JOURNAL OF FINANCIAL AND QUANTITATIVE ANALYSIS VOL. 36, NO. 4, DECEMBER 2001
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https://doi.org/10.2307/2676223 Published online by Cambridge University Press

Economic News and Bond Prices: Evidence from the U.S. Treasury Market

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Abstract

This paper uses intraday data from the interdealer government bond market to investigate the effects of scheduled macroeconomic announcements on prices, trading volume, and bid-ask spreads. We find that 17 public news releases, as measured by the surprise in the announced quantity, have a significant impact on the price of at least one of the following instruments: a three-month bill, a two-year note, a 10-year note, and a 30-year bond. These effects vary significantly according to maturity. Public news can explain a substantial fraction of price volatility in the aftermath of announcements, and the adjustment to news generally occurs within one minute after the announcement. We document significant and persistent increases in volatility and trading volume after the announcements. Bid-ask spreads, on the other hand, widen at the time of the announcements, but then revert to normal values after five to 15 minutes. The effects that we document have relevant implications for yield curve modeling and for the microstructure of bond markets.

I. Introduction

This paper studies the response of the prices of U.S. Treasury bonds to public announcements of economic news. We use data on scheduled economic announcements and consensus forecasts to calculate the surprise component in the announcement. These data, together with intraday price information, allow us to differentiate between contemporaneous announcements and to determine which announcements significantly affect prices and the size and sign of the price response, as well as how quickly public news is incorporated into Treasury prices.

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In addition to price data, our data set contains information on trading volume and bid-ask spreads, enabling us to investigate the effects of different announcements on trading activity.

The main findings of our analysis can be summarized as follows. First, we find that 17 news releases, as measured by the surprise in the announced quantity, have a significant impact on the price of at least one of the following instruments: a three-month bill, a two-year note, a 10-year note, and a 30-year bond. Second, these effects vary significantly according to maturity. While nine announcements affect the price of the T-bill, 13 announcements affect the price of the two-year note, 16 announcements affect the price of the 10-year note, and 10 announcements affect the price of the 30-year bond. Third, public news explains a substantial fraction of price volatility in the aftermath of announcements, and the adjustment to news generally occurs within one minute after the announcement. Fourth, both trading volume and volatility increase immediately after the announcements and persist for up to 60 minutes after the announcements. Finally, bid-ask spreads widen at the time of the announcements, but then revert to normal values after five to 15 minutes.

Our findings have relevant implications for models of the yield curve and of interest rate dynamics. We show that the differential impact of news on instruments of different maturity is consistent with at least two factors of uncertainty being at work in the term structure. Moreover, the almost instantaneous adjustment of prices to public news suggests that jumps are a needed component of realistic time-series models of interest rates.

Our findings also have implications for the microstructure of bond markets. The fact that prices move significantly, before the increase in volume, suggests that the initial price adjustment is mainly driven by public information. The widening of bid-ask spreads for up to 15 minutes after the announcements suggests that during a second phase, both volatility and volume are partly driven by informed trading. Finally, the persistence of volatility and volume beyond the reversion of bid-ask spreads to normal suggests that liquidity trading plays a role during a third phase after the news releases.

This paper extends the analysis of other articles looking at intraday patterns in Treasury bond prices and trading around announcement times. Ederington and Lee (1993), for example, study price volatility in the *futures* markets. Futures data has several disadvantages: i) futures contracts have delivery options that complicate the analysis, ii) futures market data do not contain bid-ask and trade volume information, and iii) futures markets are closed at the time when some important announcements are made (i.e., the 4:30PM money supply announcements).

Fleming and Remolona (1999) study price volatility and trading behavior by using data from the secondary market for U.S. Treasury securities. Our analysis extends theirs in that we consider a much broader set of macroeconomic announcements (26 instead of three), a longer sample period (five years instead of one year), and a broader set of Treasury instruments (four instead of one). We also distinguish between different types of announcement and the different components of the announcements, while Fleming and Remolona pool together the three announcements that they consider (PPI, CPI, and employment report). Moreover, Fleming and Remolona do not separate the different components of

https://doi.org/10.2307/2676223 Published online by Cambridge University Press

https://doi.org/10.2307/2676223 Published online by Cambridge University Press

the announcements (Nonfarm Payrolls and Civilian Unemployment within the employment report). Finally, we relate price changes to the surprise component of the announcement, whereas Fleming and Remolona, like Ederington and Lee (1993), only investigate overall volatility effects.

The paper is organized as follows. Section II describes the data set. Section III studies the effects of announcements on prices. Section IV studies the effects of announcements on trading activity: trading volume, bid-ask spreads, and price volatility. Section V concludes.

II. The Data

This section describes the data set used in the empirical analysis: the GovPX bond price data and the MMS forecast survey data.

A. Bond Prices

Our primary data set contains bid and ask quotes, trade prices, and trading volume for Treasury bills, notes, and bonds in the interdealer broker market. The data set covers the period from July 1, 1991, to September 29, 1995, and includes data over all 24 hours.[1]

According to the *Federal Reserve Bulletin* (September 1993), roughly 62% of the March–May 1993 Treasury security transactions in the secondary market occurred among dealers; that is, within the inner market. Treasury dealers trade with one another mainly through intermediaries, called interdealer brokers. Six of the seven main interdealer brokers[2] provide price information to the firm GovPX (the exception is Cantor Fitzgerald). In turn, GovPX provides price information directly to Treasury bond dealers and to other traders through financial news providers, such as Bloomberg. Daily trading volume in the most recently issued securities, "on-the-run" or "active" issues, is measured in the billions of dollars, and the number of transactions in the active issues recorded by GovPX is 300 to 700 a day.

Dealers leave *firm* quotes with the brokers, along with the minimum size that they are willing to trade. The best quotes across all the participating primary dealers, as well as the size of the order the quotes are good for, are posted on the GovPX screen. Thus, the posted quotes are also the prices at which actual trading takes place. At a minimum, these quotes are good for $1 million, and normal units are in millions of dollars.

B. 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

[1] For a further description of the GovPX database, see Elton and Green (1998) and Fleming (1997).

[2] Garban, EJV, Fundamental, Liberty, RMJ, and Hilliard Farber. These intermediaries handle about 70% of the trading volume.

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(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.

The properties of the MMS forecasts have been investigated, for example, by Pearce and Roley (1985). They consider forecasts of money supply, industrial production, unemployment, PPI, and CPI. They find a significant bias only in the industrial production forecasts. They also note that the MMS forecasts are more accurate than forecasts produced by autoregressive models by virtue of lower mean squared errors.[3]

The 26 economic news announcements that we consider are shown in Table 1.[4] This is a more comprehensive set of economic announcements than in any existing study. As Table 1 shows, 12 of the announcements occur at 8:30AM, two at 9:15AM, eight at 10AM, one at 2PM, and three at 4:30PM. Most of the announcements are made monthly, although M1, M2, M3, and Initial Jobless Claims figures are announced weekly. Table 1 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 percentages. Changes are reported as either absolute in units or dollars, or as a percentage change from the previous observation.

III. 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, the speed at which new information is incorporated into prices, and the size of the effect of the various announcements.

A. 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 announcement i as

$$E_i = A_i - F_i. \tag{1}$$

[3]McQueen and Roley (1993) perform similar tests for a different sample period, and they also conclude that the MMS forecasts generally have smaller mean squared errors than the forecasts of autoregressive models. In tests conducted on our sample, we find little evidence that the MMS forecasts are biased predictors of the announcements. We also find little evidence of expectations revision between the time of the survey and the time of the news release.

[4]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 began releasing this figure on July 18, 1991.

TABLE 1

Contemporaneous Announcement Releases

8:30AM Announcements	1	2	3	4	5	6	7	8	9	10	11	12
1. Civilian Unemployment (% level)	51	0	0	0	7	1	0	51	0	0	0	0
2. Consumer Price Index (% change)	0	51	0	5	0	11	5	0	0	18	5	4
3. Durable Goods Orders (% change)	0	0	51	0	0	14	0	0	0	0	0	0
4. Housing Starts (millions of units)	0	5	0	51	0	8	0	0	0	0	1	1
5. Index of Leading Indicators (% change)	7	0	0	0	50	4	0	7	0	0	0	0
6. Initial Jobless Claims—weekly (thousands)	1	11	14	8	4	219	19	1	18	19	22	22
7. Merchandise Trade Balances ($ billions)	0	5	0	1	0	22	51	0	0	0	51	51
8. Nonfarm Payrolls (change in thousands)	51	0	0	0	7	1	0	51	0	0	0	0
9. Producer Price Index (% change)	0	0	0	0	0	18	0	0	51	14	0	0
10. Retail Sales (% change)	0	18	0	0	0	19	0	0	14	51	0	0
11. U.S. Imports ($ billions)	0	5	0	1	0	22	51	0	0	0	51	51
12. U.S. Exports ($ billions)	0	5	0	1	0	22	51	0	0	0	51	51
9:15AM Announcements	**13**	**14**										
13. Capacity Utilization (% level)	51	51										
14. Industrial Production (% change)	51	51										
10:00AM Announcements	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**				
15. Business Inventories (% change)	51	0	0	0	0	0	0	0				
16. Construction Spending (% change)	0	51	1	0	43	1	5	5				
17. Consumer Confidence (% level)	0	1	51	0	1	10	0	0				
18. Factory Orders (% change)	0	0	0	51	3	0	2	2				
19. NAPM Index (index value)	0	43	1	3	51	1	5	5				
20. New Home Sales (in thousands)	0	1	10	0	1	51	7	7				
21. Personal Consumption (% change)[a]	0	5	0	2	5	7	50	50				
22. Personal Income (% change)[a]	0	5	0	2	5	7	50	50				
2:00PM Announcements	**23**											
23. Treasury Budget (change in $ billions)	51											
4:30PM Announcements	**25**	**26**	**27**									
24. M1 Medians—weekly (change in $ billions)	221	221	221									
25. M2 Medians—weekly (change in $ billions)	221	221	221									
26. M3 Medians—weekly (change in $ billions)	221	221	221									

Table 1 contains the time each announcement is released, the reported units for that announcement, and the number of times each economic announcement is released concurrently with other announcements for the 26 economic announcements considered in the study. The sample period covers July 1, 1991–September 29, 1995.

[a]The reporting of Personal Consumption and Personal Income began at 8:30AM in January 1994.

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

$$S_i = \frac{E_i}{\sigma_i}. \tag{2}$$

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 across different announcements.

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To analyze the effect of economic news on bond prices, we regress price changes on the surprise in the economic variable being studied and the surprises in variables announced simultaneously,[5,6,7]

$$(3) \qquad (P_{30it} - P_{-5it})/P_{-5it} = \beta_{0i} + \beta_{1i}S_{it} + \sum_{k=1}^{K} \beta_{k+1,i}S_{i_k t} + e_{it},$$

where

i) P_{30it} is the price 30 minutes after announcement i at time t (prices are measured as the average between the bid and ask quotes);

ii) P_{-5it} is the price five minutes before the announcement at time t,[8]

iii) β_{1i} is the sensitivity of the price to the announcement;

iv) k denotes the kth announcement concurrent with announcement i, and K is the total number of concurrent announcements;

v) $S_{i_k t}$ is the standardized surprise in the kth announcement concurrent with announcement i at time t; and

vi) $\beta_{k+1,i}$ is the sensitivity of the price to the kth announcement concurrent with announcement i.

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 seven times with the Index of Leading Indicators, 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

[5]One instance where including all simultaneously announced surprises is problematic is the case of Imports, Exports, and Merchandise Trade Balance. The three announcements are released at the same time, and Merchandise Trade Balance is simply the difference between Exports and Imports. Hence, in the regressions for Imports and Exports, we exclude the Trade Balance. In the Trade Balance regression, we exclude Imports and Exports. This accounts for the small differences in R^2 reported in Table 3.

[6]An alternative specification is to include in one regression surprises in all economic variables, where the sample for the regression includes all announcement days, not just the days for a particular announcement. We implemented this alternative specification obtaining essentially the same results as those from running the regressions separately. However, running separate regressions has the advantage that we can allow for different intercept terms, and that we can investigate the different explanatory power of the model for the different announcements.

[7]One potential concern is that the impact of economic announcements may change over time. Although we would not expect substantial variation during the 1991–1995 time period we consider, which witnessed a gradual economic expansion, we explore this possibility using the approach of Almeida, Goodhart, and Payne (1998) and allow for differential impacts for each year in our sample. We conduct tests using data for the 10-year note and examine the 15 announcements that significantly affect its price. Taking 1991 as the reference year, we tested whether the responses in the remaining four years were significantly different, for a total of 60 tests. Only in 22 cases do we reject the null of equality of the response at the 5% level, and the pattern of the rejections is quite erratic. We regard this as very weak evidence of time variation during our sample. In addition, we only have a few observations for each year, which makes the estimation of these differential effects problematic. Hence, in what follows, we assume the announcement responses are constant over time.

[8]We ran identical regressions using price changes from five minutes before to one, two, three, four, five, 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 changes.

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released. Hence, for the Civilian Unemployment rate, we include two concurrent announcements, $K = 2$, and we run the regression,

$$(4) \qquad (P_{301t} - P_{-51t})/P_{-51t} \quad = \quad \beta_{01} + \beta_{11}S_{1t} + \beta_{21}S_{8t} + \beta_{31}S_{5t} + e_{1t}.$$

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.

B. Which Economic Announcements Affect Prices?

Table 2 presents the estimation results for the four instruments: three-month bill, two-year note, 10-year note, and 30-year bond. The table shows slope coefficients, *t*-statistics, and R^2 estimates. Intercept terms are not reported, since they are rarely significant. For example, in the case of the 10-year note, only three of the 26 intercept terms are significant. The main results follow.

First, the prices of all four instruments react significantly[9] to eight announcements. These eight announcements are: Durable Goods Orders, Housing Starts, Initial Jobless Claims, Nonfarm Payrolls, Producers Price Index, Consumer Confidence, NAPM Index, and New Home Sales. In addition, three announcements affect the prices of three instruments, Consumer Price Index and M2, the longest three and Retail Sales, the shortest three. One announcement, Capacity Utilization, only affects the price of the two intermediate notes. Four other announcements, Merchandise Trade Balances, U.S. Imports, Industrial Production, and Factory Orders, only affect the price of the 10-year note. Finally, one announcement, Civilian Unemployment, only affects the price of the two-year note.

In summary, nine announcements significantly affect the price of the T-bill, 13 announcements affect the price of the two-year note, 16 announcements affect the price of the 10-year note, while 10 announcements affect the price of the 30-year bond. These differential effects on different segments of the yield curve could be the result of chance, or it could be that different announcements affect in different ways short- vs. long-term expectations.

To explore this issue further, we regressed price changes on announcement surprises and included the price change of a bond of different maturity as an additional independent variable. When we regress note and bond returns on the three-month bill return, the surprises that are significant maintain their significance. When we regress the 30-year bond return on announcement surprises and the three-month bill return, seven of 10 announcements are still significant. When we run the same regression for the 10-year note, 12 of 16 announcements maintain their significance. And, for the two-year note, only one announcement loses significance. When we regress the note and bond returns on other note or bond returns, most significant announcements lose their significance. The number of

[9]Here, and in the remainder 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.

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TABLE 2

The Effect of Announcement Surprises on Bonds of Different Maturity

		3-Month Bill		2-Year Note		10-Year Note		30-Year Bond	
	σ_I	Surprise Coeff.	R^2	Surprise Coeff.	R^2	Surprise Coeff.	R^2	Surprise Coeff.	R^2
1. Civilian Unemployment	0.169	0.004	0.644	0.053**	0.677	0.112	0.607	−0.003	0.567
2. Consumer Price Index	0.126	−0.001	0.162	−0.033**	0.281	−0.142**	0.374	−0.205**	0.446
3. Durable Goods Orders	2.735	−0.004**	0.481	−0.056**	0.552	−0.118**	0.399	−0.211*	0.498
4. Housing Starts	0.070	−0.002**	0.335	−0.031**	0.453	−0.075*	0.181	−0.119**	0.227
5. Index of Leading Ind.	0.153	−0.001	0.697	−0.006	0.772	−0.029	0.678	−0.019	0.003
6. Initial Jobless Claims	19.550	0.001**	0.031	0.020**	0.097	0.057**	0.068	0.052**	0.051
7. Merchand. Trade Bal.	1.443	0.000	0.004	0.005	0.043	0.052*	0.109	0.051	0.037
8. Nonfarm Payrolls	109.920	−0.014**	0.644	−0.160**	0.677	−0.416**	0.607	−0.592**	0.567
9. Producer Price Index	0.242	−0.002**	0.371	−0.044**	0.448	−0.184**	0.473	−0.333**	0.437
10. Retail Sales	0.496	−0.003**	0.346	−0.037**	0.320	−0.117**	0.390	−0.122	0.175
11. U.S. Imports	1.391	0.000	0.004	0.001	0.057	0.031	0.117	0.024	0.035
12. U.S. Exports	1.203	0.000	0.004	−0.008	0.057	−0.058*	0.117	−0.054	0.035
13. Capacity Utilization	0.318	−0.002	0.195	−0.029**	0.269	−0.070*	0.232	−0.055	0.135
14. Industrial Production	0.196	0.000	0.195	−0.010	0.269	−0.054**	0.232	−0.053	0.135
15. Business Inventories	0.243	0.000	0.000	0.000	0.000	0.017	0.014	0.040	0.057
16. Construction Spending	0.933	0.000	0.267	0.002	0.569	0.018	0.408	−0.002	0.432
17. Consumer Confidence	5.065	−0.002**	0.458	−0.031**	0.352	−0.109**	0.326	−0.088*	0.239
18. Factory Orders	0.500	0.000	0.007	−0.007	0.026	−0.040**	0.091	−0.034	0.017
19. NAPM Index	2.183	−0.002**	0.324	−0.061**	0.575	−0.147**	0.392	−0.233**	0.412
20. New Home Sales	61.490	−0.001**	0.314	−0.031**	0.352	−0.089**	0.252	−0.152**	0.254
21. Personal Consumption	0.187	0.000	0.065	−0.003	0.031	−0.017	0.062	0.011	0.006
22. Personal Income	0.309	0.001	0.065	−0.011	0.031	−0.047	0.062	−0.012	0.006
23. Treasury Budget	5.029	0.000	0.012	0.002	0.010	−0.002	0.000	−0.005	0.002
24. M1 Medians	3.063	−0.001	0.008	−0.002	0.295	−0.006	0.170	−0.011	0.114
25. M2 Medians	5.098	0.002	0.008	−0.011**	0.295	−0.020**	0.170	−0.028*	0.114
26. M3 Medians	6.759	−0.003	0.008	−0.004	0.295	−0.002	0.170	0.005	0.114

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

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

where P_{30it} and P_{-5it} are the prices of the instrument 30 and five minutes, respectively, after announcement i, S_{it} is the standardized surprise for announcement type i. The subscript k denotes other announcements released at the same time as announcement i. Table 2 reports standard deviations of the surprises σ_i, slope coefficients β_{1i}, and R^2s. The sample covers July 1, 1991–September 29, 1995.

* and ** indicate that the coefficients are significant at the 5% and 1% levels, respectively.

announcements that remain significant ranges from one (when we regress the 30-year on the two-year) to four (when we regress the 10-year on the two-year). Thus, the return on any intermediate or long maturity instrument seems to serve as a factor for the returns on other intermediate and long maturity instruments, but the three-month bill return does not. These results support the notion that at least two factors are at work in the yield curve around announcement times.

Second, the R^2 for the significant announcements can be quite high. For instance, in the case of the two-year note, the R^2 for the employment announcement (Civilian Unemployment and Nonfarm Payrolls) is 67.7%. This indicates that a substantial portion of price volatility around announcement time is explained by public news.

Third, 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 the availability of the MMS forecast data allows us to calculate surprises. This is to be contrasted with Fleming and Remolona (1999), who pool the CPI, PPI,

https://doi.org/10.2307/2676223 Published online by Cambridge University Press

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and employment announcements together, and Ederington and Lee (1993), who identify an announcement with a dummy variable and are not able to distinguish the different components of an announcement, or to separate between concurring announcements. Consider, for example, Nonfarm Payrolls and the Civilian Unemployment rate. These announcements are always released together at 8:30AM. Thus, without knowing the surprise components of the two announcements, there is no way to separate their influence. However, Table 2 shows that the surprises in the Civilian Unemployment rate affect prices much less than surprises in Nonfarm Payrolls. We show that the Nonfarm Payroll figure 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. 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.

Fourth, we find that for most announcements, the size of the effect generally increases with the maturity of the instrument. For the Nonfarm Payroll announcement, for example, the surprise coefficient (in absolute value) increases from 0.014 for the three-month bill to 0.160 for the two-year note, to 0.416 for the 10-year note, and to 0.592 for the 30-year bond. This is consistent with the notion that longer maturity bond prices are more volatile (duration increases with maturity).[10]

C. 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 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.[11]

Regarding the size of the price reaction, the following discussion concentrates on the behavior of the price of the 10-year note, which is representative of the behavior of intermediate- and long-term bond prices. The 16 economic announcements that significantly affect the 10-year note have different impacts in

[10]To examine whether the announcement effects are different across maturities, we calculate the covariance matrix of the estimates of the slope coefficients for the four regressions (one for each maturity considered). We then construct Wald tests to examine whether the responses are statistically different across maturities for the eight announcements that have a significant impact on all bond prices. For each announcement, we perform individual pair-wise tests that the coefficients are equal, as well as a joint test that all coefficients are equal. Out of a total of 56 tests (48 pair-wise tests and eight joint tests), only in six cases do we fail to reject that the coefficients are different at the 5% level. Hence, we conclude that the null hypothesis that the effect is the same across maturities is strongly rejected.

[11]King and Watson (1994), (1996) document the existence of an inflation-output and an inflation-unemployment tradeoff in U.S. post-war data.

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 10-year note is 0.47%. Thus, a one standard deviation surprise in Nonfarm Payrolls, corresponding to an increase in Nonfarm Payrolls of 110,000, leads to a price change of about 89% of the normal daily volatility of price changes.[12] Next in importance is PPI. A one standard deviation surprise in PPI, corresponding to a 0.24% monthly variation in the index, 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. Housing Starts, Initial Jobless Claims, U.S. Exports, Capacity Utilization, Industrial Production, and New Home Sales have effects between 12% and 19% of daily volatility. Finally, Merchandise Trade Balances, Factory Orders, and M2 Medians have the smallest effect on bond prices, with effects between 4% and 11% percent of daily volatility.

D. Speed of Impact

An 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 10-year note. Table 3 presents the results of the following regression,

$$(5) \qquad (P_{30it} - P_{\tau it})/P_{\tau it} \quad = \quad \gamma_{0i} + \gamma_{1i} S_{it} + \sum\nolimits_{k=1}^{K} \gamma_{k+1,i} S_{i_k t} + e_{it},$$

where $P_{\tau it}$ is the price τ minutes after the announcement. The regression is performed for the 16 significant announcements identified in Table 2. 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, allowing us to identify the lowest value of τ for which the price reaction is not significant. This corresponds to the time period needed for the surprise to be fully incorporated into prices.

Of the 16 announcements, only five significantly affect prices on or after $\tau = 1$:[13] Merchandise Trade Balances, U.S. Exports, Capacity Utilization, Factory Orders, and NAPM Index. None are significant beyond $\tau = 15$. Thus, even for these six announcements, information is rapidly incorporated into prices. Moreover, the pattern of significance for Merchandise Trade Balances, U.S. Exports, and Factory Orders is erratic, which casts some doubt on the relevance of these delayed price effects.

An important caveat in interpreting the statistical significance of the coefficients reported in Table 3 is that this is the significance of individual coefficients

[12]The second column of Table 3 reports the standard deviation of the surprises for each variable. This, together with the economic units reported in Table 1, facilitates an economic interpretation of the results.

[13]Note that our "time 0" after an announcement actually corresponds to any time between from 0 to 59 seconds after the announcement. This is because the GovPX digital ticker feed contains messages that reach the market every 60 seconds, but not necessarily on the minute.

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TABLE 3

Speed of Adjustment to New Economic Information

	−2	−1	0	1	2	3	4	5	10	15	20	25
2. Consumer Price Index	−0.107**	−0.102*	−0.011	−0.016	−0.015	−0.005	−0.012	0.002	−0.011	0.008	0.008	0.003
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. Housing Starts	−0.098**	−0.107**	−0.051	−0.037	−0.036	−0.035	−0.020	−0.022	−0.007	−0.012	−0.008	0.001
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
7. Merchand. Trade Bal.	0.021	0.043*	0.024	0.032*	0.022	0.038*	0.019	0.017	0.020	0.021**	0.011	0.007
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
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
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
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
13. Capacity Util.	−0.073**	−0.076**	−0.047*	−0.039*	−0.041*	−0.052**	−0.046*	−0.045*	−0.023	−0.013	−0.013	−0.016**
14. Industrial Prod.	−0.055**	−0.054**	−0.031	−0.007	−0.007	−0.008	−0.004	−0.010	−0.011	−0.007	−0.011	−0.004
17. Consumer Confid.	−0.098**	−0.082**	−0.041	0.018	−0.002	−0.001	0.004	0.000	−0.003	0.002	−0.011	−0.012
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
19. NAPM Index	−0.152**	−0.145**	−0.101**	−0.108**	−0.078**	−0.079**	−0.067**	−0.054**	−0.050**	−0.029**	−0.026	0.000
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
25. M2 Medians	−0.017**	−0.017**	−0.016**	−0.008	0.004	0.003	0.001	0.005	0.000	0.004	0.008	0.002

For each announcement i, we run the following regression,

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

where P_{30it} is the price of the 10-year note 30 minutes after announcement i, $P_{\tau ti}$ is the price of the 10-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. Table 3 reports the coefficient γ_{1i} for each time horizon for all announcements found to be significant for the 10-year note. The sample covers July 1, 1991–September 29, 1995.

* and ** indicate that the coefficients are significant at the 5% and 1% levels, respectively.

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only, not the joint significance of groups of coefficients. This difference is important, given the overlapping nature of the regressions. In fact, consider a given announcement *i*. In regressions for different values of the horizon τ, the dependent variable is measured over overlapping periods and the residuals across regressions are positively correlated. Hence, the estimates of the slope coefficients in different regressions are also positively correlated. This means that the joint significance of groups of coefficients is likely to be much less pronounced than the significance of individual coefficients.

The high speed of adjustment is also documented by the graphs reported in Figure 1, which shows the average percentage price change of the 10-year note in response to the first four significant announcements released at 8:30AM. The figure also shows that the reaction of prices to positive and negative surprises is roughly symmetric.

The almost instantaneous and significant adjustment of prices to public news suggests that a jump component is a needed ingredient in a realistic model of interest rate dynamics. The introduction of jumps in models of the short rate process has been advocated, for example, by Das (1999), while Das and Foresi (1996) provide solutions for bond prices when the short rate follows a jump-diffusion process.

IV. Economic News and Bond Trading

This section studies the effects of economic announcements on trading volume, bid-ask spreads, and price volatility. In this analysis, we focus on the three-month bill and the 10-year note whose price behavior is representative of short-term and intermediate- to long-term instruments, respectively. We concentrate on the announcements that significantly affect the price of the two instruments.[14]

A. Trading Volume

Table 4 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 10-year note and the three-month bill, together with *t*-statistics that the two average trading volumes on announcement and non-announcement days are equal.

For the 10-year note, we find consistent patterns of volume for each of the announcements that have a significant impact on prices, with the exception of Consumer Confidence. In the five-minute period ending immediately after the

[14]We do not report the results for announcements that do not have a significant impact on prices. The impact of these announcements depends on the amount of overlap with other announcements and the importance of the concurrent announcements. For example, consider the Treasury Budget and Business Inventory announcements, which do not have a significant price effect and have no concurrent announcement (see Table 1). The bid-ask spread and price volatility of the 10-year note are unaffected by these two announcements, while trading volume is slightly higher than normal for Business Inventories. In contrast, the Index of Leading Indicators, which also has an insignificant price effect, is concurrent with a number of important announcements and shows patterns in trading volume, bid-ask spread, and volatility, similar to the concurrent announcements.

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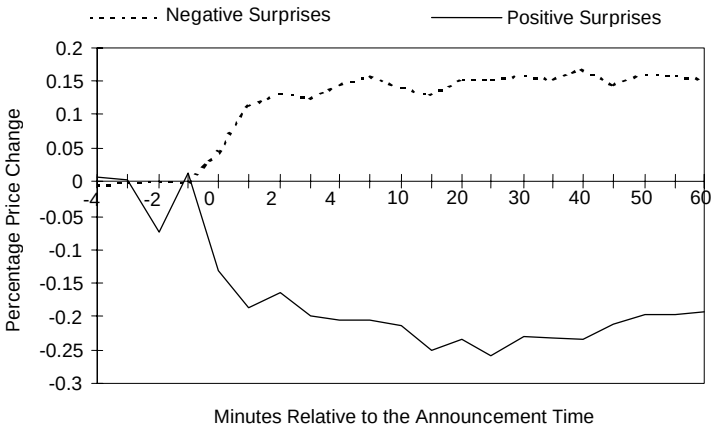
FIGURE 1

Price Response of the 10-Year Treasury Note to Selected Economic Announcements

1A. Consumer Price Index



1B. Durable Goods Orders

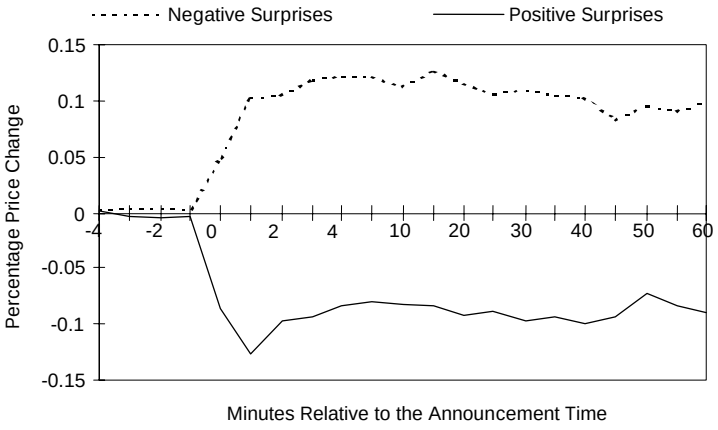


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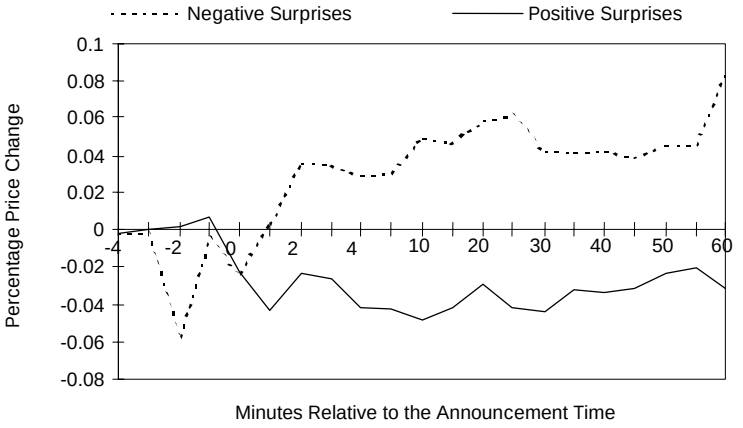
FIGURE 1 (continued)

Price Response of the 10-Year Treasury Note to Selected Economic Announcements

1C. Housing Starts



1D. Initial Jobless Claims

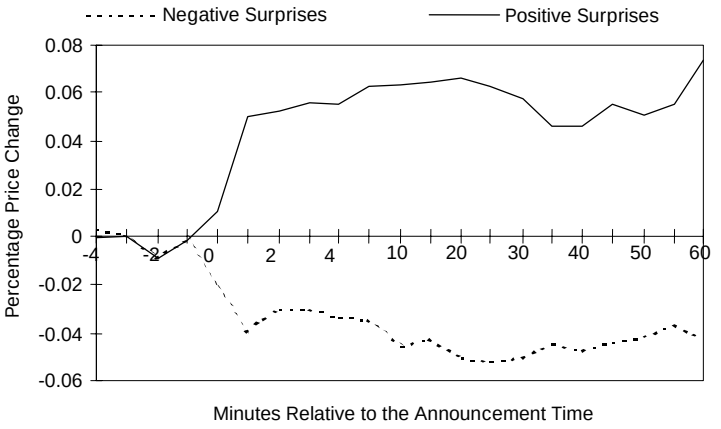


Figure 1 depicts the average percentage price change measured from five minutes before the announcement. Observations are grouped by the sign of the surprise. The sample covers July 1, 1991–September 29, 1995.

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 10 minutes, up to almost twice the size of the non-announcement

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TABLE 4

Mean Trading Volume of Announcement and Non-Announcement Days

	−30 to −5	−5 to 0	0 to 5	5 to 15	15 to 30	30 to 45	45 to 60
Panel A. Ten-Year Note							
2. Consumer Price Index	1.583**	0.850	1.916**	2.380**	1.890**	1.932**	1.699**
3. Durable Goods Orders	1.048	0.683*	1.547**	1.713**	1.416**	1.201*	1.114
4. Housing Starts	1.102	0.777	1.571**	1.821**	1.480**	1.446**	1.303**
6. Initial Jobless Claims	1.121	0.753**	1.466**	1.741**	1.500**	1.398**	1.279**
9. Producer Price Index	1.539**	0.885	2.040**	2.533**	2.063**	1.756**	1.621**
10. Retail Sales	1.540**	0.730*	1.955**	2.391**	1.923**	1.875**	1.551**
1. Civilian Unemployment & 8. Nonfarm Payrolls	1.438**	0.728*	1.615**	2.355**	2.377**	2.127**	1.768**
7. Merchandise Trade Balances, 11. U.S. Imports, & 12. U.S. Exports	1.295*	0.704*	1.359**	1.764**	1.356**	1.430**	1.348**
13. Capacity Utilization & 14. Industrial Production	1.289**	1.138	1.771**	1.916**	1.777**	1.458**	1.507**
17. Consumer Confidence	1.058	1.405**	1.795**	1.767**	1.704**	1.391**	1.240*
18. Factory Orders	1.324**	1.163	1.742**	1.706**	1.657**	1.436**	1.324**
20. New Home Sales	1.190	1.158	1.923**	1.923**	1.537**	1.339**	1.396**
16. Construction Spending & 19. NAPM Index	0.964	1.208	1.665**	1.822**	1.616**	1.468**	1.313**
24. M1 Medians, 25. M2 Medians, & 26. M3 Medians	1.291**	1.215	1.272**	1.549**	1.400**	1.373**	1.383
Panel B. Three-Month Bill							
3. Durable Goods Orders	1.029	0.679	2.420*	1.657*	1.471	1.172	1.358
4. Housing Starts	1.308	1.060	2.581**	2.175**	1.935**	0.908	2.129**
6. Initial Jobless Claims	0.860	0.971	1.662*	1.522*	1.283	1.141	1.616**
9. Producer Price Index	1.524	1.394	2.137*	1.468	1.851*	1.418	2.041**
10. Retail Sales	1.108	1.035	1.193	1.364	1.412	1.493	1.630*
1. Civilian Unemployment & 8. Nonfarm Payrolls	1.664	1.391	0.854	1.754*	1.271	1.752**	1.504
17. Consumer Confidence	1.177	2.323*	1.547	1.875**	2.160**	2.500**	1.463
20. New Home Sales	0.906	1.525	1.241	1.336	1.411	1.205	1.190
16. Construction Spending & 19. NAPM Index	1.055	1.035	1.791	1.404	1.582*	1.170	0.805

Mean trading volume is calculated around announcements and compared to the mean trading volume at the same time of day on non-announcement 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 non-announcement days. Panel A reports the results for the announcements found to have a significant impact on the 10-year note. Panel B reports the results for the three-month bill. The sample covers July 1, 1991–September 29, 1995.

* and ** indicate that the two means are significantly different at the 5% and 1% levels, respectively.

average, but then declines after another 15 minutes, while still remaining above normal.[15] For the three-month bill, we find much weaker patterns in volume. For only four of the nine announcements that significantly affect price, we find a significant increase in volume during the five minutes following the announcement.

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

[15]This pattern is strongest for the 8:30AM announcements. 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.

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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.[16] 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.

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 10-year note. From Table 2, we see that a one standard deviation surprise in Nonfarm Payroll triggers a price change that 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 five to 15 minutes after the announcement (the PPI announcement) is less than twice as big as the smallest increment (the money announcement).

Second, the announcements that affect prices most are not those that have the greatest effect on volume. Consider again the 10-year note and trading volume during the interval of five to 15 minutes after the announcement. The Nonfarm Payroll-Civilian Unemployment announcement has only the fourth largest effect on volume. From Table 2, 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 Table 2).[17]

Third, the effects of announcements on volume persist even beyond 45 minutes after the release, yet we know from Table 3 that for most of the announcements that significantly affect the price of the 10-year note, the impact is exhausted within the first minute after the release. In particular, we noted that for the CPI and the PPI announcements, we do not have any significant adjustment in the price of the 10-year note beyond 8:30AM. At the same time, trading volume up to 8:30AM is not significantly different from its average at that time. This means that the adjustment of prices to public news takes place with no unusual trading, supporting the notion that at this initial stage, private information plays little or no role.

Finally, we can compare our results to those obtained by Fleming and Remolona (1999). Similarly to us, they find a substantial increase in trading volume up to half an hour after the announcements. Their study misses the fact that several announcements in addition to CPI, PPI, and the employment report lead to significant increases in trading activity. The Retail Sales announcement, for example, leads to a relative increase in trading in the 10-year note comparable to that of the CPI announcement. Their study also misses the fact that the increase in

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

[17]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 9:15AM announcements may be affected by important announcements released 45 minutes earlier.

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trading volume is much stronger for intermediate maturity bonds than for money market instruments.

B. Bid-Ask Spreads

Table 5 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 10-year note and for the three-month bill.[18] The average spreads are 2.6 cents and 0.26 cents per $100 price, for the bill and the note, respectively.

For most announcements, for both the 10-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 15 minutes for the 10-year note. Spreads tend to remain wide somewhat longer for the three-month bill: in the case of the employment report, spreads are still twice their normal value 45 minutes after the announcement.

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 10-year note and the three-month bill. Second, in the case of the 10-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.

Our results are consistent with Fleming and Remolona (1999), who also document a relatively quick reversion of spreads toward their normal values. In addition, we show that of the three announcements that Fleming and Remolona pool together, the employment announcement has roughly twice the impact as the other two. We also show that several other announcements significantly affect

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

TABLE 5

Mean Bid-Ask Spreads on Announcement and Non-Announcement Days

	−30	−5	0	5	15	30	45	60
Panel A. Ten-Year Note								
2. Consumer Price Index	0.815	1.020	2.517**	0.898	0.885	0.847	1.033	1.087
3. Durable Goods Orders	0.999	0.886	2.132**	1.008	0.842	0.897	1.004	1.089
4. Housing Starts	0.790*	1.177	1.758**	1.025	0.854	0.988	0.980	0.909
6. Initial Jobless Claims	0.919	1.018	1.853**	0.989	0.972	0.894	0.981	1.064
9. Producer Price Index	0.947	0.982	2.061**	1.331**	0.857	1.076	1.084	0.942
10. Retail Sales	0.832	1.012	2.298**	0.932	0.778*	1.022	1.147	1.071
1. Civilian Unemployment & 8. Nonfarm Payrolls	0.842	1.274*	5.459**	1.937**	1.040	1.288*	1.527**	1.218
7. Merchand. Trade Bal., 11. U.S. Imports, & 12. U.S. Exports	0.965	1.034	1.672**	0.795	1.026	0.929	1.265*	0.923
13. Capacity Utilization & 14. Industrial Production	0.907	1.034	1.840**	1.256*	1.027	0.962	1.130	0.907
17 Consumer Confidence	0.942	0.906	1.406**	0.977	1.184	1.019	1.226*	0.900
18. Factory Orders	0.931	1.060	1.215*	0.904	0.812	1.028	0.905	0.883
20. New Home Sales	0.751*	1.060	1.516**	1.375**	1.019	1.068	1.170	0.889
16. Construction Spending & 19. NAPM Index	0.859	0.904	1.524**	0.982	1.029	1.076	1.048	0.822**
24. M1 Medians,	1.020	0.903	1.242**	1.062	1.116	1.079	0.961	0.814
25. M2 Medians, &	0.358	−1.125	3.140	0.552	1.661	1.027	−0.479	−1.166
26. M3 Medians								
Panel B. Three-Month Bill								
3. Durable Goods Orders	0.872	0.773	1.124	1.537**	0.901	1.007	0.922	0.834
4. Housing Starts	0.835	0.659**	0.960	0.871	0.790	0.808	0.777	0.840
6. Initial Jobless Claims	1.031	0.804**	1.152	1.247*	0.962	0.891	0.966	0.829*
9. Producer Price Index	0.784	0.758	1.323*	1.490**	1.419*	1.167	0.925	0.977
10. Retail Sales	0.826	0.686*	1.431**	1.759**	1.211	0.788	1.096	1.067
1. Civilian Unemployment & 8. Nonfarm Payrolls	0.938	1.236	1.329*	2.981**	2.598**	2.035**	1.944**	1.629**
17. Consumer Confidence	0.634*	0.870	1.128	1.342*	0.960	0.832	0.735*	0.050
20. New Home Sales	0.796	1.034	1.306*	1.531**	1.261	1.178	1.188	1.037
16. Construction Spending & 19. NAPM Index	1.000	1.101	1.492**	1.892**	1.386**	1.136	1.033	0.832

Mean percentage bid-ask spread is calculated around announcements and compared to the mean bid-ask spread at the same time of day on non-announcement 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 non-announcement days. Panel A reports the results for the announcements found to have a significant impact on the 10-year note. Panel B reports the results for the three-month bill. The sample covers July 1, 1991–September 29, 1995.

* and ** indicate that the two means are significantly different at the 5% and 1% levels, respectively.

spreads, and that the behavior of spreads differs according to the maturity of the instrument.

C. Price Volatility

We measure price volatility around the announcements by the ratio of the mean absolute value of price changes on announcement days over the mean absolute value of price changes on non-announcement days, during the same time

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interval.[19] The time intervals that we consider start 30 to five minutes before the announcements and end 45 to 60 minutes after the announcements. Volatility ratios are reported in Table 6.

For both the 10-year note and the three-month bill, the relative size of the volatility effects reflects the relative size of the price effects documented in Sec-

TABLE 6

Mean Price Deviations on Announcement and Non-Announcement Days

	−30 to −5	−5 to 0	0 to 5	5 to 15	15 to 30	30 to 45	45 to 60
Panel A. Ten-Year Note							
2. Consumer Price Index	0.648*	2.132**	4.682**	1.806**	1.596**	1.377*	1.786**
3. Durable Goods Orders	0.831	1.741**	3.608**	1.490**	0.920	0.878	1.000
4. Housing Starts	0.801	0.956	2.267**	1.582**	1.132	1.126	0.996
6. Initial Jobless Claims	0.920	1.197	2.696**	1.551**	1.129	1.170	1.060
9. Producer Price Index	1.293	2.237**	6.001**	2.306**	1.749**	1.488**	1.318*
10. Retail Sales	1.174	1.424*	5.460**	2.059**	1.738**	1.336*	1.484**
1. Civilian Unemployment & 8. Nonfarm Payrolls	0.731	2.905**	10.187**	4.581**	2.318**	2.385**	2.133**
7. Merchand. Trade Bal., 11. U.S. Imports, & 12. U.S. Exports	0.898	1.038	2.106**	1.672**	1.184	1.230	1.170
13. Capacity Utilization & 14. Industrial Production	0.956	1.561**	2.862**	2.050**	1.608**	1.461**	1.455**
17. Consumer Confidence	0.223**	0.882	0.805	0.624**	0.695*	0.768	0.725
18. Factory Orders	0.325**	1.039	1.045	0.580**	0.667*	0.919	1.866**
20. New Home Sales	0.223**	0.808	0.971	0.527**	0.644*	0.949	1.295
16. Construction Spending & 19. NAPM Index	0.785	1.469**	3.202**	1.787**	1.385*	1.380**	1.049
24. M1 Medians, 25. M2 Medians, & 26. M3 Medians	1.062	1.156	1.831**	1.308*	1.216*	1.138	0.896
Panel B. Three-Month Bill							
3. Durable Goods Orders	1.028	1.459	4.448**	1.514**	1.613**	1.299	1.043
4. Housing Starts	0.884	0.960	2.724**	1.297	1.298	0.891	1.164
6. Initial Jobless Claims	1.022	1.193	3.543**	1.674**	1.468**	1.158	1.287*
9. Producer Price Index	1.045	1.961**	5.992**	2.221**	1.944**	1.230	1.448*
10. Retail Sales	0.861	1.985**	6.279**	2.176**	1.485**	1.392	1.929**
1. Civilian Unemployment & 8. Nonfarm Payrolls	1.342	2.204**	19.178**	4.430**	3.057**	3.261**	1.876**
17. Consumer Confidence	0.272**	1.345	1.075	0.543	0.838	0.744	1.085
20. New Home Sales	0.352**	0.656	0.924	0.493*	0.771	0.718	1.140
16. Construction Spending & 19. NAPM Index	0.913	2.116**	3.991**	2.199**	1.440	1.404	1.109

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 at times relative to the announcement time. 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. Panel A reports the results for the announcements found to have a significant impact on the 10-year note. Panel B reports the results for the three-month bill. The sample covers July 1, 1991–September 29, 1995.

* and ** indicate that the two means are significantly different at the 5% and 1% levels, respectively.

[19] By standardizing the announcement day volatility by non-announcement day volatility at the same time of the day, we adjust for possible systematic intraday volatility patterns. The presence of such patterns in the bond futures market is examined in Bollerslev, Cai, and Song (1999).

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tion III. For example, for the 10-year note, during the time interval zero to five minutes after the announcement, the largest increases in price volatility are for the employment announcement and for the PPI announcement, with ratios of 10.2 and six, respectively. For the three-month bill, the largest increase in price volatility also corresponds to the employment announcement, with a ratio of 19.2 for the same time interval.

It is worth noting that for many of the announcements, the volatility effects persist for up to 60 minutes after the release of the announcement. For example, for the 10-year note, volatility is still more than twice the normal during the time interval 30 to 45 minutes after the employment announcement. This persistence is similar to the persistence in trading volume discussed earlier and is in contrast to the rapid adjustment of prices to new information and the relative quick reversion of spreads to their normal values.

Again, we can compare our results to those of Fleming and Remolona (1999). We find that the increase in volatility is much more pronounced for the employment report than for the CPI and PPI announcements. As in the analysis of volume and spreads, we find that other announcements significantly affect volatility and that volatility effects differ according to maturity.

Finally, we can combine our analysis of volatility and trading patterns with the analysis of price responses of the previous section. We find that the surge in volatility and trading volume persists well beyond the response of prices to surprises. This suggests that only the initial volatility (first minute or so) reflects the adjustment to public information. Informed trading is likely to play a role in a second phase, during the 15 minutes or so that bid-ask spreads are wider than usual. In a third phase after the announcement, volume and volatility are likely to be driven by liquidity trading.

V. 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 intraday 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 and to measure the role of public information in explaining volatility.

We find that several announcements significantly affect the price of various instruments and that these effects are significantly different according to maturity. For most announcements, public news tends to be incorporated very quickly into prices (one minute or less). These results suggest that at least two factors are at work in the yield curve and that jumps are a needed component of interest rate dynamics. In addition, we find that surprises explain a substantial portion of price volatility and that bid-ask spreads tend to revert quickly to their normal levels, suggesting that public information is rapidly absorbed into prices.

https://doi.org/10.2307/2676223 Published online by Cambridge University Press

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