

Events that shook the market

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Abstract

Tick data on the S&P 500 futures contract and newswire searches are used to match events to large one-to five-minute stock price changes. Sixty-nine events that led to large stock price changes are identified between 1982 and 1999, 53 of which are directly or indirectly related to monetary policy. Many large stock price changes have no events associated with them.

1. Introduction

Although it is obvious that stock prices respond to events, it is not easy to match particular events to particular changes in stock prices. For example, Cutler, Poterba and Summers (1989) chose the 50 largest daily changes in the S&P 500 index from 1946 through 1987 and attempted to find an explanation of each change in the next day's *New York Times*. They found few cases in which it could be said with any confidence that a particular event led to the change. A problem with studies like this is that the daily interval may be too long, since many events can take place in a 24-hour period.

In this paper tick data on the S&P 500 futures contract and newswire searches are used to match events to stock price changes. The tick data are used to create one-to five-minute price changes. Although it is somewhat arbitrary what one takes as a "large" price change, for purposes of this study "large" is taken to be a one-to five-minute change greater than or equal to 0.75% in absolute value. The standard deviation of the 1,918,678 one-minute price changes computed in this study is 0.048%, and the standard deviation of the 1,688,955 five-minute price changes is 0.112%. A change of 0.75% is thus a very large change.

Given each large change, newswires were searched to see if an event could be found that led to the change. Table 1, which is at the end of this paper, lists the large price changes and the events that were found. This paper is essentially a discussion of Table 1. There are 4,417 trading days in the dataset (between 21 April 1982 and 29 October 1999), and in 220 of these days at least one large price change occurred, ie a one-to five-minute change greater than or equal to 0.75% in absolute value. Events were found for 69 of these days.

Knowledge of the 69 events in Table 1 may prove useful in other studies. Each of these events is big in that it changed the total value of US equities by a large amount rapidly. This information may be useful in examining changes in individual stock prices, both absolute and relative to price changes of other stocks. From a macroeconomic perspective, the events are macro shocks, and knowledge of these shocks may be useful in examining various macroeconomic questions.

It is important to stress that this study is purely descriptive. No attempt is made to explain why a particular event led to the large price change, why other similar events did not lead to large price changes, why many large price changes have no events associated with them, and so on. The main contribution of this paper is simply to list the 69 events.²

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² There does not appear to be other studies in which events have been identified in the way done in this paper. Mitchell and Mulherin (1994) and Berry and Howe (1994) examine the effects of the amount of news per unit of time on stock prices and trading volume. Niederhoffer (1971) examines the effects of the world events on daily stock prices. Boyd, Hu and Jagannathan (1999) examine daily S&P 500 changes around days in which there is an employment announcement. French and Roll (1986) examine the volatility of individual stock prices during trading and non-trading hours. Wood, McInsh and Ord (1985) examine the behaviour of a minute-by-minute market return index. Harris (1986) examines the behaviour of portfolio returns over 15-minute intervals. A number of studies have examined the effects of announcements on *daily* changes in stock prices, and these studies are discussed in Section 4.

It is also important to stress that with a very few exceptions it is almost certain that each of the 69 events listed in Table 1 caused the particular price change. The events can thus be interpreted as "facts". For example, it is almost certain that the five-minute price decrease of 0.79% on 16 July 1982 was essentially all due to the 4.10 pm money supply announcement (see line 8, Table 1). There would likely have been, of course, a price change had there been no announcement, since the price generally changes each minute, but with a standard deviation of 0.112%, a typical price change is very small relative to a change of 0.79%. For all intents and purposes one can attribute all of the price change to the money supply announcement.

A way of thinking about the events is the following. Consider asking stock brokers a few minutes after the occurrence of one of the price changes in Table 1 that is associated with an event what led, if anything, to the change. The main point here is that almost without exception the brokers would say the event. Some events may have been missed - more will be said about this later - but there is little doubt that each of the 69 events chosen led to the particular price change.

The construction of Table 1 is discussed in Section 2, and the results are discussed in Sections 3 and 4.

2. The construction of Table 1

The price of an S&P 500 futures contract follows closely the value of the S&P 500 index. Since the S&P 500 index includes most US stocks by market value, the price of an S&P 500 futures contract is a good indicator of the total value of US equities. Tick data are available for the S&P 500 futures contracts from April 1982 on.³ For "Regular Trading Hours" (RTH) the tick data per day begin at 10.00 am prior to 30 September 1985, and at 9.30 am after that.⁴ The RTH data end at 4.15pm, which is 15 minutes after the regular market has closed. Beginning in 1994 the contracts were traded after hours on the GLOBEX market, and tick data are available for these trades as well. These data begin at 4.30 pm and end at 9.15 am the next day. The GLOBEX market is closed Friday night and all day Saturday. It opens at 6.30 pm Sunday night.

For this study the RTH data begin in 21 April 1982 and end in 29 October 1999. Data are missing for the last half of December 1991 - the 1991 data end 13 December. The GLOBEX data begin in 4 January 1994 and end in 29 October 1999. Data are missing for the last half of 1998 - the 1998 GLOBEX data end 31 July. Many government announcements of macroeconomic data occur at 8.30 am, and since the GLOBEX market is open at this time, it can respond immediately to these announcements. Had the GLOBEX market been in existence back to 1982 and tick data been available, it is likely that many more large price changes and associated events would have been found. It is also likely that a number of large price changes and associated events would have been found in GLOBEX data for the last half of 1998 had the data been available.

The one-minute price change was taken to be the price of the last trade in the current minute interval less the price of the last trade in the previous minute interval (all changes in % terms). The two-minute price change was taken to be the price of the last trade in the current minute interval less the price of the last trade in the minute interval two minutes ago, and so on through five-minute price change.

Table 1 lists the following (a large change is always a change greater than or equal to 0.75% in absolute value): (1) all large one-minute price changes; (2) all large two-minute price changes except when at least one of the two one-minute price changes is large; (3) all large three-minute price changes except when at least one of the two two-minute price changes is large; (4) all large four-minute price changes except when at least one of the four one-minute price changes is large or at least one of the three two-minute price changes is large or at least one of the two three-minute price changes is large, and; (5) all large five-minute price changes except when at least one of the five one-minute price changes is large or at least one of the four two-minute price changes is large or at least one of the three three-minute price changes is large or at least one of the two four-minute price changes is large. This procedure finds all the large one- through five-minute price changes without

³ The tick data were purchased from the Futures Industry Institute, which obtains the data from the Chicago Mercantile Exchange.

⁴ All times in this paper are Eastern even though the RTH and GLOBEX markets are in the Central time zone.

duplication. The most actively traded contract on the particular day was used for these calculations. As can be seen from Table 1, there were a total of 1,159 changes chosen.

The “end time” in Table 1 is the time at the end of the k -minute change, where k ranges from 1 to 5. “Vol.” is the total number of ticks in the k -minute interval, and “ave. vol.” is the average number of ticks per minute.

The next step was to see which event, if any, led to the large and rapid change. The Dow Jones Interactive service on the internet was used for this purpose. This service allows one to search for news reports by time of day. The following four news services were searched: *Dow Jones News Service*, *Associated Press Newswire*, *New York Times* and *Wall Street Journal*.

For example, the first case in Table 1 is for 24 June 1982, where at 3.28 pm the price had fallen by 0.85% in the last five minutes. For this case the news services were searched for news reports between 3.00 pm and 4.00 pm to see what happened about 3.23 pm that led to the large change. In this case no news report was found that seemed likely to have led to change.

In the next case in Table 1 an event was found, which was the 4.10 pm announcement that M1 was down \$2.3 billion. In the two minutes following the announcement the price rose 0.82%. Although the regular stock market is closed at 4.00 pm, the RTH market does not close until 4.15 pm, and so the RTH market has time to respond to the money supply announcements.

In some cases an event was found that seemed almost surely to have led to the price change, but for which no exact time could be found. In these cases “?time” is used in Table 1 to denote that the exact time of the event was not found. For the 9 October 1990 change it is not completely clear that the Brazil event in fact led to the change, and this is indicated by a “(?)” in the table. For the 1 August 1997 change is unclear which of the three events listed led to the change, and this is also indicated by a “(?)” in the table.

An important government announcement each month is the employment report. This report is released at 8.30 am, and it contains data from both the household survey and the establishment survey. The main variable of interest from the household survey is the unemployment rate, and the main two variables of interest from the establishment survey are the number of jobs (called “payrolls”) and average hourly earnings. The variable that gets the most attention is the payroll variable, and so the payroll announcement is listed in Table 1. The “event” is, however, the entire employment report.

To save space in Table 1, not all large changes following an initial large change are listed for a particular day, especially on highly volatile days. When some changes are omitted, it is always indicated how many changes are omitted.⁵

3. Discussion of Table 1

Although, as discussed in Section 1, it is almost certain that each of the 69 events listed in Table 1 caused the particular price change, it may be that some events have been missed (aside from the missing RTH and GLOBEX data). The most likely error is an event for which there was no news report. Less likely is a news report that was listed in the search but that was not noticed as an important event. The number of events missed is likely to be small, probably fewer than ten. Remember, however, that many more large price changes and events would likely have been found had the GLOBEX market been in existence prior to 1994.

Assuming that the number of events that have been missed is small, Table 1 shows that there are many large price changes that are not due to identifiable events. There are, for example, no events associated with any of the large number of large price changes in October 1987. Regarding the price changes with no events, consider the thought experiment about stockbrokers mentioned in Section 1. For the price changes with no associated events in Table 1, what would stockbrokers say a few minutes after the change? The argument here is that except for the few events that might have been missed in the newswire searches, the brokers would not come up with a unique event. Some might

⁵ A complete table of all the changes is available. This table in pdf format is on the website mentioned in the introductory footnote. Click “Table 1A” near the bottom of the home page of the website for the table.

say there was no event, and some might mention something non-specific like “profit taking”, “renewed confidence”, “interest rate fears” and the like.

It should be stressed that the events that have been found are not necessarily surprises in the sense of an actual value differing from an expected value, although most of them probably are. Consider, for example, a payroll announcement. Say that market participants believe that there are three possible outcomes regarding the payroll change: 100,000, 300,000 and 500,000 jobs. Assume that market participants weight each possibility equally, so that the expected value is 300,000. Assume also that the participants expect that the Fed will leave the funds rate unchanged if the outcome is 100,000 or 300,000, but raise the funds rate if the outcome is 500,000. Assume finally that participants expect the S&P 500 price to be 1,430 if there is no funds rate change and 1,400 if there is one. The expected value of the price is thus 1,420, which if the participants are risk neutral will be the price before the announcement. In this case even if the actual payroll value is equal to the expected value (300,000), the stock price will change (from 1,420 to 1,430). Simply relieving uncertainty may thus change stock prices even if the announced value is equal to the expected value. The events that have been found are thus not necessarily surprises.

The main results from Table 1 are the following. First, the breakdown of the 69 events is:

- Twenty-two events are money supply or interest rate announcements or testimony by monetary authorities. In 1982 the focus was on money supply announcements, and after that it was on the federal funds rate;
- fourteen events are payroll announcements (employment reports);
- eleven events are CPI or PPI or employment cost index announcements;
- six events concern other macroeconomic announcements (NAPM, retail sales, durable goods, new homes);
- five events concern Iraq;
- four events concern Congressional issues;
- three events concern Brazil or Mexico;
- one event is fear of Larry Summers.

The 31 non-monetary macroeconomic announcements (payroll, CPI, PPI, employment cost and other) are indirectly related to monetary policy in that these announcements may change people’s expectations about future monetary policy. If, for example, there is a large payroll increase, people may think it is more likely that the Fed will tighten in the future because of fear of inflation. If these 31 announcements are added to the 22 direct monetary policy events, this gives 53 of the 69 events that are directly or indirectly related to monetary policy.

Second, the largest response by far was to the cut in the federal funds rate at 3.14 pm on 15 October 1998. The first five one-minute price changes following this announcement were 0.89, 1.00, 1.00, 1.29 and 1.00%. This is roughly a 5% increase in five minutes. The announcement of this rate cut was unusual in that it did not follow a normally scheduled FOMC meeting.

Third, the large price changes are not close to being spread evenly across years. Between 1982 and 1993, before the introduction of the GLOBEX market, the number of days of large price changes per year are respectively: 43, 2, 2, 0, 12, 33, 6, 4, 18, 8, 3 and 1. Between 1994 and 1999 the number of days are respectively: 5, 0, 12, 26, 22 (GLOBEX data for the last half of 1998 missing) and 23 (through October).

Finally, as noted above, many large price changes have no events associated with them.

4. Implications for other studies

It seems clear that no simple model of stock price determination can explain the facts in Table 1. There have, for example, been hundreds of important macroeconomic announcements between 1982 and 1999, and only a small fraction have led to a large stock price change. An adequate model would need to explain why the particular events in Table 1 led to large price changes, while many other seemingly similar events did not. There is also the problem from a model building perspective that there are many large price changes for which there appear to be no obvious causes.

A number of statistical studies have examined the effects of announcements on *daily* changes in stock prices (ie the change from the close of one day to the close of the previous day). The daily % change in a stock index is regressed on estimates of the “surprise” components of announcements, and the components are tested for their statistical significance. The surprise component of an announcement is the difference between the announced value and an estimate of its expected value. The expected value is usually either taken from a survey or to be a prediction from an autoregressive equation.

This literature generally finds that surprise monetary announcements are significant, but little else seems to matter. Schwert (1981), Pearce and Roley (1985) and Hardouvelis (1987) find surprise monetary announcements significant, and McQueen and Roley (1993) find inflation surprises sometimes significant after controlling for different stages of the business cycle. Jain (1988) finds surprise monetary and CPI announcements significant. The results in Table 1 suggest that if anything is to be found significant in explaining stock prices it is likely to be monetary announcements, which is what the literature tends to find. The “facts” in Table 1 thus provide some support to the statistical results using daily data, but they also suggest that an adequate model of stock price determination is likely to be more complicated than the models that have been used so far for the statistical tests.

As noted in Section 1, Cutler, Poterba and Summers (1989) chose the 50 largest daily changes in the S&P 500 index from the 1946 through 1987 and attempted to find an explanation of each change in the next day’s *New York Times*. Of the 50 changes, 17 occurred between 1982 and 1987, which are years included in Table 1. It is interesting that five of these 17 changes occurred on days not listed in Table 1, in other words, on days in which there was not at least one large one- to five-minute price change. Of the 12 changes that occurred on days that are listed in Table 1, none of the price changes has an even associated with it. Table 2 lists the 12 changes and the *New York Times* explanation that Cutler, Poterba and Summers (1989, Table 4) found. It is clear that none of the explanations in Table 2 are obvious causes of the stock price changes. The results in Table 1 are consistent with this in that no events could be found to explain the large price changes on these days.

Haugen, Talmor and Torous (1991) examine daily changes in the Dow Jones Industrial Average between 1897 and 1988. They compute a measure of volatility using the daily data and choose periods of increased and decreased volatility. For the 217 periods of increased volatility that were chosen, they identified events for 28 of them. For the 224 periods of decreased volatility, they identified 18 events. Again, it is difficult with daily data to find events, which is probably the main reason they found so few events over such a long period of time.

Table 2
Twelve large daily S&P 500 price changes

Day	Percent change	<i>New York Times</i> explanation
08.17.82	4.76	Interest rates decline.
08.20.82	3.54	Congress passes Reagan tax bill; prime rate falls.
11.30.82	3.22	“Analysts were at a loss to explain why the Dow jumped so dramatically in the last two hours
09.11.86	– 4.81	Foreign governments refuse to lower interest rates; crackdown on triple witching announced
10.16.87	– 5.16	Fear of trade deficit; fear of higher interest rates; tension with Iran.
10.19.87	– 20.47	Worry over dollar decline and trade deficit; fear of US not supporting dollar.
10.20.87	5.33	Investors looking for “quality stocks”.
10.21.87	9.10	Interest rates continue to fall; deficit talks in Washington; bargain hunting.
10.22.87	– 3.92	Iranian attack on Kuwait oil terminal; fall in markets overseas; analysts predict lower prices.
10.26.87	– 8.28	Fear of budget deficits; margin calls; reaction to falling foreign stocks.
10.29.87	4.46	Deficit reduction talks begin; durable goods orders increase; rallies overseas.
10.30.87	3.33	Dollar stabilises; increase in prices abroad.

Taken from Table 4 in Cutler, Poterba, and Summers (1989).

Fleming and Remolona (1997) (FR) examine five-minute price changes for the five year US Treasury note for the period 23 August 1993 - 19 August 1994. They chose the 25 largest five-minute price changes over this period, and they find that each of these changes was preceded by a macroeconomic announcement. Of these 25 changes, 17 are on days for which S&P 500 futures data exist. Data for these 17 days are presented in Table 3. The five-minute bond price change is presented (taken from Table 3 in Fleming and Remolona (1997)) along with the five-minute S&P 500 futures price change.⁶

The stock price changes in Table 3 are in general fairly large, although not nearly as large as 0.75%, the Table 1 cutoff. It is remarkable that in every case except the last one the bond and stock price changes are in the same direction. The direction is the same in the last case if the same time 1.45-1.50pm is used, but not if 1.16-1.21 pm is used for the stock price. As FR point out (p32), bond and stock prices need not move in the same direction following an announcement, since stock prices depend on expectations of both earnings and interest rates, whereas bond prices depend only on expectations of interest rates. The fact that they do move in the same direction suggests that the announcements mostly affect interest rate expectations.

Finally, Gwilym, McMillan and Speight (1999) examine five-minute stock price changes for the UK market using FTSE-100 data. The data are for the 24 January 1992 - 30 June 1995 period. Among other things, their data show that trading volume is higher around announcement times than otherwise. The results in Table 1 are consistent with this conclusion. For example, note that in general volume is quite high around the 8.30 am announcements in the table.

5. Conclusion

As mentioned in the Introduction, this study is purely descriptive. By focusing on very short time intervals, it has been possible to associate particular events with particular stock price changes, something which is generally not possible to do using daily data. Sixty-nine events have been identified between 1982 and 1999 that led to a one- to five-minute S&P 500 futures price change greater than or equal to 0.75% in absolute value. Knowledge of these events may prove useful in both macroeconomic studies and studies of individual stock prices.

The results in Table 1 suggest that stock price determination is complicated. Many large price changes correspond to no obvious events, and so many large changes appear to have no easy explanation. Also, of the hundreds of fairly similar announcements that have taken place between 1982 and 1999, only a few have led to large price changes (ie those in Table 1), and it does not appear easy to explain why some do and some do not.

⁶ In some cases slightly different time intervals from the FR intervals were used. For the 8.30 am announcements, 8.29-8.34 am instead of 8.30-8.35 am was used, since at least in the S&P 500 futures data an 8.30 am announcement affects the 8.30 am price. For 3 June 1994, 8.30 am employment announcement, FR used 8.40-8.45 am and this was also done here. There was very little change in the price before 8.40 am. For the 2.26 pm announcement of the Federal funds rate on 17 May 1994 FR used 2.35-2.40 pm. In Table 3 both the stock price changes for 2.25-2.30 and 2.35-2.40 pm are presented. Finally, for the 1.17 pm announcement of the Federal funds rate on 16 August 1994, FR used 1.45-1.50 pm, and in Table 3 both the stock price changes for 1.16-1.21 pm and 1.45-1.50 pm are presented.

Table 3
Five-minute bond and stock price changes

Day	Bond interval	Bond change	Stock interval	Stock change	Announcement
01.07.94	8.30-8.35 am	0.282	8.28-8.33 am	0.07	8.30 am: Employment
02.04.94	8.30-8.35 am	0.315	8.29-8.34 am	0.15	8.30 am: Employment
02.04.94	11.05-11.10 am	- 0.259	11.04-11.09 am	- 0.09	11.05 am: Federal funds rate
02.11.94	8.30-8.35 am	0.223	8.29-8.34 am	0.31	8.30 am: PPI, retail sales
04.13.94	8.30-8.35 am	0.224	8.29-8.34 am	0.10	8.30 am: CPI, retail sales
05.06.94	8.30-8.35 am	- 0.536	8.28-8.33 am	- 0.14	8.30 am: Employment
05.11.94	1.40-1.45 pm	- 0.223	1.40-1.45 pm	- 0.37	1.42 pm: 10-year-note auction results
05.12.94	8.30-8.35 am	0.384	8.29-8.34 am	0.43	8.30 am: PPI, retail sales
05.17.94	2.35-2.40 pm	0.221	2.25-2.30 pm	0.33	2.26 pm: Federal funds rate
			2.35-2.40 pm	0.00	
05.27.94	8.30-8.35 am	- 0.343	8.29-8.34 am	0.20	8.30 am: GDP
06.03.94	8.40-8.45 am	- 0.265	8.40-8.45 am	- 0.23	8.30 am: Employment
07.08.94	8.30-8.35 am	- 0.440	8.29-8.34 am	- 0.30	8.30 am: Employment
07.12.94	8.30-8.35 am	0.222	8.29-8.34 am	0.28	8.30 am: PPI
07.14.94	8.30-8.35 am	0.253	8.29-8.34 am	0.11	8.30 am: Retail sales
07.29.94	8.30-8.35 am	0.407	8.29-8.34 am	0.31	8.30 am: GDP
08.05.94	8.30-8.35 am	- 0.590	8.29-8.34 am	- 0.35	8.30 am: Employment
08.16.94	1.45-1.50 pm	- 0.266	1.16-1.21 pm	0.23	1.17 pm: Federal funds rate
			1.45-1.50pm	- 0.09	

Notes: No stock trades at 8.29 am on 1.07.94 and 5.06.94. Changes are percent changes. Bond results and announcement information taken from Table 3 in Fleming and Remolona (1997).

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Table 1
One- to five-minute price changes greater than 0.75% in absolute value

	k-minute-change						Event
	day	k	end time	size	vol.	ave. vol.	
1	06.24.82	5	3.28 pm	- 0.85	23	4.6	none
2	06.25.82	2	4.11 pm	0.82	13	6.5	4.10 pm: M1 down \$2.3 billion.
3	07.06.82	4	3.36 pm	0.79	25	6.3	none
4	07.08.82	5	3.09 pm	0.78	39	7.8	none
5	07.09.82	3	4.11 pm	0.86	21	7.0	4.10 pm: M1 down \$3.7 billion.
6	07.09.82	3	4.12 pm	0.99	22	7.3	-
7	07.13.82	4	12.21 pm	0.77	17	4.3	12.20 pm: IBM profits \$1.68 vs. \$1.37 year ago.
8	07.16.82	5	4.14 pm	- 0.79	43	8.6	4.10 pm: M1 up \$5.9 billion
9	08.11.82	4	2.36 pm	0.79	33	8.3	2.30 pm: retail sales up 1.0%
10	08.13.82	2	4.13 pm	0.78	20	10.0	4.10 pm: M1 up \$2.0 billion.
11	08.17.82	4	2.20 pm	0.87	22	5.5	none
12	08.19.82	4	10.16 am	0.79	20	5.0	none
13	08.19.82	5	2.08 pm	- 0.88	32	6.4	?time: rumour a major US bank in trouble over Mexican loans. NY Fed denied rumour about 2.30 pm.
14	08.19.82	2	2.09 pm	- 0.78	15	7.5	-
15	08.19.82	5	2.14 pm	0.79	46	9.2	-
16	08.19.82	4	2.29 pm	0.93	33	8.3	-
17	08.19.82	5	2.31 pm	0.79	38	7.6	-
18	08.19.82	5	2.32 pm	0.88	34	6.8	-
19	08.19.82	5	2.33 pm	0.93	31	6.2	-
20	08.19.82	4	2.34 pm	0.79	23	5.8	-
21	08.19.82	1	2.38 pm	- 0.88	13	13.0	-
22	08.19.82	1	2.40 pm	0.88	12	12.0	-
23	08.19.82	3	2.48 pm	- 0.78	21	17.0	-
24	08.19.82	3	2.49 pm	- 0.83	17	5.7	-
25	08.20.82	5	3.21 pm	0.77	29	5.8	none
26	08.23.82	5	3.36 pm	0.85	30	6.0	none
27	08.23.82	4	3.37 pm	0.76	24	6.0	-
28	08.23.82	5	3.40 pm	0.80	24	4.8	-
29	08.24.82	3	1.41 pm	- 0.78	17	5.7	1.40 pm: GM mid-August sales down to 81,597 from 134,949.
30	08.24.82	5	3.19 pm	- 0.77	42	8.4	none
31	08.24.82	5	3.22 pm	- 0.77	43	8.6	-
32	08.24.82	5	3.23 pm	- 0.82	41	8.2	-
33	09.02.82	3	2.56 pm	0.77	13	4.3	none
34	09.03.82	4	10.04 am	0.78	29	7.3	none
35	09.03.82	3	10.21 am	0.78	33	11.0	-
36	09.03.82	3	10.23 am	0.90	39	13.0	-
37	09.03.82	5	12.43 pm	0.78	22	4.4	-
38	09.03.82	5	1.07 pm	- 0.82	34	6.8	-
39	09.03.82	5	1.08 pm	- 0.78	33	6.6	-
40	09.03.82	3	1.39 pm	0.82	10	3.3	-
41	09.03.82	4	1.58 pm	- 0.82	20	5.0	-
42	09.03.82	5	3.25 pm	0.82	24	4.8	-
43	09.14.82	5	3.34 pm	- 0.88	32	6.4	3.27 pm: Rostenkowski said tax boost needed for defence budget.
44	09.14.82	4	3.35 pm	- 0.84	29	7.3	-
45	09.23.82	5	11.12 am	- 0.77	27	5.4	?time: Five Fed Presidents testify before Congress.
46	09.30.82	5	3.38 pm	- 0.79	36	7.2	none
47	10.01.82	3	4.12 pm	- 0.84	24	8.0	4.10 pm: M1 up \$0.4 billion.
48	10.08.82	4	2.27 pm	- 0.77	17	4.3	none
49	10.08.82	1	2.28 pm	0.88	6	6.0	-
50	10.08.82	2	4.05 pm	0.85	19	9.5	-
51	10.08.82	2	4.07 pm	- 0.96	19	9.5	-
52	10.08.82	3	4.10 pm	0.77	37	12.3	4.10 pm: M1 down \$2.7 billion.
53	10.08.82	3	4.11 pm	0.92	42	14.0	-
54	10.11.82	1	2.55 pm	- 0.82	4	4.0	none

k-minute-change							Event
	day	k	end time	size	vol.	ave. vol.	
55	10.11.82	4	3.46 pm	0.82	37	9.3	–
56	10.13.82	3	12.37 pm	–0.78	22	7.3	none
57	10.13.82	3	2.09 pm	0.79	23	7.7	–
58	10.13.82	3	3.23 pm	0.86	24	8.0	–
59	10.13.82	3	3.24 pm	1.01	36	12.0	–
60	10.13.82	2	3.27 pm	0.98	23	11.5	–
61	10.13.82	2	3.29 pm	–0.90	16	8.0	–
62	10.13.82	4	3.56 pm	0.79	18	4.5	–
63	10.22.82	4	4.13 pm	–0.85	59	14.8	4.10 pm: M1 up \$3.2 billion.
64	10.26.82	4	2.58 pm	–0.78	23	5.8	none
65	10.26.82	3	2.59 pm	–0.82	15	5.0	–
66	10.26.82	5	3.20 pm	0.82	36	7.2	–
67	10.27.82	5	2.59 pm	0.77	33	6.6	none
68	11.02.82	4	3.34 pm	–0.83	32	8.0	none
69	11.05.82	2	11.46 am	–0.8	17	8.5	none
70	11.05.82	2	11.47 am	–0.98	11	5.5	–
71	11.05.82	3	3.14 pm	0.77	27	9.0	none
72	11.05.82	2	4.10 pm	–0.77	12	6.0	4.10 pm: M1 up \$2.7 billion.
73	11.05.82	2	4.11 pm	–0.84	12	6.0	–
74	11.16.82	4	3.15 pm	0.81	35	8.8	?time: Larry Speaks reported to have said Fed will reduce discount rate. Denied at 3.33 pm.
75	11.16.82	4	3.16 pm	0.77	33	8.3	–
76	11.16.82	4	3.17 pm	0.77	34	8.5	–
77	11.22.82	5	10.17 am	–0.77	37	7.4	none
78	11.30.82	5	2.53 pm	0.79	40	8.0	none
79	11.30.82	5	2.54 pm	0.82	38	7.6	–
80	12.01.82	5	2.27 pm	–0.82	40	8.0	none
81	12.01.82	4	2.28 pm	–0.82	38	9.5	–
82	12.01.82	5	2.32 pm	–0.78	41	8.2	–
83	12.02.82	4	2.38 pm	–0.75	24	6.0	2.30 pm: New home sales down 0.4%
84	12.06.82	4	3.26 pm	0.75	39	9.8	none
85	12.06.82	4	3.27 pm	0.86	43	10.8	–
86	12.07.82	5	2.55 pm	–0.83	41	8.2	none
87	12.08.82	5	2.48 pm	–0.77	32	6.4	none
88	12.09.82	3	3.24 pm	–0.85	23	7.7	?time: Howard Baker withdrew capital gains bill.
89	12.14.82	5	1.38 pm	–0.80	33	6.6	none
90	12.14.82	2	2.02 pm	–0.77	9	4.5	–
91	12.14.82	4	3.27 pm	–0.84	30	7.5	–
92	12.15.82	5	10.59 am	–0.80	28	5.6	10.56 am: Murray Weidenbaum testified that deficit an obstacle to recovery.
93	12.17.82	4	12.00 pm	0.77	7	1.8	none
94	12.21.82	2	3.40 pm	0.77	18	9.0	none
95	12.22.82	5	3.21 pm	–0.78	27	5.4	none
96	12.28.82	3	2.56 pm	–0.80	18	6.0	none
97	01.04.83	5	3.02 pm	0.76	37	7.4	none
98	01.06.83	5	12.09 pm	0.80	50	10.0	none
99	05.30.84	4	2.37 pm	0.80	38	9.5	none
100	08.06.84	5	10.33 am	0.89	70	14.0	none
101	01.08.86	3	3.48 pm	–0.79	48	16.0	none
102	01.08.86	3	3.49 pm	–0.90	63	21.0	–
103	01.08.86	4	3.53 pm	0.77	63	15.8	–
104	01.17.86	4	9.58 am	–0.76	38	9.5	9.54 am: IBM profits \$4.36 vs. \$3.55 year ago.
105	02.07.86	3	12.02 pm	–1.03	47	15.7	12.00 pm: three judge panel ruled part of Gramm-Rudman law unconstitutional.
106	02.07.86	2	12.07 pm	0.75	33	16.5	–
107	09.11.86	4	11.36 am	–0.88	59	14.8	none
108	09.11.86	4	11.53 am	0.78	58	14.5	–
109	09.12.86	4	10.05 am	–0.76	33	8.3	none (nine more through 12.16 pm)
119	09.15.86	5	9.36 am	0.78	44	8.8	none

k-minute-change							Event
	day	k	end time	size	vol.	ave. vol.	
120	09.18.86	4	9.45 am	0.86	40	10.0	none
121	09.19.86	2	3.31 pm	-0.78	36	18.0	none
122	09.25.86	4	11.01 am	-0.76	46	11.5	none
123	09.25.86	5	11.03 am	-0.83	50	10.0	-
124	10.03.86	5	11.08 am	-0.87	63	12.6	none
125	10.03.86	2	11.09 am	-0.76	21	10.5	-
126	10.03.86	3	11.11 am	-0.80	25	8.3	-
127	10.03.86	3	11.17 am	0.76	28	9.3	-
128	10.06.86	2	10.06 am	0.75	31	15.5	none
129	12.11.86	4	11.15 am	-0.95	46	11.5	none
130	12.11.86	2	11.16 am	-0.79	28	14.0	-
131	01.23.87	4	2.35 pm	-0.76	52	13.0	none (14 more during day)
146	03.09.87	5	9.35 am	-0.86	74	14.8	-
147	03.09.87	5	9.36 am	-0.81	73	14.6	-
148	03.30.87	5	9.46 am	-0.85	54	10.8	none
149	03.30.87	4	9.47 am	-0.78	42	10.5	-
150	03.30.87	3	9.48 am	-0.95	31	10.3	-
151	04.13.87	5	3.37 pm	-0.81	53	10.6	none
152	04.27.87	4	12.26 pm	-0.76	52	13.0	none
153	04.27.87	4	12.27 pm	0.78	43	10.8	-
154	04.27.87	4	12.42 pm	0.76	47	11.8	-
155	04.27.87	5	12.44 pm	0.80	67	13.4	-
156	04.27.87	5	12.45 pm	0.80	61	12.2	-
157	04.27.87	5	12.46 pm	0.87	66	13.2	-
158	05.11.87	4	4.00 pm	-0.84	48	12.0	none
159	06.02.87	5	10.07 am	-0.91	70	14.0	none
160	06.10.87	5	3.09 pm	-0.75	45	9.0	none
161	06.30.87	2	4.14 pm	-0.77	36	18.0	none
162	10.16.87	5	11.25 am	-0.83	42	8.4	none (12 more during day)
175	10.19.87	1	9.33 am	0.76	7	7.0	none (123 more during day)
299	10.20.87	1	9.31 am	1.78	5	5.0	none (161 more during day)
461	10.21.87	1	9.31 am	1.26	7	7.0	none (82 more during day)
544	10.22.87	1	9.31 am	-3.47	5	5.0	none (109 more during day)
654	10.23.87	1	9.31 am	-1.23	4	4.0	none (33 more during day)
688	10.26.87	1	9.32 am	-0.50	9	9.0	none (22 more during day)
711	10.27.87	1	9.31 am	0.84	9	9.0	none (22 more during day)
734	10.28.87	2	9.37 am	0.80	10	5.0	none (22 more during day)
757	10.29.87	1	9.32 am	1.27	6	6.0	none (7 more during day)
765	10.30.87	4	9.47 am	0.79	28	7.0	none (5 more during day)
771	11.02.87	4	9.34 am	-0.78	38	9.5	none
772	11.02.87	5	9.36 am	-0.78	50	10.0	-
773	11.03.87	2	9.35 am	0.80	19	9.5	none (18 more during day)
792	11.04.87	4	9.46 am	0.77	38	9.5	none
793	11.04.87	3	9.47 am	0.77	26	8.7	-
794	11.05.87	4	9.35 am	0.81	38	9.5	none
795	11.06.87	4	11.41 am	0.78	38	9.5	none
796	11.09.87	5	2.34 pm	-0.83	52	10.4	none
797	11.10.87	5	9.35 am	-0.88	48	9.6	none
798	11.10.87	4	9.36 am	-0.88	39	9.8	-
799	11.10.87	5	10.10 am	-0.82	51	10.2	-
800	11.19.87	2	4.02 pm	-0.75	28	14.5	none

k-minute-change							Event
	day	k	end time	size	vol.	ave. vol.	
801	12.01.87	4	4.00 pm	-0.77	64	16.0	none
802	12.08.87	4	3.58 pm	0.85	43	10.8	none
803	12.10.87	3	3.39 pm	-0.76	38	12.7	none
804	12.14.87	4	9.37 am	0.78	65	16.3	none
805	12.15.87	5	3.31 pm	0.75	59	11.8	none
806	01.08.88	4	3.39 pm	-0.76	60	15.0	none (4 more through 3.49 pm)
811	01.11.88	2	9.52 am	-0.82	21	10.5	none (7 more through 10.16 am)
819	01.15.88	3	9.43 am	-0.78	31	10.3	none
820	01.21.88	5	10.15 am	0.82	59	11.8	none
821	04.14.88	4	2.30 pm	-0.86	58	14.5	none (6 more through 2.41 pm)
828	04.21.88	5	3.08 pm	-0.81	64	12.8	none
829	10.13.89	3	3.04 pm	-0.75	27	9.0	none (6 more through 3.44 pm)
836	10.16.89	1	9.31 am	1.20	10	10.0	none (18 more during day)
855	10.17.89	5	11.17 am	-0.79	58	11.6	none
856	10.17.89	5	11.25 am	0.88	37	7.4	-
857	10.17.89	5	11.26 am	0.88	41	8.2	-
858	10.24.89	4	10.24 am	-0.78	56	14.0	none (9 more during day)
868	01.12.90	3	9.33 am	-0.86	22	7.3	none
869	01.12.90	4	2.36 pm	-0.90	40	10.0	-
870	01.12.90	4	2.41 pm	0.84	47	11.8	-
871	01.24.90	3	9.39 am	-0.83	25	8.3	none
872	01.24.90	3	9.40 am	-0.77	24	8.0	-
873	01.24.90	1	9.41 am	0.77	7	7.0	-
874	07.23.90	5	10.30 am	-0.75	58	11.6	none
875	07.23.90	4	10.32 am	-0.77	49	12.3	-
876	07.23.90	2	10.33 am	-1.10	19	9.5	-
877	07.23.90	5	10.54 am	0.91	43	8.6	-
878	08.03.90	4	9.47 am	-0.85	31	7.8	?time: Iraq invaded Kuwait.
879	08.03.90	3	9.48 am	-0.85	19	6.3	-
880	08.03.90	3	9.49 am	-1.13	22	7.3	-
881	08.03.90	5	9.55 am	0.97	34	6.8	-
882	08.03.90	2	1.49 pm	-1.11	14	7.0	-
883	08.03.90	4	2.01 pm	0.88	19	4.8	-
884	08.03.90	5	2.04 pm	0.86	28	5.6	-
885	08.06.90	5	10.27 am	0.84	31	6.2	none
886	08.17.90	3	12.16 pm	-0.78	40	13.3	12.11 pm: Pentagon recommended maybe calling up reserves.
887	08.21.90	1	11.16 am	0.77	13	13.0	11.13 am: Iraq's Aziz says ready to discuss Gulf situation.
888	08.23.90	3	9.46 am	0.96	16	5.3	none
889	09.20.90	4	10.25 am	-0.82	59	14.8	none
890	09.27.90	4	10.59 am	-0.77	50	12.5	none
891	10.01.90	4	12.18 pm	0.76	43	10.8	none
892	10.01.90	4	12.19 pm	0.78	38	9.5	-
893	10.02.90	5	9.39 am	0.78	54	10.8	none
894	10.09.90	4	3.45 pm	-0.79	47	11.8	3.39 pm: (?) Brazil's central bank president sees rescheduling needed.
895	10.10.90	3	3.28 pm	-0.88	39	13.0	none
896	10.12.90	3	11.55 am	0.77	31	10.3	11.51 pm: opposition party in exile says Iraqi leaders considering Kuwait withdrawal.
897	10.15.90	3	10.45 am	-0.82	42	14.0	none
898	10.15.90	2	10.46 am	-0.82	29	14.5	-
899	12.04.90	5	3.33 pm	0.99	45	9.0	?time: British TV reports Iraq makes new offer on Kuwait.
900	12.04.90	2	3.34 pm	0.84	20	10.0	-

k-minute-change							Event
	day	k	end time	size	vol.	ave. vol.	
901	12.18.90	2	3.27 pm	0.84	29	14.5	none
902	12.18.90	3	3.29 pm	0.88	23	7.7	-
903	01.04.91	2	12.12 pm	0.83	20	10.0	none
904	01.09.91	2	1.57 pm	-0.92	22	11.0	none
905	01.09.91	1	1.58 pm	-1.50	10	10.0	-
906	01.09.91	1	1.59 pm	-1.56	6	6.0	-
907	01.09.91	1	2.00 pm	0.94	5	5.0	-
909	01.09.91	2	2.04 pm	-0.78	14	7.0	-
910	01.14.91	4	3.19 pm	0.84	44	11.0	none
911	01.16.91	1	12.43 pm	0.84	12	12.0	none
912	01.17.91	2	9.44 am	-0.93	13	6.5	none
913	01.17.91	4	9.47 am	-0.93	29	7.3	-
914	04.30.91	2	9.32 am	0.87	28	14.0	9.30 am: Fed cut discount rate to 5.5%.
915	05.10.91	5	3.25 pm	-0.78	54	10.8	none
916	11.15.91	4	3.41 pm	-0.81	34	8.5	none
917	11.15.91	4	3.46 pm	0.76	21	5.3	-
918	11.15.91	4	3.47 pm	0.76	27	6.8	-
919	11.19.91	5	10.47 am	-0.81	57	11.4	none
920	01.02.92	5	4.05 pm	0.77	68	13.6	none
921	07.02.92	4	10.21 am	-0.82	62	15.5	?time: Fed cut discount rate to 3.0% from 3.5%;
922	07.02.92	4	10.22 am	0.87	58	14.5	anemic employment report earlier.
923	10.05.92	5	10.21 am	-0.78	57	11.4	none
924	10.05.92	3	10.26 am	-0.83	33	11.0	-
925	10.05.92	3	10.27 am	-0.78	24	8.0	-
926	10.05.92	3	11.16 am	-0.86	27	9.0	-
927	02.16.93	5	10.43 am	-0.79	55	11.0	none
928	03.02.94	1	5.15 am	-1.52	4	4.0	none
929	03.31.94	5	10.55 am	-0.78	52	10.4	none
930	03.31.94	5	10.57 am	-0.76	45	9.0	-
931	03.31.94	4	11.07 am	0.75	27	6.8	-
932	10.13.94	4	8.33 am	0.75	70	17.5	8.30 am: PPI down 0.5; core up 0.1%
933	11.15.94	3	2.38 pm	-0.83	38	12.7	2.37 pm: Fed raised discount rate to 4.75% from 4.0%
934	11.22.94	4	3.51 pm	-0.81	47	11.8	none
935	02.26.96	5	3.27 pm	-0.76	79	15.8	none
936	02.26.96	5	3.28 pm	-0.76	70	14.0	-
937	03.08.96	4	8.33 am	-0.79	110	27.5	8.30 am: payrolls up 705,000; largest increase in 12 years.
938	03.08.96	1	8.34 am	-0.75	17	17.0	-
939	03.08.96	2	3.03 pm	-0.80	21	10.5	none
940	03.08.96	4	3.27 pm	0.77	31	7.8	-
941	03.08.96	4	3.28 pm	0.77	26	6.5	-
942	04.10.96	4	3.43 pm	-0.76	46	11.5	none
943	05.03.96	4	8.30 am	0.78	89	22.3	8.30 am: payrolls up 2,000
944	05.03.96	4	8.31 am	0.89	120	30.0	-
945	05.03.96	3	8.32 am	0.96	137	45.7	-
946	05.03.96	3	8.35 am	-0.77	172	57.3	-
947	06.07.96	2	8.31 am	-0.93	94	47.0	8.30 am: payrolls up 348,000
948	06.07.96	3	8.33 am	-0.84	123	41.0	-
949	06.07.96	3	8.34 am	-0.93	124	41.3	-
950	07.11.96	3	1.44 pm	-0.79	20	6.7	none
951	07.15.96	4	3.29 pm	-0.85	40	10.0	none
952	07.16.96	4	12.22 pm	-0.84	40	10.0	none (7 more during day).

k-minute-change							Event
	day	k	end time	size	vol.	ave. vol.	
960	08.02.96	2	8.31 am	1.02	91	45.5	8.30 am: payrolls up 193,000.
961	09.06.96	1	8.30 am	0.81	61	61.0	8.30 am: payrolls up 250,000.
962	09.13.96	3	8.32 am	0.84	123	41.0	8.30 am: CPI up 0.1%; core up 0.1%. Also retail sales data.
963	12.11.96	5	2.12 am	0.80	31	6.2	none
964	01.23.97	4	3.46 pm	-0.84	27	6.8	none
965	01.23.97	5	3.48 pm	-0.76	35	7.0	-
966	01.23.97	5	3.55 pm	-0.75	41	8.2	-
967	01.23.97	4	4.00 pm	0.76	37	9.3	-
968	01.29.97	3	8.31 am	0.76	91	30.3	8.30 am: durable goods down 1.7%.
969	02.05.97	3	3.40 pm	0.76	23	7.7	none
970	02.26.97	4	10.04 am	-0.97	35	8.8	10.00 am: Greenspan testimony; angst about stock market.
971	02.26.97	2	10.05 am	-0.86	14	7.0	-
972	03.07.97	1	8.30 am	-0.81	48	48.0	8.30 am: payrolls up 339,000.
973	03.07.97	2	8.32 am	0.75	87	43.5	-
974	03.27.97	4	3.37 pm	-0.87	30	7.5	none
975	03.27.97	4	3.45 pm	0.75	26	6.5	-
976	04.15.97	3	8.31 am	0.78	115	38.3	8.30 am: CPI up 0.1%; core up 0.2%.
977	04.15.97	3	8.32 am	0.99	182	60.7	-
978	04.29.97	2	8.31 am	1.09	106	53.0	8.30 am: employment cost index up 0.6% in first quarter.
979	05.20.97	4	2.17 pm	0.82	51	12.8	2.15 pm: Fed kept rates unchanged.
980	06.06.97	1	8.31 am	-0.88	77	77.0	8.30 am: payrolls up 138,000.
981	07.09.97	4	3.38 pm	-0.75	43	10.8	none
982	07.18.97	4	10.08 am	-0.80	44	11.0	none
983	08.01.97	3	10.11 am	-0.94	24	8.0	10.00 am: ? new orders up 1.2%; strong NAPM report; Michigan sentiment revised up.
984	08.08.97	2	8.29 am	-0.89	39	19.5	none???
985	08.08.97	3	8.32 am	0.76	65	21.7	-
986	08.13.97	4	8.31 am	0.79	164	41.0	8.30 am: PPI down 0.1%; core down 0.1%. Also retail sales data.
987	08.13.97	4	8.32 am	0.85	226	56.5	-
988	08.13.97	4	8.33 am	1.04	265	66.3	-
989	08.13.97	3	8.34 am	0.84	192	64.0	-
990	08.13.97	5	10.22 am	-0.82	64	12.8	none
991	08.13.97	3	10.23 am	-0.77	38	12.7	-
992	08.13.97	3	10.24 am	-0.77	34	11.3	-
993	08.22.97	5	3.53 pm	0.83	57	11.4	none
994	09.02.97	2	10.03 am	0.84	22	11.0	10.00 am: NAPM 56.8 vs. 58.6 last month.
995	10.03.97	2	8.31 am	-0.77	97	48.5	8.30 am: payrolls up 215,000.
996	10.10.97	1	8.30 am	-0.82	73	73.0	8.30 am: PPI up 0.5%; core up 0.4%.
997	10.27.97	3	1.52 pm	-0.85	28	9.3	none
998	10.27.97	4	1.55 pm	-0.80	42	10.5	-
999	10.27.97	2	1.56 pm	-0.80	13	6.5	-
1000	10.27.97	2	3.12 pm	-1.17	20	10.0	-
1001	10.27.97	2	3.13 pm	-0.96	22	11.0	-
1002	10.27.97	4	3.23 pm	-0.96	27	6.8	-
1003	10.27.97	3	3.24 pm	-0.85	18	6.0	-
1004	10.28.97	3	6.48 am	-0.75	42	14.0	none
1005	10.28.97	4	9.42 am	0.82	27	6.8	none
1006	10.28.97	4	10.13 am	0.87	40	10.0	none (15 more during day)
1022	10.30.97	5	10.02 am	-0.88	45	9.0	none
1023	11.07.97	5	9.35 am	-0.86	52	10.4	none

k-minute-change							Event
	day	k	end time	size	vol.	ave. vol.	
1024	11.07.97	5	9.40 am	0.76	44	8.8	–
1025	12.05.97	5	8.30 am	– 0.82	129	25.8	8.30 am: payrolls up 404,000.
1026	12.05.97	2	8.31 am	– 0.92	151	75.5	–
1027	12.23.97	5	3.56 pm	– 0.79	51	10.2	none
1028	04.30.98	2	8.31 am	0.87	154	77.0	8.30 am: employment cost index up 0.7% in first quarter. Also GDP data released.
1029	08.04.98	4	3.43 pm	– 0.93	39	9.8	none
1030	08.04.98	4	3.46 pm	– 0.80	34	8.5	–
1031	08.05.98	4	9.43 am	– 0.88	22	5.5	none
1032	08.05.98	4	3.45 pm	0.93	41	10.3	none
1033	08.27.98	3	11.38 am	– 0.84	29	9.7	none
1034	08.27.98	4	11.41 am	– 0.84	46	11.5	–
1035	08.27.98	5	2.47 pm	0.84	36	7.2	none
1036	08.27.98	5	2.48 pm	0.84	40	8.0	–
1037	08.28.98	5	11.49 am	0.77	47	9.4	none
1038	08.28.98	5	11.50 am	0.86	45	9.0	–
1039	08.31.98	4	10.09 am	– 0.96	31	7.8	none
1040	08.31.98	4	3.07 pm	– 0.77	47	11.8	none (10 more during day)
1051	09.01.98	2	9.32 am	0.94	19	9.5	none (21 more during day)
1073	09.02.98	3	9.37 am	0.75	30	10.0	none
1074	09.02.98	5	3.49 pm	– 0.80	58	11.6	–
1075	09.03.98	4	9.35 am	– 0.82	37	9.3	none
1076	09.03.98	5	10.30 am	0.93	47	9.4	–
1077	09.03.98	5	10.56 am	– 0.77	45	9.0	–
1078	09.03.98	4	3.42 pm	0.77	37	9.3	–
1079	09.04.98	5	2.50 pm	– 0.76	39	7.8	none
1080	09.04.98	5	3.39 pm	0.76	48	9.6	–
1081	09.04.98	5	3.41 pm	0.85	45	9.0	–
1082	09.10.98	5	3.36 pm	– 0.80	49	9.8	none
1083	09.10.98	3	3.42 pm	0.76	37	12.3	–
1084	09.11.98	4	9.46 am	0.87	49	12.3	none
1085	09.11.98	4	9.48 am	0.77	51	12.8	–
1086	09.11.98	5	9.50 am	0.77	69	13.8	–
1087	09.11.98	3	9.53 am	0.77	36	12.0	–
1088	09.11.98	2	10.03 am	0.92	20	10.0	–
1089	09.11.98	4	2.50 pm	0.82	34	8.5	–
1090	09.11.98	4	2.51 pm	0.82	37	9.3	–
1091	09.16.98	5	3.43 pm	0.81	40	8.0	none
1092	09.29.98	2	2.17 pm	– 0.89	18	9.0	2.17 pm: fed cut funds rate 25 basis points.
1093	09.29.98	2	2.18 pm	– 1.08	18	9.0	–
1094	09.29.98	3	2.20 pm	– 0.84	30	10.0	–
1095	10.01.98	5	11.19 am	– 0.79	51	10.2	none
1096	10.02.98	5	10.18 am	– 0.90	47	9.4	none
1097	10.02.98	4	12.41 pm	0.80	42	10.5	none
1098	10.02.98	5	2.52 pm	0.75	45	9.0	none
1099	10.02.98	4	3.15 pm	0.75	30	7.5	none
1100	10.05.98	4	3.37 pm	0.78	31	7.8	none
1101	10.05.98	4	3.42 pm	0.80	33	8.3	–
1102	10.05.98	4	3.43 pm	0.75	30	7.5	–
1103	10.07.98	5	10.12 am	0.91	41	8.2	none
1104	10.07.98	5	3.06 pm	0.76	41	8.2	none
1105	10.07.98	4	3.26 pm	– 0.75	44	11.0	none
1106	10.07.98	5	3.41 pm	0.91	48	9.6	none
1107	10.08.98	3	9.50 am	– 0.78	32	10.7	none (eight more during day)
1116	10.09.98	4	10.14 am	– 0.77	31	7.8	none
1117	10.15.98	1	3.15 pm	0.89	11	11.0	3.14 pm: Fed cut funds rate and discount rate 25 basis points (not a normal FOMC meeting).
1118	10.15.98	1	3.16 pm	1.00	11	11.0	–
1119	10.15.98	1	3.17 pm	1.00	9	9.0	–
1120	10.15.98	1	3.18 pm	1.29	10	10.0	–

k-minute-change							Event
	day	k	end time	size	vol.	ave. vol.	
1121	10.15.98	1	3.19 pm	1.00	8	8.0	–
1122	10.15.98	1	3.21 pm	– 1.19	8	8.0	–
1123	10.15.98	1	3.22 pm	– 1.29	7	7.0	–
1124	10.15.98	5	3.44 pm	0.80	36	7.2	–
1125	10.15.98	5	3.45 pm	0.80	34	6.8	–
1126	10.15.98	5	3.46 pm	0.80	36	7.2	–
1127	11.17.98	2	2.19 pm	0.83	19	9.5	2.15 pm: Fed cut funds rate and discount rate 25 basis points.
1128	11.17.98	2	2.20 pm	1.14	17	8.5	–
1129	01.15.99	5	7.31 am	– 0.78	198	39.6	none
1130	01.15.99	4	8.10 am	0.77	102	25.5	8.10 am: Estado said Brazil central bank won't intervene in foreign exchange market.
1131	01.15.99	5	8.12 am	0.81	125	25.0	–
1132	01.15.99	5	8.16 am	0.82	159	31.8	–
1133	01.31.99	1	5.57 pm	0.85	9	9.0	none
1134	02.23.99	5	10.04 am	– 0.82	68	13.6	10.00 am: Greenspan testimony; economy may be stretched.
1135	03.05.99	2	8.31 am	1.05	152	76.0	8.30 am: payrolls up 275,000.
1136	04.16.99	4	9.48 am	– 0.78	47	11.8	none
1137	04.16.99	5	1.17 pm	– 0.86	54	10.8	none
1138	05.12.99	1	9.47 am	– 0.81	17	17.0	?time: Rubin to announce resignation;
1139	05.12.99	1	9.48 am	– 0.81	12	12.0	Summers is successor.
1140	05.12.99	1	9.50 am	0.88	12	12.0	–
1141	05.18.99	4	2.14 pm	– 0.80	41	10.3	2.11 pm: Fed let rates stand; adopted tightening bias.
1142	06.01.99	5	10.05 am	– 0.85	54	10.8	10.00 am: NAPM 55.2 vs. 52.8 last month.
1143	06.04.99	3	8.33 am	– 0.88	191	63.7	8.30 am: payrolls up 11,000.
1144	06.13.99	1	5.35 pm	– 0.77	2	2.0	none
1145	06.15.99	1	4.19 pm	– 1.01	3	3.0	none
1146	06.16.99	3	8.30 am	0.79	170	56.7	8.30 am: CPI unchanged; core up 0.1%
1147	06.30.99	2	2.17 pm	0.96	24	12.0	2:15 pm: Fed raised funds rate 25 basis points; adapted neutral bias.
1148	06.30.99	3	2.19 pm	0.89	31	10.3	–
1149	08.06.99	2	8.30 am	– 0.83	151	75.5	8.30 am: payrolls up 310,000.
1150	09.03.99	1	8.30 am	0.89	150	150.0	8.30 am: payrolls up 124,000.
1151	09.10.99	1	8.31 am	0.80	93	93.0	8.30 am: PPI up 0.5%; core down 0.1%
1152	09.15.99	1	8.30 am	0.81	106	106.0	8.30 am: CPI up 0.3% core up 0.1%.
1153	10.05.99	2	2.12 pm	– 0.93	32	16.0	2.12 pm: Fed let rates stand; adopted tightening bias.
1154	10.05.99	2	2.13 pm	– 0.80	27	13.5	–
1155	10.08.99	1	8.30 am	0.75	126	126.0	8.30 am: payrolls down 8,000.
1156	10.13.99	2	4.21 pm	– 0.77	5	2.5	none
1157	10.13.99	1	4.22 pm	– 0.84	1	1.0	–
1158	10.15.99	1	8.30 am	– 0.95	150	150.0	8.30 am: PPI up 1.1%; core up 0.8%.
1159	10.20.99	1	4.27 pm	1.21	3	3.0	none

Notes: CPI = consumer price index; core excludes food and energy. PPI = producers price index; core excludes food and energy. Percentage changes are at monthly rates except for the change in the employment cost index, which is at quarterly rate. NAPM = National Association of Purchasing Managers.

Comments on Ray Fair's paper "Events that shook the market"

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Professor Fair's findings highlight some of the dilemmas we face in trying to understand price formation and market liquidity, both from a macro and a micro-economic perspective. Firstly, I would like to express my admiration for the amount of work that has gone into collecting data on the millions of 5 minute intervals between 1982 and 1999 and the extensive research of newswires for clues on what might have triggered large intra-day stock price changes. As a practitioner I am appealed by the use of tick data as it reflects the actual behaviour of financial markets, and may shed light on issues such as market dynamics and market structure. The more common use of average daily data is less useful in this regard. My comments on the paper are divided into three parts: general comments, technical issues and a suggestion for further research.

General comments

One important observation is that we still do not understand what moves market prices very well. In the paper only one third of the large price movements could be traced to a single event. Most of the 'explainable' events are related to data releases impacting expectations on the future course of monetary policy. This seems to suggest that central banks still matter, which is a comforting thought if you work for one, as I do. The fact that macro-economic data show up as an important determinant of stock prices should not of course be too surprising given the fact that interest rates impact the cost of capital of firms and the net present value of future earnings.

In the search for explanations of price moves it may be useful to have knowledge of the market conditions prevailing at the time of the identified events. In particular, some of the large price changes may have followed the breaching of important technical support and resistance levels that prevailed at the time or may be related a lack of market liquidity. My experience with the monitoring of developments in foreign exchange market suggests that such triggers for large-price moves are frequent. It may also be worthwhile to look into the pattern of order flows during the course of these days. This volume information could shed light on the depth of the market, i.e. the ability of the market to absorb large order flows without substantial price moves. It may also shed light on the behaviour of market participants in the minutes surrounding important data releases. I suspect a bunching of orders and trades at these times. Thus it may be possible to filter out some cases of large intra-day price that may be more related to market functioning than to the incorporation of new information into the market. This may be particularly the case when the large price move does not persist during the course of subsequent five-minute trading intervals.

Technical comments

- With regard to the tick data, I have assumed that these data reflect prices upon which trades (however small or large) have actually taken place. If this is not the case, for instance when such data is based on mid-price of the best bids and offers in the central order limit book, one has to be aware of distortions caused by widening bids and offers during moments of market uncertainty.
- The data shows there are several occasions of successive five-minute periods with large price moves. This suggests that a longer period may be used in such cases to describe a particular event.
- The stock market crash of October 1987 is one of those 'non explainable' events during which price developments and a seizing up of market liquidity reflected a widespread loss of confidence in the stability of the financial system. The divergence of valuations in cash and futures markets reflected a fragmentation of price discovery and market liquidity, which was in part triggered by large delays in processing order flows. Analysis of such price divergences on an intra-day basis may allow some judgement on the evolution of market functioning on those tumultuous days.

Suggestion for further research

The main contribution of this paper is to make an extensive database of tick data available and to link large intra-day price moves to certain events. In addition to searching for news events that impacted prices, further research into market conditions prevailing at the time of large price moves seems promising. This information would be useful from a micro-economic perspective, to better understand the functioning and structure of financial markets.

A second suggestion for further research concerns the impact of changes in the shape of the yield curve on stock prices. Here it may be of interest to research if there are different outcomes in the case of Nasdaq and S&P500 stocks. Some analysts have suggested the valuation of technology stocks are less sensitive to the level of interest rates since earnings lie further in the future (in some sense comparable with a high duration bond). Since there is also a very liquid index-futures contract on the Nasdaq-index, it would be of interest to study differences in the behaviour of this contract vis-à-vis the S&P futures for the large intra-day price moves in recent years.

Comments on Ray Fair's paper "Events that shook the market"

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Discussion

In the empirical literature, the relationship between news and asset prices has typically been analysed by asking two different questions: What is the price impact of a certain type of news? What news has caused a certain large price change? The first, "ex-ante", approach is usually carried out by regressing the changes in asset prices over a variable representing the event or its unexpected component. The second, "ex-post", approach is implemented in two stages: first, "large" price changes are computed and then an event that may explain each such big move is looked for.

Recently intraday data have allowed researchers to gain more profound insights on the relationship between asset prices and information. By using transaction data for the US bond market, Fleming and Remolona (1999a) attempt to identify information that may account for the sharpest price changes, and also estimate the price impact of scheduled macroeconomic announcements. Andersen and Bollerslev (1998) address the same two key questions for the deutsche mark-dollar spot exchange rate.

The paper by Professor Fair extends this line of research to the U.S. stock market, applying the ex-post methodology to a huge amount of transaction data on the S&P 500 futures contract (the sample period runs from 21 April 1982 to 29 October 1999). The paper is a major contribution that provides a highly detailed picture of the price discovery process in the US stock market.

The results of the above-mentioned studies are quite similar for the bond and forex markets. For the on-the-run five-year US Treasury note, Fleming and Remolona (1999a) found that, between September 1993 and August 1994, each of the twenty-five sharpest five-minute price changes could be associated with a just-released macroeconomic announcement. Similarly, Andersen and Bollerslev (1998) were able to associate an event with each of the twenty-five largest five-minute jumps in the deutsche mark-dollar exchange rate recorded between October 1992 and September 1993. In this case, however, the events included 15 releases of macroeconomic data, eight other economic events and three political events.

In Fair's study of the S&P 500 futures contract, 220 of the 4417 trading days in the dataset recorded at least one large price change. The most striking result of the paper is that events were found only for 69 of these days. The latter included 31 macroeconomic announcements, 22 monetary policy events, seven other economic events and nine political events. These findings are consistent with those obtained by Cutler, Poterba and Summers (1989) for the 50 largest daily changes in the S&P 500 index from 1946 through 1987.

My brief comments will discuss three aspects of the work: (1) the definition of a "large" stock price change; (2) the sensitivity of stock prices to news about monetary policy and the business cycle; (3) the main finding that several stock price gaps are apparently unexplained.

Identifying "large" price changes is analogous to a problem of outlier detection. As such, it should take into account the statistical properties of the S&P 500 transactions data, and in particular the persistence in their volatility (Chan, Chan and Karolyi, 1991). As regards the time interval, Fair devises a procedure that finds all the large one to five-minute changes without duplication. This is a convenient solution. Nevertheless, as pointed out by Fair, it is important to consider that five out of the 17 price gaps computed on daily data by Cutler, Poterba and Summers between 1982 and 1987 are not detectable on one to five-minute data, indicating that the results are substantially affected by the sampling frequency. The choice of the minimum size is also very important. Fair sets a level of 0.75 percent in absolute value. The choice of an unconditional threshold implies that during turmoil a huge number of price gaps are selected, while in normal periods large jumps in prices can be missed. The adoption of a time-varying threshold level could significantly increase the share of (conditional) large price changes that are explained by some news event.

Table 1 clearly shows that monetary policy is a factor in stock price gaps. For instance, in the second half of the nineties seven interest rate decisions shook the market. In that period, two Testimonies also caused price gaps. This evidence is not surprising. Since monetary policy decisions in the US are

made known in a limited number of scheduled FOMC meetings and speeches per year, market participants tend to revise their expectation about the future stance of monetary policy in the days in which these institutional events take place. It is also interesting to note that in the last three interest rate shocks in 1999 that were accompanied by a statement on the bias of monetary policy it was the latter that determined the correction in stock prices, rather than the change in the policy interest rate. This means that market participants are ready to extract information about the future tightness of monetary policy from any signal provided by the central bank. This fact should be taken into account by empirical studies that attempt to identify monetary policy shocks on high frequency data by focusing exclusively on the unexpected component of the policy interest rate.

It must be emphasised that these events represent purely exogenous monetary policy shocks. As Fair clearly points out with respect to the first monetary surprise detected on 16 July 1982 “for all intents and purposes one can attribute all of the price change to the money supply announcement”. As purely discretionary monetary shocks, these events could be used to identify sectorial responses to monetary policy shocks by carrying out event study analyses of the kind used by Fleming and Remolona (1999b) for the bond market. (To reduce the incidence of non-synchronous trading, the analysis could be limited to the stocks included in the S&P 100.)

While there is no doubt that at least 22 events can be directly ascribed to Fed decisions, the effect of news about payroll, prices, etc. cannot be primarily connected with expectations about the future stance of monetary policy. Business cycle news affects not only expected discount rates, but also expected cash flows and expected excess returns on stocks (notably the perceived “riskiness” of stocks). The relevance of developments in real activity for the stock market is likely to be much more pervasive than the evidence reported in Table 1 seems to suggest. First, as noted by Fair, since many macroeconomic announcements occur at 8.30 am, if we also had data on after-hours trading for the period before 1994 (when the S&P 500 futures contract began to be traded on the GLOBEX market), it is likely that many more effects of macroeconomic data would have been found. Moreover, since information about the business cycle is dispersed over a wide set of indicators (Stock and Watson, 1999), the price impact of each data release can be limited. Finally, if we set a lower minimum level for price gaps, we would certainly find more events linked to macroeconomic announcements. In fact, between September 1993 and August 1994 the impact on the S&P 500 futures price of 17 relevant macroeconomic news events was comparable to that found for bond prices (cf. Table 3).

As mentioned above, the most striking result of the paper is the huge number of large price changes that apparently are not associated with any event, a situation that seems peculiar to the stock market. Cutler, Poterba and Summers (1989) discard the possibility that market analysts can systematically miss news about fundamental values that are instead observed by market participants, and indicate two alternative explanations. First, large market movements may reflect changes in average assessments of fundamental values as investors re-examine existing data or present new arguments. Second, many investors do not trade on the basis of their own assessment of values, but rely on market prices to gauge them—a form of departure from the assumption of rational behaviour. According to Cutler, Poterba and Summers, the latter hypothesis would explain, for instance, why, during the stock market crisis of October 1987, most shares were not traded despite the dramatic drop in their prices.

Recent theoretical research has pointed out how the introduction of fundamental uncertainty in standard equilibrium models can help replicate key aspects of financial data series, and in particular volatility clustering and time-varying risk premia (Veronesi, 1999). If the economy shifts between two unobservable states at random times (say, between high-growth and low-growth states), risk-averse investors will tend to overreact to bad news in good times and to underreact to good news in bad times, since in these cases the incoming information increases the uncertainty of investors about the latent state of the economy. It also implies that the reaction of prices to news will tend to be large in good times and small in bad times.

A different explanation assumes that there are investors who show some kind of cognitive bias and limit the activity of fully rational arbitrageurs. In these cases, prices will tend to overreact or underreact to fundamental news depending on the processes of belief formation assumed for the different types of investors (Schleifer, 2000).

The stylised facts about stock price movements highlighted by Fair can provide a useful yardstick for evaluating the predictive accuracy of these different explanations.

In conclusion, the paper by Professor Fair clearly shows that intraday data are well suited for investigating the relationship between price movements and information arrival for the stock market as

well. Full exploitation of the statistical properties of intraday data could substantially improve the outcome of the signal extraction process.

In the US, monetary policy is a factor in large stock price movements. The paper identifies a number of purely exogenous monetary policy shocks that provide suggestions for further research. Such evidence is also relevant to the debate on whether and to what extent central banks should abstain from monetary surprises.

The most striking feature of the US stock market is that many, if not most, large price changes are unexplained. A theoretical explanation of this fact could be provided by recent equilibrium models that assume rational learning or some departure from the hypothesis of rational expectations, along the lines suggested by Cutler, Poterba and Summers (1989) after the stock market crash of 1987.

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