Surprises in U.S. macroeconomic releases: Determinants of their relative impact on T-Bond futures *

Dieter Hess

Center of Finance and Econometrics (CoFE)
University of Konstanz, D-78457 Konstanz, Germany

email: dieter.hess@uni-konstanz.de
tel: +49 7531 883164
fax: +49 7531 883559

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Abstract

This paper investigates the intraday response of CBOT T-bond futures prices to surprises in headline figures contained in scheduled U.S. macroeconomic news releases. While several previous studies try to find out which releases have a significant impact on prices and volatility in financial markets, considerably less effort has been devoted to the question what makes some releases important in contrast to others that seem to attract no attention at all. In order to identify the factors determining the relative importance of releases, the time series properties and the information content of the macroeconomic news flow are investigated. In particular, several types of information regarding inflation and economic strength are distinguished. The explanatory power of the type of information is tested against the alternative hypothesis that the timeliness of a release determines its impact. The results indicate that the value of the information contained in a release decreases with the number of previously released figures highlighting similar aspects. Thus, the price impact of a release decreases as the additional information contained in a release becomes smaller.

Keywords: Macroeconomic news; scheduled announcements; information processing; price formation; Treasury bonds; futures markets

JEL classification: E44, G14

1 Introduction

Every month, a variety of macroeconomic reports, such as monthly employment figures, consumer prices, and building permits, are released providing brand new information about the state of the economy. While several studies try to find out which releases have a significant impact on prices or on volatility in financial markets, considerably less effort has been devoted to the question why some releases provoke significant market reactions while others seem to be ignored.

Based on an analysis of the time series properties of the macroeconomic news flow and the information content of reports, this paper presents and tests some alternative hypotheses explaining the relative importance of releases. Unlike a regular time series of say temperature measurements obtained from a single meteorological station at the end of each month, several measurements of economic conditions in a given period are taken from different perspectives. Moreover, instead of announcing all these figures simultaneously, macroeconomic reports are released one after another – some with a pronounced time lag. Hence, one hypothesis argues that the value of the information provided by a release, and thus its impact on prices, depends on its timeliness. On the other hand, macroeconomic reports contain different types of information about the state of the economy, especially different indicators of inflation as well as economic strength. Therefore, an alternative hypothesis argues that the type of information is crucial in determining the relative importance of releases. More precisely, it states that the information value of a release diminishes with the number of previously released reports providing a similar information content. These hypotheses are tested in this paper.

From the previous literature it is well known that information arrival has an impact on prices and volatility in financial markets (see e.g., Goodhart and O'Hara 1997 for an overview). Since information arrival is a rather broad concept, previous studies have stressed various aspects of news arrival by employing different measurement concepts.[1] Scheduled macroeconomic announcements stand out from the steady flow of information which hits financial markets. Several studies show that these releases have a very distinct impact on volatility. Their importance is underlined, for example, by the findings of Fleming and Remolona (1997) that out of the 25 largest intraday price changes in the U.S. treasury market all but one occurred after such an announcement. This is confirmed by Bollerslev, Cai, and Song (2000) for T-bond futures. Constructing dummy variables from the schedule of macroeconomic releases, Ederington and Lee (1993), Crain and Lee (1995), and others find that quite a number of releases have a significant impact on volatility in bond and foreign exchange markets. Using robust tests, Franke and Hess (2000a) find an even larger spectrum of releases to be significant in the T-bond futures market. The increase in volatility seems to be rather short-lived, although this period may vary substantially across releases.[2] Providing a comprehensive study of high- and low-frequency volatility components in T-Bond futures returns, Bollerslev, Cai, and Song (2000) restrict the volatility response horizon for all macroeconomic releases except for the employment report to one hour. The estimated pattern suggests that ten minutes after an announcement the initial impact is reduced by one half.[3]

[1] Mitchell and Mulherin (1994), for example, use the daily number of news announcements reported by Dow Jones & Company (Broadtape) in order to explain patterns in trading activity. Chang and Taylor (1996) investigate intraday volatility employing a keyword count in Reuters headlines.

[2] Volatility seems to persist longer in the more liquid futures markets (Christie-David and Chaudhry 1999).

[3] Not only volatility is affected by announcements. Balduzzi, Elton, and Green (1997) and Fleming and Remolona (1999a) present evidence for the U.S. Treasury market that trading volume surges and bid-ask spreads widen after a release. Moreover, Franke and Hess (2000a) find that the

Volatility studies do not account for surprises in releases, i.e. non-anticipated information. In general, the impact of the mere existence of an announcement is investigated using dummy variables. In contrast, another branch of the literature investigates the impact of surprises in announcements on the level of prices, mainly in bond and foreign exchange markets. Usually, these studies measure the magnitude of surprises employing survey data on analysts' forecasts for certain headline figures contained in macroeconomic reports. Early studies focus on a small number of releases investigating their impact on daily returns. Berkman (1978), Urich and Wachtel (1981, 1984), and others analyze money growth announcements, Cook and Korn (1991) and Prag (1994), for example, focus on employment reports. Since in the early 1980s the Federal Reserve deemphasized monetary aggregates to guide its policy actions, Dwyer and Hafer (1989) among others, examine whether the Fed's focus on current economic conditions leads to significant interest rate changes after surprises in various macroeconomic reports. Interestingly, they find that the impact of money growth announcements diminishes in the mid-1980s. Consequently, other studies, such as Hardouvelis (1988) and Edison (1996), find a growing influence of employment figures, releases of consumer or producer prices, durable goods orders and retail sales. While these studies examine daily interest rate changes, Becker, Finnerty, and Kopecky (1996) and Fleming and Remolona (1997, 1999b) focus on narrow intraday windows around the announcements. This should help to separate the impact of scheduled announcements from other not explicitly observed news which may arrive occasionally over the course of a trading day. As a consequence, Fleming and Remolona find more releases that have a significant impact on prices

correlation of intraday price changes of T-bond and Bund futures is significantly increased, Christiansen (2000) finds significantly higher conditional correlations of daily bond returns for different maturities.

in the Treasury market.

This paper contributes to the previous literature by analyzing the information content of releases and the time series properties of the announcement cycle. On the basis of this analysis, competing hypothesis concerning the relative importance of releases are derived: The impact is determined by the timeliness (or the sequence) of announcements, and/or by the type of information in a report. Performing a series of tests for these hypotheses shows that timeliness alone is not sufficient to explain differences in the impact of releases. Better results are obtained taking into account that macroeconomic reports provide different types of information, i.e. different indicators of inflation and economic strength. While the previous literature is primarily concerned with the question which releases have a significant impact on prices (or volatility) in a regression framework, this study tackles the issue of the underlying factors driving the relative impact of macroeconomic releases. This should help to resolve some contradictory results of previous studies. For example, Fleming and Remolona (1999b) find a significant impact of the Index of Leading Indicators (LI), while Fleming and Remolona (1997) do not. Since the main components of LI are available well in advance of the announcement of the index, and in addition, LI comes rather late in the release cycle, this paper would decide the case for Fleming and Remolona (1997) despite the fact that their results are based on a shorter sample period. Although here the focus is on first moments (i.e. signed price changes), the results do have implications for the analysis of volatility as well. For example, the finding of a significantly higher volatility around the announcement of a given report has to be interpreted more carefully if this report does not lead to consistent and significant changes in the price level due to the fact that the report contains rather outdated information.

The remainder of the paper is organized as follows. The next section describes the structure of the macroeconomic release cycle and the content of major releases. Moreover, some hypotheses concerning the relative importance of reports are presented. In section 3, these hypotheses are tested on the basis of a system of equations describing the impact of surprises in headline figures on prices. Section 4 concludes.

2 The impact of information arrival on prices

2.1 T-Bond futures price changes and surprises

Using narrow five-minute windows around announcement times, T-Bond futures price reactions to non-anticipated information in U.S. macroeconomic announcements are investigated. This futures contract is listed at the Chicago Board of Trade (CBOT) and calls for delivery of a T-bond with at least 15 years to maturity. Note that T-bond futures prices are by far more sensitive to changes in long-term interest rates than to short rate movements.[4]

Let ΔP_i denote the change of the futures price in a narrow time interval around t_i. More precisely, this is the difference between the last trading price observed before t_i and the last price observed within the interval $(t_i, t_i + \Delta t]$, where Δt equals five minutes. This price change is modeled as a linear function of distinct pieces of news arriving during this period, especially headline figures in scheduled macroeconomic reports. These headline figures summarize the information contained in such a report (e.g. the overall unemployment rate in the employment report; see table 5 for more details). Since they are closely watched by market participants, analysts' forecasts

[4] Due to the high duration of the underlying bonds and the short contract maturity of the investigated front month contract, bond price movements outweigh the cost-of-carry impact on futures prices by far. For details see, for example, Jarrow (1996).

are polled and published in advance. Like in previous studies, the median forecast ('consensus forecast') of analysts surveyed by Standard & Poors Global Markets (also known as MMS) is employed here. Let F_j denote this forecast for headline j and A_j its announced value. $D_{j,i}$ is a dummy variable equal to one if A_j becomes available during the time interval $(t_i, t_i + \Delta t]$, and zero otherwise. The future price change may then be written as a function of surprises in headline figures, i.e. $A_j - F_j$,

$$\Delta P_i \;=\; \sum_j \alpha_j \left(A_j - F_j\right) D_{j,i} + \varepsilon_i \; . \tag{1}$$

Any other information arriving between t_i and $t_i + \Delta t$ which might surprise market participants and other effects on prices are reflected by the error term ε_i in (1). Since price reactions in very narrow time windows around announcements are investigated, the probability that other information besides the observed releases arrives and affects prices significantly should be fairly small. Eq. (1) is analyzed for the three major release times of scheduled macroeconomic announcements, i.e. 8:30, 9:15, and 10:00 a.m. ET (Eastern Time).

According to the well known efficient market hypothesis one would expect that the impact of a surprise is incorporated rapidly in prices, especially since the price response of one of most actively traded futures contracts to widely anticipated headline figures is analyzed here.[5] Hence, it would be rather astonishing to find that a surprise in an 8:30 headline still has an impact on five-minute price changes around 9:15. Since the remainder of this paper analyzes the value of information contained in releases, it is rather essential that we look at a market that processes information efficiently. Therefore, the following hypothesis is tested as a prerequisite:

[5] Information processing in the open outcry system of the CBOT should be very efficient. For a discussion of information diffusion in electronic and floor trading systems see, for example, Franke and Hess (2000b).

H1: Immediate response

> If markets process information efficiently, price changes should not be affected systematically by previous announcements (i.e. reports being released 45 or 90 minutes earlier during the day).

Since non-anticipated information is measured by the deviation of announcements from analysts' forecasts, another prerequisite for the analysis of the impact of non-anticipated information is that market participants are actually surprised by these deviations, i.e. that they are not predictable. Several previous studies provide tests on the performance of analysts' forecasts (see, for example, Pearce and Roley 1985 or Becker et al 1996). They suggest that these forecasts are not always efficient, especially if short test periods are used. But at least, most of the time they outperform commonly used time series models (Hardouvelis 1988, Moersch 2001). Test results provided in table 7 confirm these results largely. On the 1% level, the efficiency of analysts' forecasts can be rejected for only 1 out of the 24 headline figures analyzed here, i.e. for GDP_1. Splitting the sample period into halves, no consistent pattern of predictability remains.

2.2 The content of macroeconomic reports

This study investigates U.S. macroeconomic reports which are released on a monthly or quarterly schedule within floor trading hours of CBOT T-bond futures (see table 5).[6] To gain a better understanding of the relative importance of these reports, in the remainder of this section headline figures are classified according to the type of information they provide. Unexpected macroeconomic news may lead agents to

[6] For a description of individual releases and headline figures see, for example, Rogers (1994).

revise their expectations of nominal interest rates, due to either higher future inflation rates or higher real rates. Previous studies have tried to identify whether an announcement provides information that might alter market participants expectations of real rates or inflation rates.[7] Following Edison (1996), headline figures are categorized into two broad content groups: figures that provide inflation measures (C1), and others that indicate higher or lower levels of real activity (C2). Note that in contrast to studies like Hardouvelis (1988) or Dornau and Schröder (2000), the purpose of this classification is neither to find out which macroeconomic model market participants might have in mind nor to assess the empirical relevance of different models. The sole purpose is to identify reports with a similar information content. Identifying relatively homogeneous sets of information constitutes the basis for testing whether the information content helps to explain the relative impact of releases.

Higher levels of real economic activity may be associated with higher real interest rates. If increasing economic activity is coupled with increasing investments, and thus with a higher demand for capital, interest rates should rise given a finite elasticity of capital supply. Information about higher economic activity might also alter agents' expectations of future inflation rates, since inflation could be spurred by an overheating economy. Thus, an unexpected increase in real activity could drive interest rates up through higher real rates and/or higher inflation expectations. Headline figures about economic activity are classified as C1. Since they are rather heterogeneous, three subcategories, i.e. (a) to (c), are distinguished.

[7]Other studies, for example Dwyer and Hafer (1989), investigate also monetary phenomenons. Since money supply figures are released after floor trading hours, i.e. at 4:30 p.m. ET, they are not included here.

C1: Economic activity (and subcategories)

(a) Overall production level: $NAPM_1$, IP_1, DGO_1, GDP_1, LI_1, FI_2.

(b) Demand for consumption goods: CC_1, RS_1, PI_2.

(c) Demand in housing sector: HS_1, NHS_1, CS_1.

The first subcategory in C1 includes headline figures that provide evidence about the overall production level: The industrial production figure (IP_1, see table 5 in the appendix), the level of the gross domestic product (GDP_1), the index of the National Association of Purchasing Managers ($NAPM$)[8], the index of leading indicators (LI), durable goods orders (DGO), and factory orders (FI_2).[9] The second subcategory of figures provides specific information about consumer demand, e.g. the retail sales figure (RS) and personal consumption expenditures (PI_2). In addition, consumer confidence (CC) may permit some conclusions about the future spending behavior of consumers. The third group of related figures covers the demand in the housing sector, i.e. the number of housing starts (HS), new home sales (NHS), and construction spending (CS).

C2: Inflation expectations (and subcategories)

(a) Measures of past price changes: PPI_2, CPI_2, GDP_2.

(b) Early inflation indicators: E_2, IP_2, ECI_1, FI_1, PC_1, BI_1.

Classification (C2) includes measures of inflation. Two subcategories are distinguish

[8]This composite index is based on a questionnaire covering several areas of business activity, among them the current level of production, new orders from customers, and employment in the manufacturing sector.

[9]Durable goods orders measure orders, shipments, and unfilled orders placed with U.S. manufacturers for goods with a life expectancy of at least three years, factory orders include non-durable goods as well.

in order to obtain homogeneous information sets. The first subcategory in C2 contains figures measuring past price changes at the very end of the production process, i.e. inflation in finished or almost finished goods. Among them are the monthly consumer and producer price indices (PPI_2, CPI_2)[10] as well as the price deflator contained in the quarterly GDP report (GDP_2). The second subcategory contains indications of price pressures at earlier stages of the production process and shortages of production factors. While several reports include such information on price pressures, e.g. raw material prices included in the producer price report, only for two headline figures analysts' forecasts are available. These are labor costs (ECI) and productivity (PC). Both, higher than expected wages and lower productivity, might suggest that inflation pressures are building up, especially if wages rise faster than productivity. Shortages of production factors which might translate into price pressures of input factors are indicated, for example, by a stretched capacity utilization (IP_2) or by low inventories (BI_1, FI_1). Furthermore, if a tight labor market gives employees more bargaining power, a lower than expected unemployment rate (E_2) may foreshadow higher wages and, thus, inflation pressures.

2.3 Determinants of the relative impact of releases

This section derives some hypotheses in order to investigate the determinants of the relative impact of releases. The first hypothesis (H2) follows immediately from the very special time series properties of surprises in macroeconomic releases. Compare these reports, for example, to a regular time series of temperature measurements obtained at the end of each month. Instead of drawing one observation for each

[10] Previous studies use the overall consumer and producer prices indices. Instead, here the less volatile core inflation numbers are employed which exclude food and energy.

period, assume that several meteorological stations measure temperature at the same time, but for some technical reason, these figures are not released at the same time. A similar structure is found for macroeconomic reports. There are several macroeconomic reports referring to the same period and measuring similar aspects of economic strength and inflation. Again, these figures are not released at the same time but with a more or less extended time lag to the reporting period (see figure 1 in the appendix). It seems reasonable to assume that the price impact of the non-anticipated information in a report depends on the time lag to the reporting period, and thus, its impact on prices (hypothesis H2).

H2: Timeliness

> The price impact of non-anticipated information in a release depends on the time between the announcement of the report and the end of the reference period.

H2 restates an observation previously made by Fleming and Remolona (1997). They find that the four most recent available government reports (E, CPI, PPI, and RS) have the highest impact on five year T-note prices. From this they conclude that the time between the end of the period covered by a report and the announcement helps to explain the impact of a release.

It may be questioned whether the timeliness of a report is best measured by the number of days determining the time lag. Instead, a report may become 'outdated' due to the fact that other reports which provide similar information are released in advance. This is stated by hypothesis H3:

H3: Sequence

> The price impact of non-anticipated information in a release decreases with the number of previously released reports for a given reference period.

Note that H2 and H3 are rather similar since both imply a monotonically declining impact of subsequently released reports. However, if one does not find such a strict relation, H2 will provide another testable implication: Reports with a time lag of more than a month should have almost no impact since reports for the following calendar month are already available. This should be the case for LI and all subsequently released reports (see figure 1).

Both, H2 and H3 ignore any differences in the type of information. However, it seems more reasonable to assume that market participants differentiate between various aspects of economic strength and inflation in order to assess the equilibrium long-term interest rate. In this case, a formulation of H3 that builds on the content analysis of the previous section (see C1 and C2) seems more appropriate. Therefore, H4 explicitly differentiates between the type of information, hypothesizing that the additional information provided by a report for a given month diminishes with the number of already released reports with a similar content. For example, this would imply that a figure like housing starts HS could have quite a significant impact since it is the first figure providing evidence on the demand in the housing sector. In contrast, according to H3 (and H2) the impact of HS should be rather moderate since several other figures - although highlighting different aspects - would be already available.

H4: Sequence within content classes

> The price impact of non-anticipated information in a release depends on the number of previously released reports with a similar content.

A strong argument in favor of this hypothesis comes from the fact that certain figures repeat to some extent information contained in previously released reports. A rather outdated figure in this sense is the factory orders number (FI_2) since an earlier estimate can be derived from both, the report on durable good orders which account for over 50% of total factory orders, and the new orders component in the NAPM report. Even worse, the NAPM report for the subsequent month is already available when FI comes out.

3 Empirical results

3.1 Data description

This study analyzes surprises in 24 headline figures contained in 19 different U.S. macroeconomic reports over a 6 year period, i.e. January 1994 to December 1999. This includes monthly as well as quarterly reports scheduled during the floor trading hours of T-Bond futures at the Chicago Board of Trade. These are reports which are released at either 8:30 a.m., 9:15 a.m., or 10:00 a.m. ET (Eastern Time). Due to strict lock-up conditions, described for example in Fleming and Remolona (1997), reports are released precisely according to the schedule.[11] A major disruption of

[11] Fleming and Remolona (1999b) cite two exceptions of this rule. These are two occurrences of inadvertently early released reports, i.e. the November 1998 employment report and the January 1999 PPI report. Nevertheless, the strict lockup conditions normally prevent a leakage of information before the official release time (see e.g., Fleming and Remolona 1999). This is confirmed by Ederington and Lee (1995) who find no significantly positive correlation between returns in several intervals preceding an announcement and returns immediately after an announcement.

the news flow occurred in December 1995 and January 1996 caused by a temporary shutdown of several federal agencies due to a federal budget dispute. Since the whole forecasting process might have been affected, all observations from December 1995 through February 1996 are excluded. The sample contains 69 observations for each of the 16 monthly reports and 23 observations for the 3 quarterly reports in our sample. Out of the 1497 trading days, on 769 days at least one report is released.

Consensus forecasts, i.e. median analysts' forecasts, of headline figures were generously provided by Standard & Poors Global Markets (MMS) for the period 1995–1999. Earlier forecasts as well as actual outcomes were obtained from several print sources, especially the Wall Street Journal, Barron's, Financial Times, and Business Week. Surprises, i.e. non-anticipated information in announced headline figures, are calculated subtracting consensus forecasts from the actual outcomes. Note that non-revised figures are used as they were available to market participants at the time of announcement. These figures may differ substantially from those available from statistical agencies today.[12]For each headline figure standardized surprises are computed dividing surprises by the sample standard deviation of outcomes (i.e. $S_i/Std(A_i)$). Descriptive statistics for both, outcomes and non-standardized surprises are given in table 6.

Intraday data on CBOT T-Bond futures trading provided by the Futures Industry Institute are used.[13] Focusing on the front month contract, i.e. the most actively traded contract among the nearby and second nearby contract, price changes over

[12]Many macroeconomic figures are subject to several revisions afterwards. For example, the initially reported unemployment rate is revised every January for the previous five years.

[13]This is a so-called tick-by-tick data set containing a time-stamped record whenever a price change is observed. Transaction volumes are not recorded.

five minute intervals around 8:30, 9:15, and 10:00 releases are analyzed.[14] For example, five-minute price changes around 8:30 are calculated using the price of the last transaction in the front month contract recorded before 8:30 and the last price before 8:35.

3.2 Estimation of the impact of surprises on price changes

In order to test hypotheses H2 through H4, a system of three equations is estimated, one for each release time.

$$\begin{aligned}
\Delta P_{8:30} &= \kappa_1 + \sum_{i=1}^{15} \alpha_i S_i^{(8:30)} + \varepsilon_1 \\
\Delta P_{9:15} &= \kappa_2 + \sum_{i=1}^{15} \beta_i S_i^{(8:30)} + \sum_{i=16}^{17} \alpha_i S_i^{(9:15)} + \varepsilon_2 \\
\Delta P_{10:00} &= \kappa_3 + \sum_{i=1}^{15} \gamma_i S_i^{(8:30)} + \sum_{i=16}^{17} \beta_i S_i^{(9:15)} + \sum_{i=18}^{24} \alpha_i S_i^{(10:00)} + \varepsilon_3
\end{aligned}$$

Here, $\Delta P_{8:30}$, $\Delta P_{9:15}$, and $\Delta P_{10:00}$ denote five-minute price changes around 8:30, 9:15, and 10:00 releases, respectively. $S_{(\cdot)}^{(time)}$ denotes standardized surprises occurring at a given release time. For example, $S_1^{(8:30)}$ denotes the surprise in headline figure E_1, i.e. nonfarm payrolls contained in the employment report which is released at 8:30 a.m. ET. These variables are zero if no such report is announced during a given five-minute interval. Note that price responses to signed surprises are analyzed according to the hypothesized T-bond future reactions which are detailed in table 5. For example, since it is hypothesized that T-bond futures prices should fall if the announced non-farm payroll figure (A_{E_1}) is higher than its forecast (F_{E_1}) a surprise in E_1 is calculated as $-(A_{E_1} - F_{E_1})$. Hence, a positive $S_{(\cdot)}$ should be "good news" for futures prices.

[14] Until around 3 weeks before expiration, the nearby contract is the most actively traded one.

Table 1: Results of an iterative seemingly unrelated regression (SUR)

Signed variable	Release time		8:30 equation			9:15 equation			10:00 equation	
$-\ CC_1$	10:00							α_{18}	**11.287**	***
$-\ NAPM_1$	10:00							α_{19}	**13.763**	***
$-\ E_1$	8:30	α_1	**13.201**	***	β_1	- .610	***	γ_1	.201	
$+\ E_2$	8:30	α_2	**22.732**	**	β_2	1.108	***	γ_2	.527	
$-\ PPI_2$	8:30	α_3	**6.725**	***	β_3	.349	**	γ_3	- .327	***
$-\ RS_1$	8:30	α_4	**5.801**	***	β_4	- .065		γ_4	.317	***
$-\ CPI_2$	8:30	α_5	**5.883**	***	β_5	.315		γ_5	- .212	**
$-\ IP_1$	9:15				α_{16}	**.197**		β_{16}	-1.428	***
$-\ IP_2$	9:15				α_{17}	**17.274**	***	β_{17}	2.557	***
$-\ HS_1$	8:30	α_6	**5.494**	***	β_6	- .208		γ_6	- .687	***
$-\ DGO_1$	8:30	α_7	**4.353**	***	β_7	.018		γ_7	- .355	***
$-\ ECI_1$	8:30	α_8	**3.086**		β_8	.750		γ_8	- .039	
$-\ GDP_1$	8:30	α_9	**6.575**	*	β_9	1.462	***	γ_9	- .135	
$-\ GDP_2$	8:30	α_{10}	**6.320**	**	β_{10}	.005		γ_{10}	1.927	
$-\ PI_1$	8:30	α_{11}	**1.937**	*	β_{11}	.487	***	γ_{11}	- .905	
$-\ PI_2$	8:30	α_{12}	**-1.776**		β_{12}	- .105	**	γ_{12}	- .903	
$-\ NHS_1$	10:00							α_{20}	**7.345**	***
$-\ LI_1$	8:30,10:00	α_{13}	**.154**		β_{13}	- .576	***	γ_{13}	4.151	
$-\ CS_1$	10:00							α_{21}	**- .873**	
$+\ FI_1$	10:00							α_{22}	**- .402**	
$-\ FI_2$	10:00							α_{23}	**4.559**	***
$+\ PC_1$	10:00							α_{24}	**- .139**	**
$+\ BI_1$	8:30,10:00	α_{14}	**.189**		β_{14}	- .558		γ_{14}	-1.053	***
$+\ TRD_1$	8:30	α_{15}	**.349**	***	β_{15}	.043		γ_{15}	.050	
Adjusted R^2			.309			.120			.226	
BG(30)			17.484			26.877			28.270	

Five minute price changes are regressed on standardized signed surprises (i.e. $S_{i,t}/Std(A_i)$), based on a system of three equations, one for each release time, i.e. 8:30, 9:15, and 10:00. Parameters of the system are estimated accounting for heteroskedasticity and contemporaneous correlation in the errors across equations. Estimated constants are omitted since they are insignificant (see table 2). Parameter tests are based on the heteroscedasticity consistent White variance-covariance matrix. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively. The sample period is 1/94–12/99, including 1497 trading days. There are 69 observations for each monthly report, and 23 for each quarterly report, resulting in 769 days on which at least one report is released. Breusch-Godfrey (BG) tests have been performed for several lag lengths. Since none of these is able to detect autocorrelation in residuals, test statistics are displayed only for the largest lag length, i.e. 30 days. Adjusted R^2s are provided for each equation. The system-wide R^2 measure according to McElroy (1977) is $R^2_* = .226$.

Price changes are regressed on surprises occurring within the corresponding time interval, and in addition, on surprises occurring earlier at a given day.[15] The α_i coefficients capture the immediate price impact of a release, i.e. the price change occurring in the five minute interval around the announcement. The β_is (γ_is) capture the impact of headlines being released 45 (90) minutes earlier at a given day. If markets process information efficiently one would expect that the impact of a surprise is incorporated rapidly into prices. Hence, if release i has an impact, one should find a significant α_i while β_i and γ_i should not be significantly different from zero.

The system of the three equations is estimated by a seemingly unrelated regression (SUR). Generalized least squares estimates are used in order to account for heteroskedasticity across trading days and contemporaneous correlation in the errors across equations. The employed estimation technique yields results that are asymptotically efficient.[16] Parameter estimates are provided in table 1 in the appendix. Since signed surprises are used, only positive α_is are in line with the hypothesized immediate price response. Interestingly, with only one exception the signs of the significant α_is are indeed positive. This exception is PC_1. However, the impact of a

[15] The announcement time for two reports (i.e. LI and BI) changes from 8:30 to 10:00 within our sample. Thus, the immediate impact of these releases has be captured in two equations. If these figures are released at 8:30, an α_i coefficient is included in the 8:30 equation, otherwise in the 10:00 equation. However, the corresponding coefficients are restricted to take on the same values in both equations.

[16] Efficiency gains are primarily to be expected from the fact that restrictions are imposed across equations. Otherwise, if the error terms in the above given equations are uncorrelated, a separate least squares estimation of the equations yields efficient parameter estimates, assuming well behaved data (see e.g., Dwivedi and Srivastava 1978). The correlation of single equations residuals estimated with ordinary least squares is indeed small but significantly different from zero at the 10% level. Hence, it cannot be taken for granted that the equations are actually unrelated. This is confirmed on the 10% level by a test on the diagonality of the variance-covariance matrix of the first-stage residuals (see e.g., Baltagi 1999, Ch. 10).

surprise in PC_1 is quite small.[17] Note that the right hand variables in table 1 are sorted according to the median report time lag (see figure 1). Thus, the ordering reflects the release sequence of the reports.

3.3 Tests of hypotheses

A prerequisite for an analysis of the value of information is to test whether the T-bond futures market processes information efficiently. As a minimum requirement previous releases should have no systematic impact on current prices. Thus, the β_i's and γ_i's should be zero (hypothesis H1). Indeed, most of β_is and γ_is are rather small, but 15 out of 32 parameters are significantly different from zero. In contrast, 17 out of the 24 α_is are significant, 12 of them at the 1% level. The arising first impression that futures prices respond immediately to surprises in macroeconomic announcements is confirmed by a Wald test (see table 2, row 3).[18] This test cannot reject the hypothesis that the β_is and γ_is are zero as a group. Thus, after 45 (as well as 90) minutes no significant systematic impact can be found. In contrast, a test on the immediate impact of surprises reveals that the hypothesis $\hat{\alpha}_i = 0$, $\forall i = 1, ..24$, is strongly rejected (table 2, row 2). This is not surprising, since one would expect that non-anticipated information leads to an immediate price response.

A much more critical question for our analysis is whether this impact differs across releases. Whether the immediate impact of surprises is more or less the same across releases can be tested on the basis of the restriction $\hat{\alpha}_i = \theta^*$, i.e. whether the individual first-stage parameters α_i can be replaced by a common second-stage parameter

[17] A surprise of the magnitude of one sample standard deviation of the observed outcomes leads to a price reaction of an eight of one tick.

[18] The same result is obtained testing separately whether the β_i's are zero and whether the γ_i's are zero (Hess 2000).

θ^*. Taking into account the variance-covariance matrix of parameters estimated in the first stage, an asymptotically consistent and efficient estimate of θ^* can be obtained by means of asymptotic least squares (see e.g., Gourieroux and Monfort 1995, Ch. 9). Results of this estimation are given in the right hand panel of table 2 (row 2). Being not able to reject this set of restrictions would imply that all the releases have virtually the same impact on prices, and thus would provide strong evidence against any of the three hypotheses (H2 to H4). This is not the case. The restriction $\hat{\alpha}_i = \theta^*$ is strongly rejected by the highly significant χ^2 statistics. In contrast, the results of the Wald test for the lagged impact are confirmed by this test (row 3). The restriction $\hat{\beta}_i, \hat{\gamma}_i = \theta^*$ holds while the estimated common parameter $\hat{\theta}^*$ is not significantly different from zero.

Table 2: Wald tests and Asymptotic Least Squares.

	Wald tests		**Asymptotic least squares estimates**		
Est. no.	Imposed restrictions	χ^2 test on imposed restrictions	Imposed restrictions	2nd stage parameter estimates	χ^2 test on imposed restrictions
(1)	$\hat{\kappa}_i = 0$	$\chi^2_{(3)} = 2.48$	$\hat{\kappa}_i = \theta^*$	$\hat{\theta}^* = 0.014$	$\chi^2_{(2)} = 2.39$
(2)	$\hat{\alpha}_i = 0$	$\chi^2_{(24)} = 1261.10^{***}$	$\hat{\alpha}_i = \theta^*$	$\hat{\theta}^* = 3.266^{***}$	$\chi^2_{(23)} = 795.25^{***}$
(3)	$\hat{\beta}_i, \hat{\gamma}_i = 0$	$\chi^2_{(32)} = 38.13$	$\hat{\beta}_i, \hat{\gamma}_i = \theta^*$	$\hat{\theta}^* = -0.004$	$\chi^2_{(31)} = 38.13$

Each line displays test results for a given set of parameters. The left hand side panel shows Wald tests restricting the given parameter set to zero, i.e. $\hat{\kappa}_i = 0$, for $i = 1, 2, 3$ (row 1), $\hat{\alpha}_i = 0$, $i = 1, \ldots, 24$ (row 2), and $\hat{\beta}_i = 0$, $i = 1, \ldots, 17$ as well as $\hat{\gamma}_i = 0$, $i = 1, \ldots, 15$ (row 3). The $\chi^2_{(\nu)}$ test statistic with ν degrees of freedom is given as well. The right hand panel displays an alternative test: Instead of restricting a set of parameters to zero, these parameters are restricted to a common value θ^* which is estimated on the basis of asymptotic least squares. Significance tests of $\hat{\theta}^*$ are constructed from the asymptotic variance-covariance matrix of restricted parameters. A test of the null hypothesis that the set of restrictions holds is obtained on the basis of the asymptotically $\chi^2_{(\nu)}$ distributed statistic (for details see e.g., Gourieroux and Montfort 1995, Ch. 9, 18). ***, **, and * indicates significance at the 1%, 5%, and 10% level, respectively.

Hypotheses H2 to H4, all imply a monotonically decreasing impact of releases. H3 implies that the impact of a surprise declines with the number of previously released reports, H2 relates the impact to the time lag of a release. In contrast, H4 conditions on the sequence within content categories. In order to obtain a formal test of these hypotheses, again a asymptotic least squares estimation is performed imposing certain constraints on the parameters estimated in the first stage. For example, a somewhat strict form of H2 (timeliness) postulates that the impact of releases declines linearly with the time lag of a release τ_i. This results in the restrictions $\alpha_i = \theta_0^* + \theta_1^* \tau_i$, $\forall i = 1, \ldots, 24$. Given that these restrictions hold, one can test whether $\hat{\theta}_1^*$ is significantly negative, as it is suggested by H2. Results of this estimation are given in table 3, line (1). Line (2) contains results for H3 (sequence) stating that the impact of surprises decreases with the number of previously released reports for the same reporting period, n_i, i.e. $\alpha_i = \theta_0^* + \theta_1^* n_i$. Line (3) to (7) provide results for H4 (sequence within content categories), i.e. $\alpha_i = \theta_0^* + \theta_1^* c_{i,j}$, where $c_{i,j}$ represents the number of previously released figures falling into the same category j as headline i.

Judging from the estimated slope coefficients $\hat{\theta}_1^*$ in table 3, the impact of these releases seems to be decreasing. These coefficients are all negative and all but one highly significant. This would support all three hypotheses if not several of the sets of restrictions were rejected by the corresponding χ^2 statistics. Especially, hypotheses H2 and H3 are strongly rejected. This suggest that although the impact of successive releases may be decreasing with n_i as well as t_i, assuming that the impact decreases linearly is too restrictive. In contrast, the results for H4 are slightly more favorable. At least the restriction of a linearly decaying impact within content categories cannot be rejected for two of the five categories (C1b 'Demand for consumption goods' and

C2a 'Measures of past price changes'). But again, for the remaining three categories this restriction is too strong.

Table 3: Test of hypotheses H2 to H4 by means of asymptotic least squares

Est. no.	Imposed restrictions	2nd stage parameter estimates $\hat{\theta}_0^*$	$\hat{\theta}_1^*$	χ^2 test on imposed restrictions
(1)	$\hat{\alpha}_i = \theta_0^* + \theta_1^* \tau_i$	9.646***	−0.244***	$\chi^2_{(22)} = 329.47$***
(2)	$\hat{\alpha}_i = \theta_0^* + \theta_1^* n_i$	9.468***	−0.478***	$\chi^2_{(22)} = 298.39$***
(3)	$\hat{\alpha}_i = \theta_0^* + \theta_1^* c_{i,1}$	7.539***	−1.398***	$\chi^2_{(4)} = 132.23$***
(4)	$\hat{\alpha}_i = \theta_0^* + \theta_1^* c_{i,2}$	12.217***	−6.882***	$\chi^2_{(1)} = 0.67$
(5)	$\hat{\alpha}_i = \theta_0^* + \theta_1^* c_{i,3}$	9.398***	−4.951***	$\chi^2_{(1)} = 21.55$***
(6)	$\hat{\alpha}_i = \theta_0^* + \theta_1^* c_{i,4}$	6.594***	−0.497 *	$\chi^2_{(1)} = 0.28$
(7)	$\hat{\alpha}_i = \theta_0^* + \theta_1^* c_{i,5}$	6.717***	−1.707***	$\chi^2_{(4)} = 83.21$***

Each line displays results of an asymptotic least squares estimation for a given set of linear restrictions. Line (1) and (2) provide tests for hypothesis H2 and H3, respectively, by restricting estimated first stage parameters $\hat{\alpha}_i$ as a linear function of τ_i, i.e. the time lag of a release, and n_i, i.e. the number of previous releases. Results for H4 are given in lines (3) to (7) testing whether the $\hat{\alpha}_i$'s may be expressed as a linear function of $c_{i,j}$, i.e. the number of previous releases within a given content category $j = 1, \ldots, 5$ (corresponding to classification C1a, C1b, C1c, C2a, and C2b, respectively). A test of the null hypothesis whether the constraints hold is obtained on the basis of the asymptotically $\chi^2_{(\nu)}$ distributed statistic with ν degrees of freedom, t-statistics for $\hat{\theta}_i^*$ are constructed from the asymptotic variance-covariance matrix of restricted parameters (see e.g. Gourieroux and Montfort 1995, Ch. 9, 18). ***, **, and * indicates significance at the 1%, 5%, and 10% level, respectively.

In order to obtain more evidence, some less rigorous implications of the hypotheses are tested in the remainder of this section. For example, hypothesis H2 implies that releases with a time lag larger than a month should have no impact since information for the subsequent report period are already available. Interestingly, all but one of the reports being released within one month after the end of the reporting period (i.e. *CC* to *NHS*, see figure 1) are significant, most of them at the 1% level (see table 1). In contrast, out of the remaining seven headline figures which are released in the second month (i.e. LI to TRD) only two are significant. This may serve as preliminary evidence in favor of a somewhat loose interpretation of hypothesis H2. Nevertheless, on the basis of a Wald test the hypothesis that their impact as a group is zero has to be rejected. So, according to this test H2 has to be rejected again. Note that the implications for hypothesis H3 are quite similar.

Turning to hypothesis H4, instead of imposing linear restrictions on the coefficients one may perform a series of pairwise t-tests on the difference of coefficients within a content category. If the impact of reports decreases strictly within a content group, for each pair of successive reports the difference between consecutive coefficients should be significantly positive. It is not surprising that this very strong result is obtainable for only one of the five content categories, since the restriction of a linear decay in the coefficients was already rejected for three of them. Nevertheless, very strong evidence of a decreasing price impact can be found investigating a somewhat less strict formulation of H4: The first or second release within a content category should have a higher price impact than all the subsequent releases. Table 4 displays the results of pairwise comparisons of the first and the second headline figure in a given content category with the subsequently released headlines falling into the same category. Tests for hypotheses H2 are H3 omitted since the first two releases, i.e. $NAPM$ and CC have a significantly lower impact than the following ones. Thus, H2 are H3 are easily rejected again by this test.

Table 4: Test of hypothesis H4 by means of sequential pairwise t-tests

C1a: Overall production

	$NAPM_1$	IP_1
IP_1	13.565 ***	
DGO_1	9.410 ***	-4.155
GDP_1	7.188 ***	-6.377
LI_1	13.608 ***	0.043
FI_2	9.204 ***	-4.361

C1b: Consumption goods

	CC_1	RS_1
RS_1	5.486 ***	
PI_2	13.063 ***	7.577 ***

C1c: Housing sector

	HS_1	NHS_1
NHS_1	-1.851	
CS_1	6.366 ***	8.217 ***

C2a: Past price changes

	PPI_2	CPI_2
CPI_2	0.841	
GDP_2	0.405	-0.436

C2b: Early indicators

	E_2	IP_2
IP_2	5.458 ***	
ECI_1	19.646 ***	14.188 ***
FI_1	23.134 ***	17.676 ***
PC_1	22.871 ***	17.413 ***
BI_1	22.543 ***	17.085 ***

Tests on a decreasing impact of subsequent releases in individual content categories. The first and second headline figure is compared with all subsequently released figures within a given content category. Differences between estimated coefficients are displayed for each of the five content categories. A positive entry indicates that the impact of the previously released headline (i.e. the headline figure given on top) is larger than the impact of the report released subsequently (i.e. the headline figure to the left). A significantly positive (negative) difference according to a one-sided t-test at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively. Standard errors of the differences are constructed from the estimated White variance-covariance matrix of parameters.

As can be seen from table 4, in none of the categories the first release's impact is outweighed by subsequent releases. At worst, its impact is insignificantly lower than that of the second release (category C1c 'Housing sector'). For three of the five categories, the first release has a significantly higher impact than all others. In a fourth category (again, C1c), there is no significant difference between the first and second release, but both dominate the third. There remains only one category in which subsequent releases do not have a significantly lower impact (C2a 'past price changes'). However, even this category does not provide evidence against hypothesis H4 since the impact of subsequent releases is decreasing, too, although not significantly. Hence, the sequences of pairwise t-tests given in table 4 support hypothesis H4.

Overall, hypothesis H4 cannot be rejected if one does not demand that the impact of subsequent releases declines strictly linearly. A similar result cannot be obtained for Hypothesis H2 are H3 since both, the first and second release have a considerably lower impact than several subsequent releases. Thus, the type of information plays a substantial role in explaining the relative impact of non-anticipated information in macroeconomic releases on T-bond futures price changes.

4 Summary and conclusions

T-bond futures prices like bond prices are driven mainly by market participants' expectations of real interest rates and future inflation rates. Therefore, the set of headline figures in scheduled macroeconomic releases is divided into two broad content categories, news related to inflation expectations and news related to economic activity. Among them five subcategories are distinguished. For example, inflation related news are differentiated according to their time horizon, i.e. measurements of past price changes in finished goods versus indications of price pressures further down in the production channel. Interestingly, all but one of the significant coefficients capturing the immediate futures price response to surprises show the correct sign, i.e. the introduced information classification may well explain the direction of futures price changes.

Investigating the sequence of releases without differentiating for content, at best some week evidence can be obtained that the mere sequence or the timeliness of reports matters (hypotheses H3 and H2). On the one hand, the rather strict implication of a monotonically linearly decaying impact has to be rejected. But on the other hand, the response to releases coming out in the first month after the end of the reporting period is somewhat stronger than the impact of releases announced in the second month. Nevertheless, the releases in the second month are still significant as a group although this information should be rather outdated since several reports for the subsequent month are already available.

Test results are much more favorable if headline figures are differentiated by the type of information. The rather strong hypothesis of a strictly linearly decreasing impact within content categories is only rejected for three of the five categories. More importantly, a pairwise comparison of the impact of surprises reveals that the first and/or second release within a given content category has the highest impact on prices. This leads to the conclusion that the type of information is an important determinant of the relative impact of releases (hypothesis H4). This result suggests that market participants consider various aspects of inflation and economic growth to be relevant in order to assess the equilibrium long-term interest rate. Moreover, it implies that the information value of an additional release for a given reporting period decreases with the number of already available figures providing a similar content. For example, market participants seem to learn enough from the first two housing figures about the strength of demand in that sector, and thus the subsequently released figure has almost no price impact.

A Headline figures in macroeconomic reports

Table 5: Headline figures in macroeconomic reports and hypothesized reactions to non-anticipated information.

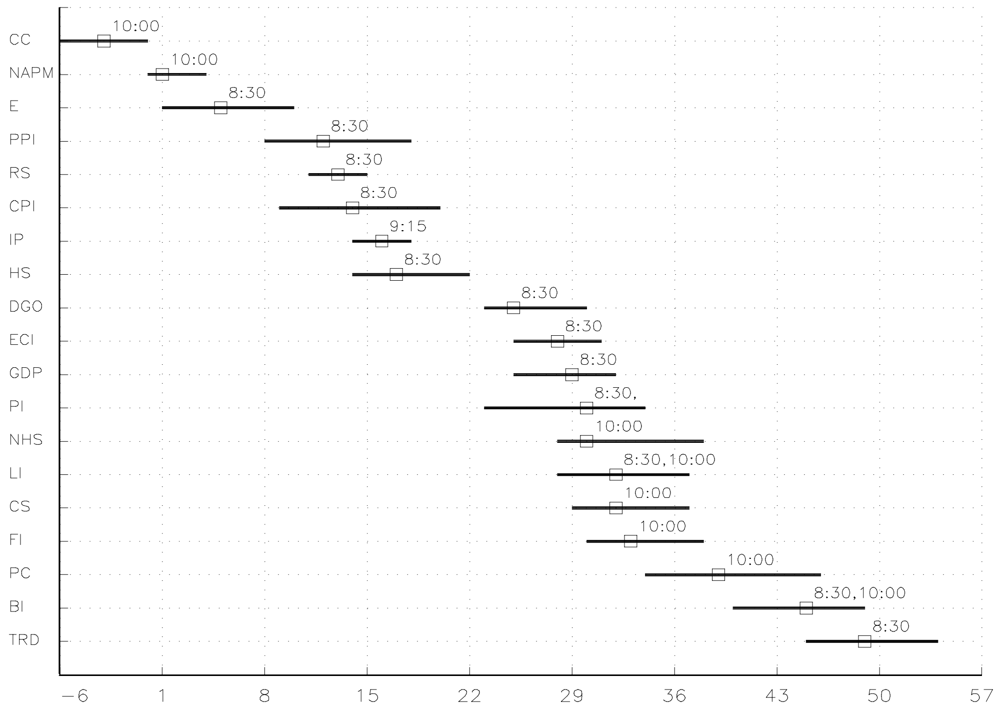
Abbr.	Headline figure	Reporting agency[a]	Higher outcomes signal higher interest rates due to: already higher prices	higher consumer demand	supply bottle-necks	Hypothesized price response of T-Bond futures
CC_1	Consumer confidence index	CB		+		−
$NAPM_1$	Overall NAPM index	NAPM	+	+	+	−
E_1	Non-farm payrolls	BLS			+	−
E_2	Unemployment rate				−	+
PPI_2	PPI ex. food and energy	BLS	+			−
RS_1	Retail sales	CENS		+		−
CPI_2	CPI ex. food and energy	BLS	+			−
IP_1	Industrial production	FED		+		−
IP_2	Capacity utilization				+	−
HS_1	Housing starts	CENS		+	+	−
DGO_1	Durable goods orders	CENS		+		−
ECI_1	Employment cost index	BEA	+			−
GDP_1	Real GDP			+		−
GDP_2	GDP deflator		+			−
PI_1	Personal income	BEA		+		−
PI_2	Consumption expenditures			+		−
NHS_1	New home sales	CENS		+		−
LI_1	Index of leading indicators	BEA				−
CS_1	Construction spendings	CENS		+		−
FI_1	Factory inventories	CENS			−	+
FI_2	Factory orders			+		−
PC_1	Productivity	BEA			−	+
BI_1	Business inventories	CENS			−	+
TRD_1	Trade deficit	CENS		−		+

For each report, headline figures, reporting agency, and hypotheses concerning the reaction of T-Bond futures prices to surprises in these figures are given. "+" ("−") indicates a positive (negative) reaction to a higher than expected announcement of individual figures. For example, a higher than expected consumer confidence index suggests stronger consumer demand which might translate into price pressures. Thus, a positive impact on interest rates ("+") and a negative impact on T-bond futures prices ("−") is to be expected.

[a]BEA: Bureau of Economic Analysis, BLS: Bureau of Labor Statistics, CB: Conference Board, CENS: Bureau of the Census, FED: Federal Reserve Board, TRES: Department of the Treasury, NAPM: National Association of Purchasing Managers

B Release cycle

Figure 1: Timeliness of reports



For each report the number of calendar days between the announcement and the end of the reference month is displayed (see table 5 for abbreviations). For monthly (quarterly) releases this is the end of the calendar month (quarter). The median time lag is indicated by a square. A solid line reveals the range between the minimum and maximum number of days. Announcement times are also provided. While most of the reports are released always at the same time, either 8:30, 9:15, or 10:00 a.m. ET, the time schedule of LI and BI changes within the sample period, i.e. January 1994 to December 1999. Note that Releases during the government shutdown period in early 1996 are excluded. The release cycle is opened by the report on consumer confidence which is released usually during the last week of the reference month. It is followed by the NAPM report which usually appears at the first business day of the succeeding month.

C Descriptive statistics

Table 6: Descriptive statistics of released headline figures and surprises

	Outcomes				Surprise			
Headline	Min.	Mean	Max.	Std.dev.	Min.	Mean	Max.	Std.dev.
CC_1	80.8	113.9	139.0	17.51	−7.5	1.0	13.3	4.06
$NAPM_1$	45.1	53.1	61.2	4.00	−4.8	−0.0	3.8	1.95
E_1	−101.0	212.1	705.0	134.15	−274.0	10.9	408.0	119.93
E_2	4.1	5.1	6.7	0.69	−0.4	−0.1	0.3	0.14
RS_1	−0.8	0.3	1.5	0.48	−1.1	−0.1	1.1	0.39
PPI_2	−0.5	0.1	0.8	0.20	−0.6	−0.0	0.4	0.18
CPI_2	0.1	0.2	0.4	0.08	−0.2	−0.0	0.2	0.08
IP_1	−0.6	0.3	1.7	0.45	−0.5	0.1	0.9	0.25
IP_2	80.1	82.9	85.7	1.47	−0.6	0.1	0.7	0.30
HS_1	1.2	1.5	1.8	0.14	−0.2	0.0	0.1	0.07
DGO_1	−5.2	0.6	6.1	2.51	−4.6	0.3	4.3	2.09
ECI_1	0.4	0.9	3.5	0.64	−0.4	0.1	2.7	0.65
GDP_1	0.5	3.6	5.9	1.38	−1.1	0.5	1.7	0.69
GDP_2	0.8	1.7	3.1	0.70	−1.3	−0.3	0.7	0.46
PI_1	−0.3	0.5	1.4	0.30	−0.6	0.0	0.5	0.16
PI_2	−0.2	0.5	1.3	0.29	−0.5	0.1	0.7	0.25
NHS_1	−551.0	793.3	983.0	104.15	−102.0	14.7	126.0	51.57
LI_1	−0.6	0.1	1.3	0.30	−0.2	0.0	0.2	0.10
CS_1	−2.4	0.3	3.3	1.19	−2.6	−0.0	3.3	1.23
FI_1	−0.9	0.2	1.0	0.33	−0.7	0.1	0.8	0.35
FI_2	−2.5	0.5	4.4	1.46	−0.9	0.1	1.3	0.47
PC_1	−0.2	1.9	4.5	1.61	−1.4	0.3	1.5	0.91
BI_1	−0.2	0.3	1.1	0.28	−0.4	0.0	0.6	0.20
TRD_1	−24.9	−11.9	−7.3	4.16	−48.5	−1.0	3.1	6.11

Displayed are the minimum, mean, maximum, and standard deviation of initially released non-revised headline figures (left hand panel) and of non-standardized surprises (right hand panel) for the total sample period, i.e. 1/1994 to 12/1999. Surprises are measured as deviations of announced figures from consensus forecasts. Consensus forecasts are defined as the median of analysts' forecasts polled by Standard & Poors Global Markets.

D Efficiency of consensus forecasts

Table 7: Test on the efficiency of MMS consensus forecasts

	Total Sample 1/1994–12/1999			Subsample 1/1994–12/1996			Subsample 1/1997–12/1999		
Headline	F	R^2	BG	F	R^2	BG	F	R^2	BG
CC_1	0.70	0.02	5.89	0.63	0.05	3.46	1.86	0.09	7.32 *
$NAPM_1$	0.58	0.02	2.01	1.94	0.12	1.45	0.57	0.03	1.27
E_1	2.38	0.05	0.50	2.93 *	0.09	1.21	0.37	0.02	1.65
E_2	2.45 *	0.06	0.62	2.73 *	0.16	0.64	2.37	0.11	1.29
RS_1	0.14	0.01	0.87	0.43	0.04	1.06	0.11	0.01	0.51
PPI_2	1.09	0.03	1.26	0.55	0.04	0.95	0.83	0.04	1.92
CPI_2	2.86 *	0.08	0.21	3.61 **	0.15	0.26	1.28	0.09	0.48
IP_1	4.17 **	0.16	0.47	4.49 **	0.13	3.51	2.12	0.22	0.51
IP_2	0.61	0.01	4.75	5.03 **	0.24	4.29	0.62	0.05	7.99 **
HS_1	0.01	0.00	1.90	0.20	0.01	0.78	0.23	0.01	1.06
DGO_1	2.73 *	0.06	5.80	2.16	0.08	1.71	1.50	0.08	3.39
ECI_1	0.22	0.03	9.93 **	5.49 *	0.46	5.43	28.61 ***	0.53	1.08
GDP_1	8.09 ***	0.45	1.13	1818.7 ***	0.98	0.45	4.30 *	0.49	0.49
GDP_2	2.46	0.16	0.93	3.29	0.32	1.35	4.40 *	0.38	4.36
PI_1	0.31	0.01	4.20	0.07	0.00	2.25	0.74	0.02	8.36 **
PI_2	0.70	0.04	1.10	0.62	0.05	1.04	2.10	0.09	1.19
NHS_1	1.65	0.03	5.68	5.53 ***	0.07	3.06	1.21	0.07	1.88
LI_1	0.90	0.02	3.67	1.04	0.03	0.88	0.13	0.01	10.29 **
CS_1	2.10	0.06	0.79	0.09	0.01	0.71	3.68 **	0.18	0.43
FI_1	1.76	0.06	0.70	3.04 *	0.15	0.90	0.27	0.02	4.49
FI_2	0.96	0.03	3.60	0.89	0.06	0.69	0.25	0.02	4.02
PC_1	0.45	0.05	4.06	0.40	0.00	4.00	0.74	0.15	4.22
BI_1	4.63 **	0.13	4.59	2.01	0.11	0.95	6.96 ***	0.28	7.12 *
TRD_1	0.62	0.12	4.22	4.92 **	0.27	0.63	0.73	0.15	3.17

Surprises in each headline figure, i.e. deviations of announced from forecasted values ($S_{i,t} = A_{i,t} - F_{i,t}$), are regressed on the corresponding previous two outcomes by means of ordinary least squares: $S_{i,t} = \alpha_0 + \alpha_1 A_{i,t-1} + \alpha_2 A_{i,t-2}$. These estimations are performed on the total sample period (1/1994–12/1999) as well as on two three-year subsamples. Ordinary coefficients of determination are displayed (R^2) along with the results of an F-test (F) of the null hypothesis $H_0 : \alpha_1 = \alpha_2 = 0$ based on the heteroscedasticity consistent White covariance matrix of parameters. In addition, results of a Breusch-Godfrey (BG) test on autocorrelation in residuals up to five lags are reported. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

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