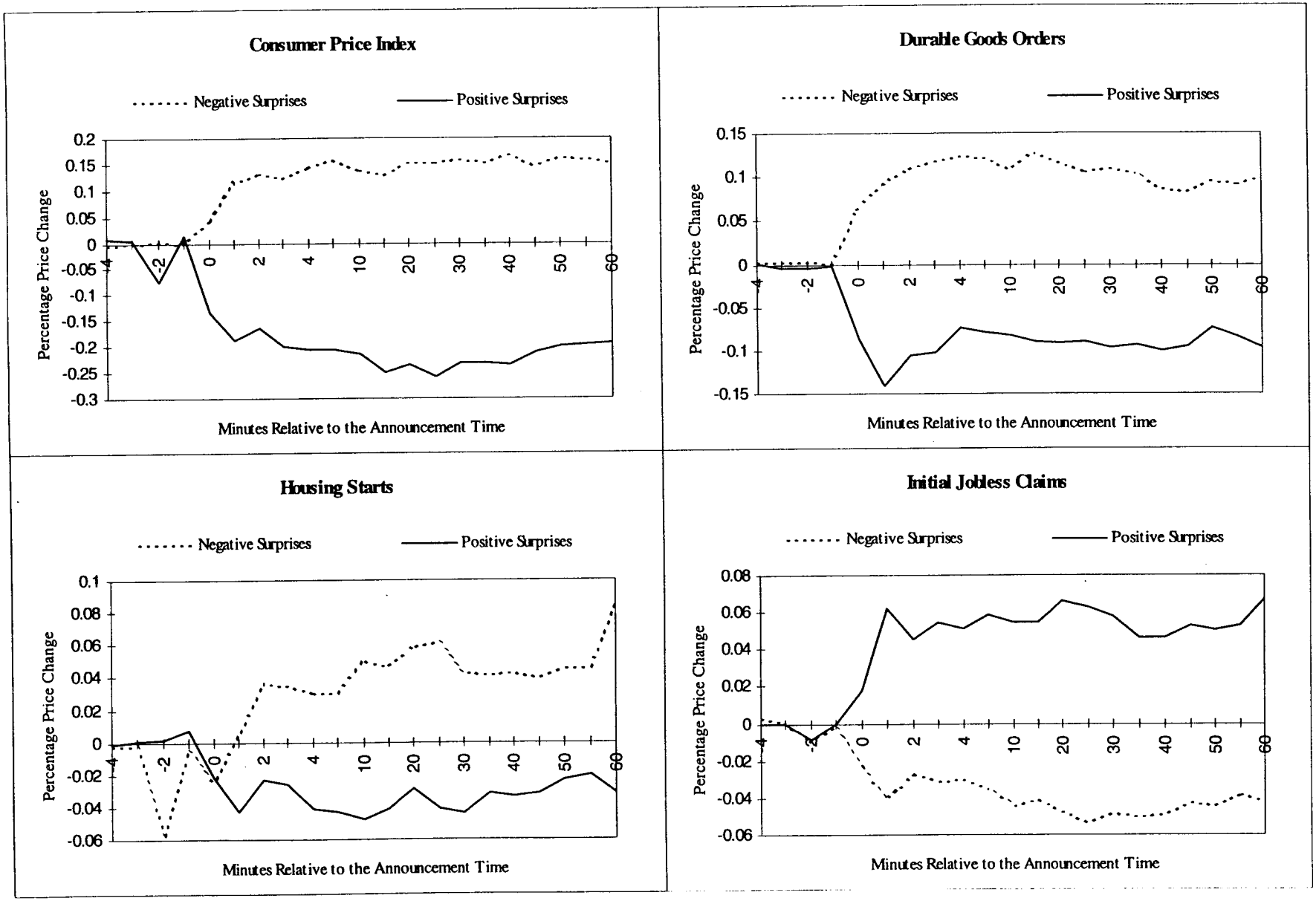
	No Announce. Obs.	Obs.	Ratio of Deviations	t-stat	No Announce. Ave.	Average
2 Consumer Price Index	323	41	4.6823	12.2154	0.0338	0.1583
3 Durable Goods Orders	323	45	3.6084	10.5544	0.0338	0.1220
4 Housing Starts	323	44	2.2670	5.6462	0.0338	0.0766
6 Initial Jobless Claims	323	190	2.6955	8.0105	0.0338	0.0911
9 Producer Price Index	323	44	6.0010	14.7664	0.0338	0.2028
10 Retail Sales	323	40	5.4596	13.8556	0.0338	0.1845
1 Civilian Unemployment and 8 Nonfarm Payrolls	323	33	10.1874	16.8704	0.0338	0.3444
7 Merchandise Trade Balances, 11 U.S. Imports, and 12 U.S. Exports	323	49	2.1063	4.8466	0.0338	0.0712
13 Capacity Utilization and 14 Industrial Production	321	46	2.8619	9.1529	0.0228	0.0653
17 Consumer Confidence	326	49	3.0142	9.6371	0.0252	0.0760
18 Factory Orders	326	47	1.5931	3.0757	0.0252	0.0402
20 New Home Sales	326	45	3.4868	8.6088	0.0252	0.0880
16 Construction Spending and 19 NAPM Index	326	52	3.2022	9.0482	0.0252	0.0808
24 Consumer Credit	306	50	1.1214	0.7607	0.0177	0.0198
25 M1 Medians, 26 M2 Medians, and 27 M3 Medians	289	188	1.8310	4.3829	0.0128	0.0235

Table 9 (cont.)
Mean Price Deviation on Announcement and Nonannouncement Days
3 Month Bill

Mean price deviation is calculated around announcements and compared to the mean price deviation at the same time of day on nonannouncement days. Price deviation is defined as the absolute value of the percentage price change measured from the time of the announcement to five minutes after the announcement. Announcements that are usually released alone are considered in isolation. Announcements that are frequently released at the same time are grouped together. The table reports the ratio of price deviation on announcement days over the price deviation on nonannouncement days. Reported below the ratio is the t-statistic for a test that the two means are equal.

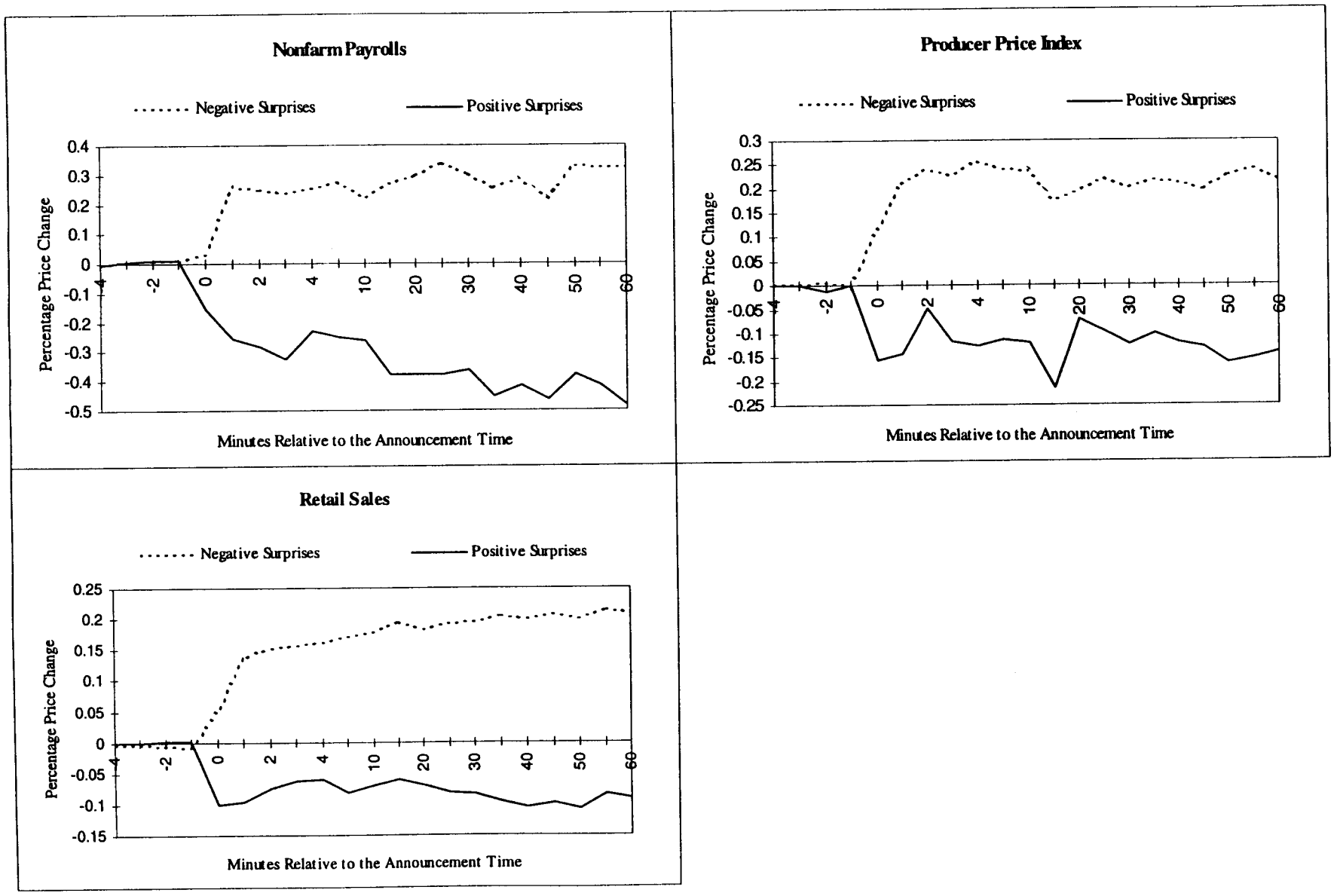
	No Announc. Obs.	Obs.	Ratio of Deviations	t-stat	No Announc. Ave.	Ave.
3 Durable Goods Orders	287	41	5.0419	2.7512	0.0035	0.0179
6 Initial Jobless Claims	287	181	3.229	2.4006	0.0035	0.0114
1 Civilian Unemployment	287	30	12.7849	6.321	0.0035	0.0453
8 Nonfarm Payrolls						
			11:30 Announcements			
28 Fed Target Changes	302	10	26.3609	11.1605	0.0002	0.0062
			2:15 Announcements			
	298	11	3.2004	0.7266	0.0019	0.006

Figure 1
Price Response of the Active 10 Year T-Note to Economic Announcements



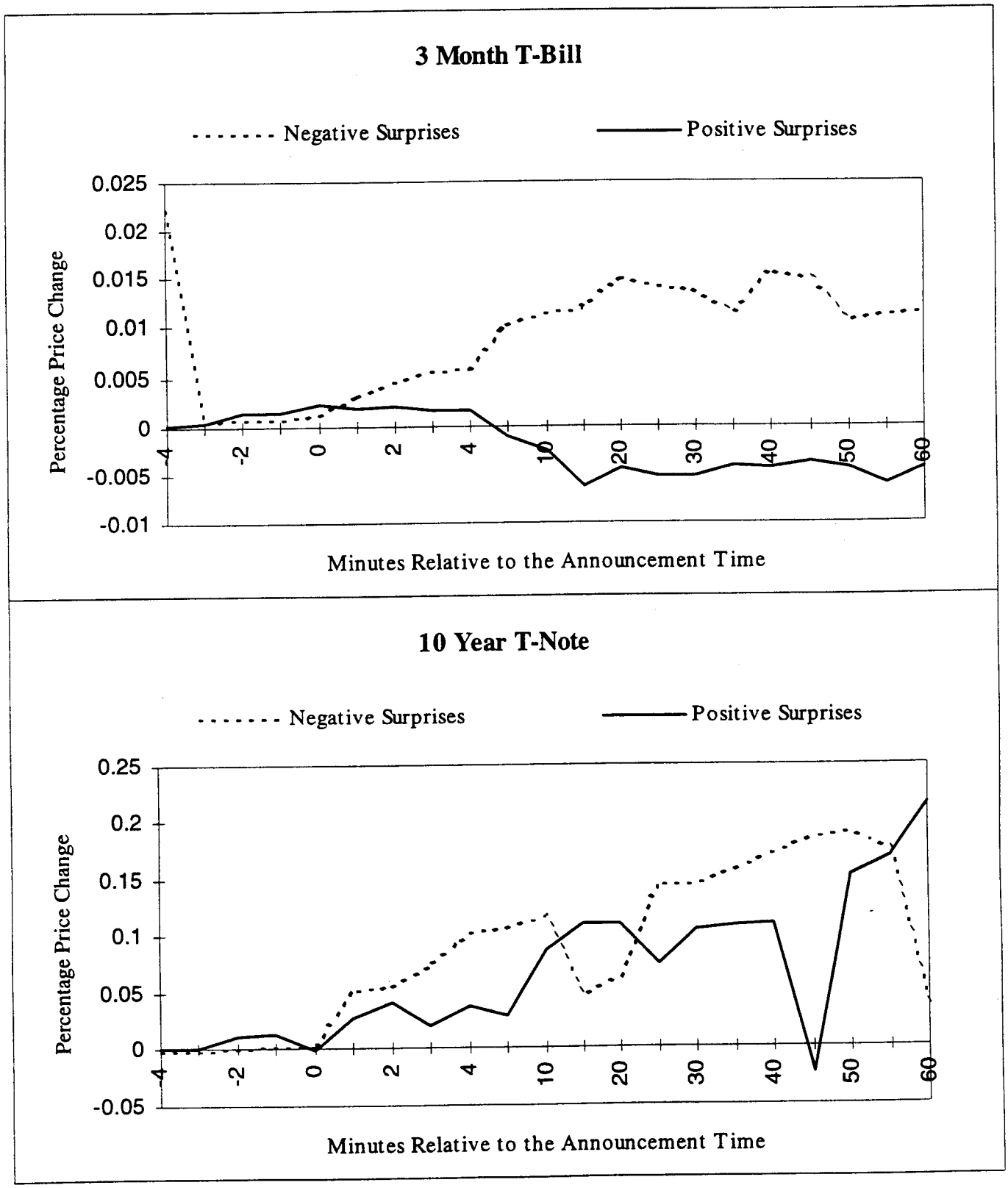
The charts depict the average percentage price change relative to five minutes before the announcement. Observations are grouped by the sign of thei of the surprise. The sample covers 7/1/91 to 9/29/95.

Figure 2.
Price Response of the Active 10 Year T-Note to Economic Announcements



The charts depict the average percentage price change relative to five minutes before the announcement. Observations are grouped by the sign of the surprise. The sample covers 7/1/91 to 9/29/95.

Figure 3.
Price Response to Surprises in the Federal Funds Target Rate



The charts depict the average percentage price change relative to five minutes before the announcement. Observations are grouped by the sign of the surprise. The sample covers 7/1/91 to 9/29/95.