WHAT MOVES OPTION-IMPLIED BOND MARKET EXPECTATIONS?

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This article examines the impact of macroeconomic news announcements on bond market expectations, as measured by option-implied probability distributions of future bond returns. The results indicate that expected bond market volatilities increase in response to higher-than-expected inflation and unemployment announcements. Furthermore, the asymmetries in bond market expectations are found to be affected mostly by surprises in inflation and economic production figures. In particular, it is found that higher-than-expected inflation announcements cause option-implied bond return distributions to become more negatively skewed or less positively skewed, implying a shift in market participants' perceptions toward future increases in interest rates. Finally, the results indicate that market expectations of future extreme movements in bond prices are virtually unaffected by macroeconomic news releases. Some evidence is

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found, however, that suggests that after extreme surprises in inflation announcements market participants attach higher probabilities for extreme movements in bond prices. Jrl Fut Mark 25:817–843, 2005

INTRODUCTION

This article focuses on the impact of surprises in macroeconomic news announcements on bond market expectations, as measured by option-implied probability distributions of future bond returns. Because the price of an option depends on the probability of the underlying asset price exceeding the strike price of the option, a set of option prices with the same maturity but with different strike prices can be used to infer the entire probability distribution of the underlying asset price at the maturity of the option. Previously, a number of articles have used option-implied probability distributions to examine the behavior of market expectations around specific events, such as financial crises (e.g., Gemmill & Saflekos, 2000; Melick & Thomas, 1997; Söderlind, 2000), elections (e.g., Coutant, Jondau, & Rockinger, 2001; Gemmill & Saflekos, 2000), and central bank actions (e.g., Cooper & Talbot, 1999; Galati & Melick, 2002; Vähämaa, 2005). In brief, these studies show that option-implied probability distributions are useful for assessing the behavior of market expectations.[1] In this article, data on German government bond futures options is used to examine the impact of surprises in U.S. and European macroeconomic news announcements on option-implied bond market expectations. Unlike for stock and corporate bond markets, most of the value-relevant information for government bonds is related to macroeconomic fundamentals.[2] Hence, it is of interest to examine how macroeconomic announcements affect market expectations about the future development of bond prices.

The existing literature shows that bond prices are significantly affected by macroeconomic announcements (see, e.g., Ahn, Cai, & Cheung, 2002; Balduzzi, Elton, & Green, 2001; Becker, Finnerty, & Kopecky, 1995; Fleming & Remolona, 1997, 1999; S. J. Kim, McKenzie, & Faff, 2004; S. J. Kim & Sheen, 2001; McQueen & Roley, 1993). McQueen and Roley (1993), for instance, document the short-term U.S. Treasury bills and long-term Treasury bonds to be most significantly affected by

[1]Gemmill and Saflekos (2000), however, conclude that although implied distributions are useful for revealing the market sentiment, they do not have much power for forecasting future events.
[2]Fleming and Remolona (1997) and Ahn et al. (2002) show that the largest price movements in the U.S. and German bond markets are caused by macroeconomic news announcements.

labor market announcements (unemployment rate and nonfarm payrolls). In addition, they find the long-term bond also to be strongly affected by inflation indicators (consumer and producer price indices). Similar findings on the major impact of unemployment and inflationary news on bond prices were later reported, for example, in Ederington and Lee (1993); Fleming and Remolona (1997, 1999); Jones, Lamont, and Lumsdaine (1998); Balduzzi et al. (2001); and Ramchander, Simpson, and Chauhry (2003).

Several articles show that macroeconomic news announcements have a significant impact on bond market volatility (see, e.g., Balduzzi et al., 2001; Bollerslev, Cai, & Song, 2000; Ederington & Lee, 1993; Jones et al., 1998; S. J. Kim et al., 2004; Li & Engle, 1998; Ramchander et al., 2003). These articles use autoregressive conditional heteroskedasticity (ARCH) modeling or other time-series–based volatility estimates to assess the impact of macroeconomic news on bond market uncertainty. Although the time-series–based volatility estimates are by construction constrained to be *ex post,* an *ex ante* perspective with volatilities implied by option prices is taken in Ederington and Lee (1996), Fornari and Mele (2001), Heuson and Su (2003), and Sun and Sutcliffe (2003).[3] Regardless of the approach, the existing literature demonstrates that bond market volatility is mostly affected by inflationary and unemployment news. The *ex post* studies usually find a short-duration spike in volatilities immediately after the announcements, and the *ex ante* studies document that implied volatilities tend to increase before the announcements and to decrease afterwards.

This article extends the literature by examining the impact of surprises in scheduled macroeconomic news announcements on volatility, skewness, and kurtosis of option-implied probability distributions of future bond returns. The previous studies that examine the impact of macroeconomic news on implied bond market volatility focus solely on the impact of the arrival of scheduled news announcements, and thereby suffer from a potential deficiency as the actual content of the announcement is ignored. For instance, Ederington and Lee (1996) argue that implied bond market volatility should decrease after macroeconomic news, regardless of the content of the news. However, previous empirical findings in the foreign exchange (Madura & Tucker, 1992) and stock markets (Nofsinger & Prucyk, 2003) indicate that the impact of news on implied volatility depends also on the content of announcement. Hence,

[3]Recently, the impact of macroeconomic announcements on implied volatilities has also been examined in the foreign exchange market (see, e.g., M. Kim & Kim, 2003) and in the stock market (see, e.g., Graham, Nikkinen, & Sahlström, 2003; Nofsinger & Prucyk, 2003).

it is conceivable that in the bond markets the impact of news on implied volatility would also depend on the actual content, and especially on the surprise component of the announcement. In particular, based on the findings of Nofsinger and Prucyk (2003), it is plausible to expect that in the bond markets implied volatility would also increase after bad news, and decrease after good news.

In a similar vein, it may be expected that the impact of macroeconomic news on implied skewness depends on the content of the announcement. In particular, because skewness of option-implied probability distribution reflects asymmetries in market participants' expectations about future bond price developments, it is conceivable that market participants attach higher probabilities for sharp increases (decreases) in bond prices after good (bad) news. Therefore, it is expected that good (bad) news, such as lower- (higher-) than-expected inflation announcements have a positive (negative) impact on implied skewness. Finally, given that implied kurtosis reflects market participants' perception of the likelihood of future extreme events, the impact of macroeconomic news on implied kurtosis may be expected to depend on the magnitude of the surprise in the announcement. Particularly, it would be plausible that market participants revise their expectations about future extreme movements in bond prices after extreme surprises in macroeconomic announcements.

The idea of combining option-implied probability distributions and macroeconomic news announcements is not novel. Beber and Brandt (2003) use data on 30-year U.S. Treasury bond futures options to examine the impact of macroeconomic news releases on bond market expectations. In brief, Beber and Brandt (2003) find that not only is volatility affected by the announcements but also the higher-order moments of option-implied bond return distributions. Furthermore, their results suggest that higher-order moments are mostly affected by bad news.

This article extends the work of Beber and Brandt (2003) in three main respects. First, data on futures options on 2-year and 10-year German government bonds are used. Given that previous studies (see e.g., Balduzzi et al., 2001; Christie-David & Chaudhry, 1999; McQueen & Roley, 1993) indicate that short-term and long-term bonds may react very differently to macroeconomic announcements, the analysis in this article contributes to the literature by examining the impact of macroeconomic news releases on market expectations of both 2-year and 10-year bonds.[4] Furthermore, the German government bond futures and futures

[4]For instance, inflationary news may be considered more value relevant for longer-term bonds.

options are the most actively traded derivatives in the world, and hence, the characterization of the impact of macroeconomic news announcements on these instruments is a high-priority task. Second, whereas Beber and Brandt (2003) provide results only regarding inflationary and unemployment announcements, here the analysis is extended by the inclusion of measures of the current and perceived state of the economy. Finally, given that the empirical tests are joint in the sense that they rely on a particular option pricing model, the work of Beber and Brandt (2003) is extended here by applying two methods to extract implied distributions. The first method corresponds to the Gram-Charlier expanded model used also in Beber and Brandt (2003), and the other assumes that the distribution of the underlying asset price is a mixture of lognormal distributions.[5]

The empirical findings demonstrate that option-implied bond market expectations are significantly affected by macroeconomic news announcements. Consistent with the literature on the impact of macroeconomic news on bond prices and bond market volatilities, the findings suggest that option-implied probability distributions of future bond returns are also mainly influenced by news releases on inflation and unemployment. In particular, the results indicate that expected bond market volatilities increase in response to higher-than-expected inflation and unemployment announcements. This finding contradicts the results of Ederington and Lee (1996) and Heuson and Su (2003), and thereby extends the literature on the impact of macroeconomic announcements on implied bond market volatility by demonstrating that the impact of the news depends on the surprise component of the announcement. Consistent findings in the foreign exchange and stock markets have been reported in Madura and Tucker (1992) and Nofsinger and Prucyk (2003). Furthermore, it is found that the asymmetries in market expectations, as measured by option-implied skewness, are mostly affected by surprises in inflation and economic production figures. Particularly, higher-than-expected inflation announcements cause option-implied bond return distributions to become more negatively skewed or less positively skewed. Intuitively, these findings are reasonable, as they imply a shift in market participants' perceptions toward future increases in interest

[5]Although Jondeau and Rockinger (2000) show that the implied distributions obtained with the use of the Gram-Charlier expansions and the lognormal-mixture approach are rather similar, the lognornal-mixture approach may be considered theoretically more competent, as it precludes the possibility of negative tail probabilities often obtained with Gram-Charlier expansions. Moreover, the mixture of lognormals is perhaps the most widely used method in the literature (see, e.g., Gemmill & Saflekos, 2000; Melick & Thomas, 1997; Söderlind, 2000).

rates after higher-than-expected inflation announcements. However, the present results contradict the findings of Beber and Brandt (2003), as they report implied skewness to be positively affected by higher-than-expected inflation announcements. Finally, the present findings indicate that market expectations of future extreme movements in bond prices, as measured by option-implied kurtosis, are virtually unaffected by macroeconomic news releases. Some evidence found, however, suggests that after extreme surprises in inflation announcements market participants attach higher probabilities for extreme movements in bond prices.

The remainder of the article is organized as follows. The second section describes the macroeconomic announcements and the bond futures options data used in the empirical analysis. The methodology used to extract market expectations from option prices is presented in the third section. In the fourth section, the empirical findings on the impact of macroeconomic news announcements on bond market expectations are reported. Finally, the fifth section offers concluding remarks.

DATA

Macroeconomic Announcement Data

The macroeconomic announcements considered in this article measure inflationary and labor market developments as well as the current and perceived state of the economy. In particular, the set of announcements used in the analysis consists of German (a) consumer prices, (b) gross domestic product, (c) IFO industry survey of business climate, (d) industrial production, and (e) unemployment rate; and euro area (a) consumer prices, (b) industrial production, (c) purchasing managers index, and (d) unemployment rate. In addition, given that Becker et al. (1995), Ahn et al. (2002), and Ehrmann and Fratzscher (2002) find that U.S. macroeconomic announcements significantly affect the European bond markets, the following U.S. announcements are also included in the analysis: (a) consumer confidence index, (b) consumer prices, (c) gross domestic product, (d) industrial production, (e) initial jobless claims, (f) producer prices, (g) purchasing managers index, and (h) the University of Michigan survey of economic sentiment. All the announcements considered are monthly, except for quarterly announcements of the GDP and weekly U.S. jobless claims figures. The announcements used in the analysis cover the period from January 4, 1999 to June 30, 2003.

To capture the surprises in macroeconomic announcements, market expectations of the announcements are taken from the surveys conducted by Bloomberg. Every Friday, Bloomberg surveys key financial institutions—mainly investment banks—for their forecasts regarding macroeconomic releases in the following week. The median forecast of the survey is taken as the market expectation. The surprises in macroeconomic announcements are then calculated by subtracting the market expectation from the actual announcement. To make the surprises comparable across different announcements, the surprises are standardized by dividing through by their sample standard deviations. As the next step, the individual standardized surprises are aggregated into four variables that measure the current state of the economy (production), the perceived state of the economy (confidence), inflationary developments (inflation), and the situation in the labor market (unemployment). Finally, because the aim is to examine the impact of new unanticipated macroeconomic information on bond market expectations, the low-surprise announcements are ignored in the analysis in order to clarify the surprise effects of the announcements. Hence, the aggregated surprise series are filtered out with upper and lower quartiles used as the sampling boundaries.[6] These four aggregated surprise series are used to examine the impact of macroeconomic news announcements on bond market expectations.[7]

Summary statistics for both the (unfiltered) aggregated and individual surprises in macroeconomic announcements are reported in Table I. Note that the consensus forecasts for confidence, production, and unemployment indicators have, on average, exceeded the actual realizations. Inflation announcements, however, have on average been higher than expected. In general, the mean surprises of the individual macroeconomic announcements indicate that the consensus forecasts are more accurate for the U.S. news releases.

Government Bond Futures Options Data

The bond market expectations are extracted from the daily settlement prices of futures options on short-term and long-term German government bonds traded at Eurex. The bonds underlying the futures contracts are Bundesschatzanweisungen (Schatz) and Bundesanleihen (Bund).

[6]As noted in the Results section, the empirical findings are not sensitive to the sampling boundaries used in the analysis. The results remain virtually unchanged when the lowest and highest third and fifth of the surprises are used.

[7]The individual announcements included in the aggregated surprise series are summarized in Table I.

TABLE I
Summary Statistics for Macroeconomic News Announcements

	Mean surprise	*Median surprise*	*Max. positive surprise*	*Max. negative surprise*	*No. of obs.*
Confidence	−0.074	−0.031	3.925	−2.814	223
German IFO	−0.157	−0.264	1.849	−2.994	51
Euro area PMI	−0.161	−0.338	1.692	−1.805	26
U.S. PMI	−0.018	−0.094	2.005	−2.311	54
U.S. economic sentiment	−0.036	0.095	4.170	−2.652	52
U.S. consumer confidence	−0.017	0.037	2.392	−2.526	54
Inflation	0.185	0.092	2.751	−2.325	139
German CPI	0.293	0.544	2.176	−1.632	26
Euro area HICP	0.311	0.430	2.407	−1.547	26
U.S. CPI	0.187	0.108	2.695	−1.186	49
U.S. PPI	0.000	0.032	2.582	−2.486	42
Production	−0.060	−0.148	2.212	−3.784	158
German GDP	−0.490	−0.390	0.975	−2.794	15
German industrial production	−0.220	−0.214	1.937	−2.400	53
Euro area industrial production	0.265	0.244	1.907	−1.653	26
U.S. GDP	0.157	0.119	1.675	−1.355	19
U.S. industrial production	−0.052	−0.183	2.592	−1.752	50
Unemployment	−0.082	−0.009	6.233	−4.720	293
German unemployment	−0.035	−0.078	3.759	−2.898	43
Euro area unemployment	−0.459	−0.421	1.123	−3.228	30
U.S. jobless claims	0.006	0.042	3.775	−3.443	233

Note. The table reports summary statistics for standardized surprises in the aggregated (in italics) and individual macroeconomic news announcements.

Schatz and Bund are notional German government bonds with 6% coupon and maturities of 1¾ to 2¼ and 8½ to 10½ years, respectively. The settlement prices for the futures and futures options are obtained from Eurex. The sample period used in the analysis extends from January 4, 1999 to June 30, 2003.

German government bond futures and futures options are the most actively traded derivatives in the world.[8] These derivatives are commonly regarded as the benchmark for the euro area yield curve. The options on German government bond futures traded at Eurex are ideal for deriving implied probability distributions, because a wide range of strike prices is continuously available for trading. Moreover, the high liquidity of the options and the underlying futures contracts ensures that the prices of these derivatives instruments reasonably accurately reflect the information set available to financial markets.

[8]The daily trading volumes of German government bond futures and futures options exceed the volumes of the corresponding U.S. Treasury derivatives.

The options on Schatz and Bund futures are American style. However, because of the futures-style margining procedure, these options are actually priced as European options, and hence the option prices do not include premium for the early exercise possibility (see Chen & Scott, 1993 and Bahra, 1997 for further discussion). The expiration months for the Schatz and Bund futures options are the three nearest calendar months as well as the following month within the quarterly expiration cycle of March, June, September, and December. The futures contracts expire in March, June, September, and December. The underlying contract for the options expiring in the quarterly expiration cycle months is the futures contract expiring in the same month. For other expiration months, the underlying contract is the next maturing futures contract in the quarterly expiration cycle. The options on Schatz and Bund futures expire 6 trading days before the first calendar day of the contract month.

To reduce noise in the estimation of option-implied distributions, the standard filtering constraints are imposed to the option data set. First, in order to avoid expiration-related unusual price and volume fluctuations, options with less than 5 trading days to maturity are excluded from the sample. Second, only at-the-money (ATM) and out-of-the-money (OTM) options are used in the empirical analysis. In-the-money (ITM) options are discarded because they are less liquid than OTM and ATM options, and because by using both OTM call and put options it can be ensured that the complete strike price spectrum is efficiently utilized in the estimation of implied distributions. Finally, options for which the quoted settlement price equals the minimum possible price quotation are discarded, as their prices are considered uninformative and unreliable.

EXTRACTING BOND MARKET EXPECTATIONS FROM OPTION PRICES

The price of an option can be expressed as the present value of the option's expected future payoff, where the expectations are taken with respect to a risk-neutral probability density function.[9] Hence, the price of a call option, c, written on a bond futures contract F, equals the discounted expected value of the option's payoff function, $\max[F - K, 0]$, where K denotes the strike price of the option. Given a risk-neutral

[9]The risk-neutral probability distribution may differ from the objective distribution. Risk neutrality, however, should mainly affect the location of the distribution, and influence the distributional shape only negligibly (see e.g., Rubinstein, 1994).

density function of the underlying asset price at the maturity of the option, $f(F_T)$, the price of a European call option at time t, with expiration date T, can be written as

$$c = e^{-r(T-t)} \int_K^\infty f(F_T)(F_T - K)\, dF_T \tag{1}$$

where r denotes the risk-free interest rate. Analogously, the price of a put option equals the discounted expected value of the payoff function, $\max[K - F, 0]$, and hence, the price of a European put option, p, can be expressed as

$$p = e^{-r(T-t)} \int_0^K f(F_T)(K - F_T)\, dF_T \tag{2}$$

Because the option price is a function of the risk-neutral probability density function, $f(F_T)$, a set of option prices observable in the market can be used to extract this density. In principle, the density function may take any functional form. In practice, however, finite variance distributions that are stable under addition are the only reasonable candidates. Applying the lognormal distribution to Equations (1) and (2), for instance, leads to the Black-Scholes model (Black & Scholes, 1973).

Several alternative methods for extracting probability density functions from option prices have been proposed in the literature. Reviews of different techniques are provided in Bahra (1997), Jackwerth (1999), and Bliss and Panigirtzoglou (2002); Campa, Chang, and Reider (1998) and Jondeau and Rockinger (2000) provide comparisons of alternative methods. In this article, option-implied probability distributions are extracted based on a lognormal-mixture model of Bahra (1997) and a Gram-Charlier expanded model of Corrado and Su (1996). These models are briefly reviewed in the following.

Lognormal-Mixture Model

Given that financial asset price distributions are known to be close to lognormal, Ritchey (1990), Melick and Thomas (1997), Bahra (1997), Campa et al. (1998), Gemmill and Saflekos (2000), and Söderlind (2000), among others, assume that the risk-neutral density function of the underlying asset price is a mixture of lognormal densities. This approach is relatively flexible in the sense that a wide variety of distributional shapes can be approximated by a mixture of lognormal distributions.[10] Usually, the density function of the underlying asset price at the maturity of the option is assumed to be a linear combination of two lognormal density functions:

$$f(F_T) = \omega L(\alpha_1, \beta_1, F_T) + (1 - \omega)L(\alpha_2, \beta_2, F_T) \tag{3}$$

where $L(\cdot)$ denotes the lognormal density function, α_i and β_i are the location and dispersion parameters for the lognormal density i, respectively, and ω is a weighting parameter. Under the mixture of two lognormals assumption, Equation (1) can be rewritten as

$$c = e^{-r(T-t)}\int_K^\infty [\omega L(\alpha_1, \beta_1, F_T) + (1 - \omega)L(\alpha_2, \beta_2, F_T)](F_T - K)\, dF_T \tag{4}$$

Bahra (1997) derives a closed-form solution for the price of a European call option on a futures contract:

$$c = \omega[e^{\alpha_1 + \frac{1}{2}\beta_1^2}N(d_1) - KN(d_1 - \beta_1)] + (1 - \omega)[e^{\alpha_2 + \frac{1}{2}\beta_2^2}N(d_2) - KN(d_2 - \beta_2)] \tag{5}$$

where

$$d_1 = \frac{-\ln K + \alpha_1 + \beta_1^2}{\beta_1}, \quad d_2 = \frac{-\ln K + \alpha_2 + \beta_2^2}{\beta_2}$$

and $N(\cdot)$ denotes the cumulative standard normal distribution function.

Gram-Charlier Expanded Model

Corrado and Su (1996) and Brown and Robinson (2002) apply a Gram-Charlier series expansion of the standard normal probability density function to derive a skewness and kurtosis adjusted density function. The skewness and kurtosis adjusted density function $g(z)$ is obtained by truncating the infinite series expansion to exclude the terms beyond the fourth moment:

$$g(z) = n(z)\left[1 - \frac{\mu_3}{3!}(z^3 - 3z) + \frac{\mu_4 - 3}{4!}(z^4 - 6z^2 + 3)\right] \tag{6}$$

[10]The approach based on a mixture of lognormals allows for arbitrary asymmetries and multimodality in the option-implied distribution.

where

$$z = \frac{\ln(F_T/F_0) - (r - \sigma^2/2)(T - t)}{\sigma\sqrt{T - t}}$$

and $n(\cdot)$ denotes the standard normal density function, F_t is the price of the underlying asset at time t, σ is the volatility of the underlying asset, r is the risk-free interest rate, $T - t$ is the time to maturity of the option, and μ_3 and μ_4 denote the standardized coefficients of skewness and kurtosis, respectively. The density function given by Equation (6) can be applied to derive the price of a European call option on a futures contract F as

$$c = e^{-r(T-t)} FN(d) - Ke^{-r(T-t)}N(d - \sigma\sqrt{T - t}) \\ + \mu_3 Q_3 + (\mu_4 - 3)Q_4 \qquad (7)$$

where

$$Q_3 = \frac{1}{3!} e^{-r(T-t)} F\sigma\sqrt{T - t}[(2\sigma\sqrt{T - t} - d)n(d) + \sigma^2(T - t)N(d)]$$

$$Q_4 = \frac{1}{4!} e^{-r(T-t)} F\sigma\sqrt{T - t}[(d^2 - 1 - 3\sigma\sqrt{T - t}(d - \sigma\sqrt{T - t}))n(d) \\ + \sigma^3(T - t)^{3/2} N(d)]$$

$$d = \frac{\ln(e^{-r(T-t)} F/K) + (r + \sigma^2/2)(T - t)}{\sigma\sqrt{T - t}}$$

and $N(\cdot)$ denotes the cumulative standard normal distribution function and K is the strike price of the option. The first two terms of Equation (7) constitute the Black-Scholes (1973) option pricing formula, whereas the additional terms, $\mu_3 Q_3$ and $(\mu_4 - 3)Q_4$, adjust the Black-Scholes price for the effects of nonnormal skewness and kurtosis, respectively.

Estimation of Option-Implied Bond Return Distributions

Following the standard approach of simultaneous equations, the unobserved distributional parameters for the lognormal-mixture density and for the Gram-Charlier expanded density are estimated from a set of option prices by minimizing the sum of squared deviations between the observed market prices and theoretical option prices given by Equations (5) and (7):

$$\min_{\theta} \sum_{i=1}^{N} [\hat{c}_i - c_i(\theta)]^2 \tag{8}$$

where N is the number of option price observations on a given day for a given maturity class, $\hat{c}$ and c denote the observed and theoretical option prices, respectively, and $\theta = \{\alpha_1, \alpha_2, \beta_1, \beta_2, \omega\}$ for the lognormal-mixture density and $\theta = \{\sigma, \mu_3, \mu_4\}$ for the Gram-Charlier expanded density. Once the distributional parameters are estimated, the option-implied return distribution of the underlying asset is constructed.

Option-implied probability distributions are estimated from the bond futures options data for each trading day in the data set, and for each maturity of option contracts on a given day. To avoid spurious inference due to the time-to-maturity effects of options, time series of option-implied moments with a constant maturity of 30 days are constructed. The constant maturity time series are obtained by linear interpolation between two adjacent maturity implied moment estimates. The three shortest maturity option contracts are used as follows. The shortest and the second shortest option contracts are used until the second shortest has 30 days to maturity. Thereafter, the second and the third shortest option contracts are used until the expiry of the shortest maturity contract. The changes in the constant maturity option-implied moments over time should purely reflect changes in bond market expectations. The resulting data set contains 1171 time-series observations for the option-implied volatility, skewness, and kurtosis estimates of the Schatz and Bund futures return distributions.

Summary statistics for the option-implied bond return distributions estimated with the lognormal-mixture model (LM) and Gram-Charlier expanded model (GC) are reported in Table II. Panel A reports the descriptive statistics for the short-term bond (Schatz), and the statistics for the long-term bond (Bund) are given in Panel B. The statistics show that the implied volatility for Schatz is considerably lower than for Bund. Implied return distributions for both the short-term and long-term bonds appear negatively skewed. This implies that, on average, market participants attach higher probabilities for sharp declines in bond prices (i.e., yield increases) than for sharp price appreciations. Interestingly, implied return distributions of the Bund are on average more left skewed than

TABLE II
Summary Statistics for Option-Implied Bond Return Distributions

	DLN			*GC*		
	Volatility	*Skewness*	*Kurtosis*	*Volatility*	*Skewness*	*Kurtosis*
Panel A: Schatz						
Mean	1.506	−0.043	3.714	1.516	−0.047	3.863
Median	1.476	−0.010	3.543	1.481	0.000	3.832
Minimum	0.559	−0.724	1.322	0.826	−0.730	2.757
Maximum	2.455	0.568	6.976	2.475	0.373	5.381
Standard deviation	0.302	0.171	0.632	0.300	0.142	0.352
Skewness	0.387	−0.492	1.078	0.412	−0.675	0.299
Kurtosis	3.337	3.811	5.137	3.316	4.354	3.116
Number of Observations	1171	1171	1171	1171	1171	1171
Panel B: Bund						
Mean	5.558	−0.148	3.887	5.551	−0.142	3.724
Median	5.373	−0.091	3.825	5.366	−0.079	3.705
Minimum	3.487	−0.731	2.954	3.418	−0.727	3.125
Maximum	8.936	0.389	6.187	8.934	0.186	4.685
Standard deviation	1.041	0.205	0.457	1.047	0.190	0.244
Skewness	0.643	−0.606	0.797	0.646	−0.826	0.323
Kurtosis	2.768	2.625	4.024	2.778	2.825	2.850
Number of Observations	1171	1171	1171	1171	1171	1171

Note. The table reports summary statistics for volatility, skewness, and kurtosis estimates of option-implied probability distributions of future bond returns. LM and GC denote lognormal-mixture and Gram-Charlier expanded option pricing models, respectively. Schatz and Bund are notional German government bonds with maturities of approximately 2 and 10 years, respectively.

the distribution of the Schatz. Kurtosis estimates show that the implied bond return distributions are fat-tailed for both bonds. Finally, the descriptive statistics indicate that the two methods applied to extract implied distributions produce virtually identical time-series of option-implied moments. In fact, the correlations between the implied volatility time-series produced by the two models are almost equal to unity, and also the skewness time-series are very highly correlated, with correlation coefficients of 0.98 for Bund and 0.86 for Schatz. The kurtosis time-series exhibit somewhat lower correlations, as the correlation coefficients are 0.74 and 0.42 for Bund and Schatz, respectively.

RESULTS

Bond Market Expectations and Surprises in Macroeconomic Announcements

To examine the impact of macroeconomic news announcements on bond market expectations, the moments of option-implied bond return distributions are regressed on the surprises in macroeconomic announcements:

$$\Delta\mu_{i,t} = \alpha + \sum_{j=1}^{4} \beta_j S_{j,t} + \varepsilon_t \tag{9}$$

where $\mu_{i,t}$ denotes the ith moment of option-implied bond return distribution at time t, $S_{j,t}$ denotes standardized surprise in aggregated macroeconomic announcement j at time t, and Δ is the first difference operator. The Ljung-Box statistic indicates significant serial correlation in the residuals of the regressions, and hence, AR(p) and MA(q) terms are added to the models. Moreover, because Engle's LM test indicates significant serial correlation in the squared residuals of the regressions, GARCH(1,1) is fitted.

Panel A of Table III reports the regression results for the implied volatilities of Schatz and Bund. The results show that surprises in inflation and unemployment news significantly affect implied volatilities of both the short-term and long-term bonds. In particular, regardless of the technique applied to extract implied probability distributions, the estimated regression coefficients for inflation and unemployment are positive, suggesting that higher-than-expected announcements lead to an increase in implied volatility, and lower-than-expected announcements decrease volatility. The estimated coefficients for inflation surprises are significant only at the 10% level for the short-term bond, and are soundly significant for the long-term bond, hence suggesting that the uncertainty in the long-term bond is to a larger extent driven by inflationary news.

These results are contradictory to the previous empirical findings on the impact of macroeconomic announcements on implied volatility, which are based on dummy regressions (Ederington & Lee, 1996; Heuson & Su, 2003). In particular, the present findings contradict the model of Ederington and Lee (1996), which predicts that implied volatility should always decrease after macroeconomic news, regardless of the content of the announcement. However, by using dummy regressions, the previous studies have taken only the announcement effect into account. According to the present empirical findings, implied volatility may decrease only if surprises in inflation and unemployment announcements are negative. Hence, consistent with the studies based on realized volatilities (see, e.g., S. J. Kim et al., 2004; Li & Engle, 1998) and implied volatilities in the foreign exchange (Madura & Tucker, 1992) and stock markets (Nofsinger & Prucyk, 2003), the present results suggest that the actual content of the announcement is an important determinant of the market's reaction.

TABLE III
Impact of Surprises in Macroeconomic Announcements on Option-Implied Bond Return Distributions

	Schatz		*Bund*	
	DLN	*GC*	*DLN*	*GC*
Panel A: Implied volatility				
Constant	−0.002	−0.001	−0.003	−0.004
	(−1.120)	(−0.647)	(−0.714)	(−0.821)
Confidence	−0.001	−0.001	0.000	−0.002
	(−0.463)	(−0.589)	(−0.117)	(−0.653)
Inflation	0.004*	0.003*	0.011**	0.010**
	(1.806)	(1.781)	(2.311)	(2.357)
Production	0.000	0.001	0.004	0.003
	(0.005)	(0.371)	(0.627)	(0.459)
Unemployment	0.005***	0.006***	0.010**	0.008*
	(3.013)	(5.884)	(2.119)	(1.729)
Adjusted R^2	0.015	0.005	0.007	0.001
F statistic	3.079***	0.115	1.863*	0.359
Panel B: Implied skewness				
Constant	0.000	0.000	0.001	0.001
	(0.530)	(−0.048)	(1.108)	(1.551)
Confidence	−0.001	−0.001	−0.002	−0.001
	(−0.809)	(−1.332)	(−1.593)	(−0.995)
Inflation	−0.004**	0.000	−0.003*	−0.002*
	(−2.324)	(−0.099)	(−1.895)	(−1.803)
Production	−0.002	−0.002	−0.001	0.000
	(−1.375)	(−1.372)	(−0.726)	(0.182)
Unemployment	0.000	−0.003***	0.000	0.001
	(0.113)	(−2.865)	(0.350)	(0.670)
Adjusted R^2	0.282	0.263	0.261	0.213
F statistic	46.795***	40.013***	46.806***	36.083***
Panel C: Implied kurtosis				
Constant	0.001	0.000	0.000	0.000
	(0.371)	(0.283)	(0.005)	(−0.388)
Confidence	−0.013	0.000	0.004	0.003
	(−1.405)	(0.103)	(0.949)	(1.422)
Inflation	−0.004	−0.001	−0.001	0.000
	(−0.439)	(−0.289)	(−0.203)	(0.148)
Production	0.000	0.001	0.002	0.000
	(0.019)	(0.273)	(0.331)	(0.067)
Unemployment	−0.015	0.002	0.007	0.003
	(−1.601)	(0.403)	(1.620)	(1.199)
Adjusted R^2	0.320	0.339	0.367	0.245
F statistic	61.930***	67.491***	76.190***	43.033***

Note. The reported results are based on the following regression specification:

$$\Delta\mu_{i,t} = \alpha + \sum_{j=1}^{4} \beta_j S_{j,t} + \varepsilon_t$$

where $\mu_{i,t}$ denotes the ith moment of option-implied bond return distribution at time t, $S_{j,t}$ denotes standardized surprise in macroeconomic announcement j at time t, and Δ is the first difference operator. LM and GC denote lognormal-mixture and Gram-Charlier expanded option pricing models, respectively. Schatz and Bund are notional German government bonds with maturities of approximately 2 and 10 years, respectively. The sample period used in the analysis extends from January 4, 1999 to June 30, 2003 for a total number of 1170 observations. t statistics are reported in parentheses.

*Significance at 0.10 level.
**Significance at 0.05 level.
***Significance at 0.01 level.

The regression results for the implied skewness estimates are presented in Panel B of Table III. The results demonstrate that the asymmetries in bond market expectations are significantly affected by surprises in inflationary announcements. The estimated coefficients of inflation are negative and statistically significant in three regression specifications. This implies that higher- (lower-) than-expected inflation announcements cause implied bond return distributions to become more (less) negatively skewed or less (more) positively skewed, suggesting that market participants attach a greater weight to the possibility of negative (positive) future bond returns. These findings are reasonable, given that higher-than-expected inflation announcements are bad news for the bond markets. In addition, the results for the short-term bond indicate that implied skewness based on the Gram-Charlier expanded model is negatively affected by unemployment announcements.

Panel C of Table III presents the regression results for the kurtosis of option-implied bond return distributions. Interestingly, the results indicate that regardless of the method applied to extract implied distributions, the kurtosis estimates of both Schatz and Bund are unaffected by macroeconomic announcements. This suggests that although macroeconomic news announcements have a significant impact on the dispersion and asymmetry of bond market expectations, they seem not to have any impact on implied kurtosis. However, given that implied kurtosis reflects the likelihood of extreme events, market participants may revise their expectations about future extreme movements in bond prices only after extreme surprises in macroeconomic announcements.

Is the Impact of Positive and Negative Surprises Symmetric?

So far, the analysis has assumed that bond market expectations react symmetrically to positive and negative surprises, that is, in opposite directions but with the same magnitude. However, recent studies by Beber and Brandt (2003) and S. J. Kim et al. (2004) indicate that negative and positive surprises may have different impacts on financial assets. To ascertain whether positive and negative surprises in macroeconomic announcements have symmetric impacts on bond market expectations, the moments of the option-implied bond return distributions are regressed on positive and absolute negative surprises:

$$\Delta\mu_{i,t} = \alpha + \sum_{j=1}^{4} \beta_j PS_{j,t} + \sum_{j=1}^{4} \beta_j |NS_{j,t}| + \varepsilon_t \qquad (10)$$

where $\mu_{i,t}$ denotes the ith moment of option-implied bond return distribution at time t, $PS_{j,t}$ is standardized positive surprise in aggregated macroeconomic announcement j at time t, $NS_{j,t}$ is standardized negative surprise in aggregated announcement j at time t, and Δ is the first difference operator. Again, the serial correlation in the residuals and squared residuals is removed by adding AR(p), MA(q), and GARCH(1,1) terms into the models.

When interpreting the estimation results, it should be noted that the terms *positive* and *negative* surprise refer only to the sign of the surprise, and not to the quality of the news announcement, and hence, positive (negative) surprise should not be misinterpreted as good (bad) news. For instance, positive surprises in inflation may be regarded as bad news for the bond market.

The regression results for the implied volatilities of Schatz and Bund are reported in Panel A of Table IV. Interestingly, the results indicate that only positive surprises cause investors to revise their expectations about bond market uncertainty. In particular, the results show that higher-than-expected unemployment figures increase implied volatility of the 2-year bond while the volatility of the 10-year bond is increased by higher-than-expected inflation and unemployment announcements. The weak impact of inflation announcements on the volatility of the 2-year bond documented in Panel A of Table III cannot be found when the announcements are separated into positive and negative surprises. Hence, these estimation results confirm that the implied volatility of the long-term bond is to a larger extent driven by inflationary news. It may also be noted from Panel A of Table IV that the estimation results are insensitive to the method applied to extract implied distributions. In fact, the estimated coefficients for inflation and unemployment surprises seem virtually identical regardless of the model. Finally, the finding that implied volatilities are increased by positive surprises, or bad news, is consistent with recent literature, as Beber and Brandt (2003) report positive coefficients for bad news in bond markets and Nofsinger and Prucyk (2003) show that bad news increases implied volatility in stock markets.

Panel B of Table IV presents the regression results for the implied skewness estimates. In general, the results show that asymmetries in market expectations are mostly affected by surprises in inflation and economic production figures. Consistent with the findings reported in Panel A for implied volatilities, it can be noted that also the asymmetries in bond market expectations are mainly affected by positive surprises. Particularly, regardless of the method used to extract implied distributions,

TABLE IV
Impact of Positive and Negative Surprises on Option-Implied Bond Return Distributions

	Schatz		Bund	
	DLN	*GC*	*DLN*	*GC*
Panel A: Implied volatility				
Constant	−0.003*	−0.003	−0.004	−0.005
	(−1.663)	(−1.632)	(−0.851)	(−1.038)
Positive surprises				
Confidence	−0.001	−0.001	0.001	−0.002
	(−0.566)	(−0.557)	(0.077)	(−0.346)
Inflation	0.003	0.002	0.009**	0.008**
	(1.401)	(1.411)	(2.163)	(2.117)
Production	0.002	0.002	−0.001	−0.002
	(0.658)	(1.019)	(−0.092)	(−0.334)
Unemployment	0.005***	0.006***	0.012**	0.010**
	(4.294)	(7.091)	(2.412)	(2.206)
Absolute negative surprises				
Confidence	0.000	0.000	0.001	0.001
	(0.122)	(0.163)	(0.232)	(0.374)
Inflation	−0.001	0.000	−0.006	−0.005
	(−0.487)	(−0.074)	(−1.156)	(−1.034)
Production	0.002	0.001	−0.004	−0.003
	(0.813)	(0.519)	(−0.783)	(−0.592)
Unemployment	−0.002	−0.002	−0.004	−0.001
	(−0.910)	(−0.678)	(−0.727)	(−0.244)
Adjusted R^2	0.010	0.000	0.006	0.003
F statistic	1.959**	0.705	1.609*	1.311
Panel B: Implied skewness				
Constant	0.001	0.000	0.001	0.002***
	(1.103)	(0.457)	(1.426)	(2.707)
Positive surprises				
Confidence	0.000	0.001	−0.001	0.000
	(−0.253)	(0.616)	(−0.790)	(0.026)
Inflation	−0.006***	−0.003**	−0.003**	−0.003***
	(−3.436)	(−2.077)	(−2.302)	(−3.372)
Production	−0.001	−0.001	−0.003**	−0.002*
	(−0.361)	(−0.404)	(−2.268)	(−1.754)
Unemployment	0.001	−0.001	0.001	0.001
	(0.476)	(−0.789)	(1.046)	(0.771)
Absolute negative surprises				
Confidence	0.001	−0.001	0.001	0.000
	(0.411)	(−0.966)	(1.086)	(0.230)
Inflation	−0.003	−0.002	−0.002	−0.001
	(−1.552)	(−1.310)	(−1.086)	(−1.176)
Production	0.003*	0.003**	−0.001	−0.001
	(1.941)	(2.106)	(−0.347)	(−1.179)
Unemployment	−0.001	0.002*	0.000	−0.001
	(−0.357)	(1.739)	(0.359)	(−0.538)
Adjusted R^2	0.284	0.223	0.264	0.246
F statistic	34.040***	20.885***	33.134***	27.789***

(*Continued*)

TABLE IV
Impact of Positive and Negative Surprises on Option-Implied Bond Return Distributions (*Continued*)

	Schatz		Bund	
	DLN	*GC*	*DLN*	*GC*
Panel C: Implied kurtosis				
Constant	−0.001	0.005**	−0.001	0.001
	(−0.142)	(2.020)	(−0.195)	(0.330)
Positive surprises				
Confidence	−0.006	−0.006	0.005	0.003
	(−0.544)	(−1.119)	(0.938)	(0.825)
Inflation	−0.008	−0.000	0.004	0.003
	(−0.755)	(−0.070)	(0.685)	(1.027)
Production	0.003	−0.007	−0.002	−0.003
	(0.291)	(−1.644)	(−0.348)	(−0.910)
Unemployment	−0.008	−0.002	0.004	−0.001
	(−0.872)	(−0.412)	(0.756)	(−0.345)
Absolute negative surprises				
Confidence	0.012	−0.003	−0.002	−0.001
	(1.366)	(−0.839)	(−0.353)	(−0.606)
Inflation	0.008	0.001	0.006	0.004
	(0.782)	(0.097)	(1.059)	(1.120)
Production	0.001	−0.009	−0.005	−0.004
	(0.044)	(−1.558)	(−0.820)	(−1.184)
Unemployment	0.013	−0.000	−0.005	−0.004
	(1.231)	(−0.056)	(−1.002)	(−1.254)
Adjusted R^2	0.318	0.320	0.365	0.246
F statistic	42.813***	37.1884***	52.661***	30.298***

Note. The reported results are based on the following regression specification:

$$\Delta\mu_{i,t} = \alpha + \sum_{j=1}^{4} \beta_j PS_{j,t} + \sum_{j=1}^{4} \beta_j |NS_{j,t}| + \varepsilon_t$$

where $\mu_{i,t}$ denotes the ith moment of option-implied bond return distribution at time t, $PS_{j,t}$ is standardized positive surprise in macroeconomic announcement j at time t, $NS_{j,t}$ is standardized negative surprise in macroeconomic announcement j at time t, and Δ is the first difference operator. LM and GC denote lognormal-mixture and Gram-Charlier expanded option pricing models, respectively. Schatz and Bund are notional German government bonds with maturities of approximately 2 and 10 years, respectively. The sample period used in the analysis extends from January 4, 1999 to June 30, 2003 for a total number of 1170 observations. *t* statistics are reported in parentheses.

*Significance at the 0.10 level.
**Significance at the 0.05 level.
***Significance at the 0.01 level.

the estimated coefficients of positive inflation surprises for both the short-term and long-term bonds are negative. This suggests that after a higher-than-expected inflation announcement, option-implied bond return distributions become more negatively skewed or less positively skewed. Intuitively, these findings are very reasonable, as they imply a shift in market participants' perceptions toward future increases in interest rates after higher-than-expected inflation announcements. However, the present findings contradict those of Beber and Brandt (2003), as they report implied skewness to be positively affected by positive surprises (bad news) in inflationary and unemployment announcements. On the other hand, Beber and Brandt (2003) also find that lower-than-expected producer price index announcements have a positive impact on implied skewness, thereby suggesting that market participants attach higher probabilities to decreases in interest rates after lower-than-expected inflation announcements. This finding may be interpreted to be consistent with the findings regarding positive surprises in inflation.

In addition to the impact of inflationary news on implied skewness documented in Panel B of Table III, the results reported in Table IV show that surprises in economic production also significantly affect asymmetries in bond market expectations. Positive surprises in production increase negative skewness or decrease positive skewness in the implied distribution of the 10-year bond. Skewness of the 2-year bond, however, is significantly and positively affected by negative surprises, suggesting that option-implied distributions become less negatively skewed or more positively skewed due to lower than expected production figures. These findings are reasonable, considering that positive (negative) surprises in production may be considered bad (good) news for the bond market. Finally, the results for the short-term bond indicate that implied skewness estimated with the Gram-Charlier expanded model is positively affected at the 10% level by negative surprises in unemployment announcements. Otherwise, the estimation results reported in Panel B seem insensitive to the method applied to extract implied distributions.

Panel C of Table IV reports the regression results for the kurtosis estimates of option-implied bond return distributions. Consistent with the regression results in Table III, where the sign of the surprise is ignored, the estimation results reported in Table IV indicate that implied kurtosis estimates of both the 2-year and 10-year bonds are unaffected by surprises in macroeconomic announcements, regardless of the method applied to extract implied distributions. However, as noted previously, a potential deficiency in this test is that market participants may revise their expectations about future extreme movements in bond prices only after extreme surprises in macroeconomic announcements. This issue is addressed in the following section.

Does the Magnitude of the Surprise Matter?

Because the objective of this article is to examine the impact of surprises in macroeconomic announcements on bond market expectations, the low-surprise announcements were ignored in the preceding analysis in order to clarify the surprise effects of the news releases. A similar approach was used in Nofsinger and Prucyk (2003). The empirical results reported in the previous two sections are based on surprise series that are filtered with upper and lower quartiles used as the sampling boundaries. These results seem to be insensitive to the sampling boundaries used in the analysis, as the empirical findings remain virtually unchanged when the lowest and highest third and fifth of the surprises are used. However, when the analysis is repeated with the use of only the low surprise announcements, no statistically significant impacts of macroeconomic announcements on option-implied bond return distributions are found.

The empirical results reported in the preceding two sections suggest that implied kurtosis is unaffected by macroeconomic announcements. However, given that implied kurtosis reflects market participants' expectations of the likelihood of extreme movements in bond prices, it is likely that market participants revise their expectations about extreme price movements only after extreme surprises in macroeconomic announcements.[11] Hence, it is of interest to examine the impact of extreme surprises on implied kurtosis. For this purpose, the changes in implied kurtosis are regressed on a set of dummy variables that identify extreme surprises in macroeconomic news releases:

$$\Delta\mu_{4,t} = \alpha + \sum_{j=1}^{4} \beta_j D_{j,t} + \varepsilon_t \tag{11}$$

where $\mu_{4,t}$ denotes kurtosis of option-implied bond return distribution at time t, $D_{j,t}$ is a dummy variable to identify extreme surprise in macroeconomic announcement j at time t, and Δ is the first difference operator. The dummy variables in Equation (11) are set equal to 1 if the surprise in a given macroeconomic announcement is among the lowest or highest tenth of the surprises.

The estimation results for the impact of extreme surprises on implied kurtosis are reported in Table V. As can be seen from the table, implied kurtosis of the long-term bond is statistically significantly affected by extreme surprises in inflation announcements. The estimated coefficients are positive in both regression specifications, suggesting that after extreme surprises in inflation announcements market participants attach higher probabilities for future extreme movements in bond prices.

[11]The authors are grateful to an anonymous referee for suggesting this idea.

TABLE V
Impact of Extreme Surprises on Option-Implied Kurtosis

	Schatz		*Bund*	
	DLN	*GC*	*DLN*	*GC*
Constant	0.000	0.006**	−0.002	−0.001
	(0.019)	(2.172)	(−0.807)	(−0.446)
Confidence	0.003	−0.027	0.000	0.001
	(0.066)	(−1.474)	(−0.014)	(0.068)
Inflation	0.034	0.017	0.079**	0.030*
	(0.623)	(0.694)	(2.535)	(1.956)
Production	0.029	−0.032	−0.018	−0.020
	(0.500)	(−1.087)	(−0.583)	(−1.149)
Unemployment	−0.012	−0.018	0.016	−0.003
	(−0.282)	(−1.034)	(0.814)	(−0.267)
Adjusted R^2	0.315	0.340	0.347	0.248
F statistic	56.977***	63.902***	65.772***	43.728***

Note. The reported results are based on the following regression specification:

$$\Delta\mu_{4,t} = \alpha + \sum_{j=1}^{4} \beta_j D_{j,t} + \varepsilon_t$$

where $\mu_{4,t}$ denotes kurtosis of option-implied bond return distribution at time t, $D_{j,t}$ is a dummy variable to identify extreme surprise in macroeconomic announcement j at time t, and Δ is the first difference operator. LM and GC denote lognormal-mixture and Gram-Charlier expanded option pricing models, respectively. Schatz and Bund are notional German government bonds with maturities of approximately 2 and 10 years, respectively. The sample period used in the analysis extends from January 4, 1999 to June 30, 2003 for a total number of 1170 observations. t statistics are reported in parentheses.

*Significance at the 0.10 level.
**Significance at the 0.05 level.
***Significance at the 0.01 level.

However, the implied kurtosis of the short-term bond seems to be unaffected even by extreme surprises in macroeconomic announcements.

CONCLUSIONS

This article focuses on the impact of surprises in macroeconomic news announcements on bond market expectations, as measured by probability distributions implied by option prices. In particular, this article uses data on German government bond futures options to examine the impact of surprises in German, euro area, and U.S. macroeconomic news releases on bond market expectations. The macroeconomic announcements considered in the analysis measure inflationary and labor market developments as well as current and perceived state of the economy. In order to ensure that the empirical results are not dependent on a particular option pricing model, implied bond return distributions are extracted from the market prices of bond futures options based on two methods, a

Gram-Charlier expanded model (Brown & Robinson, 2002; Corrado & Su, 1996) and a lognormal-mixture model (Bahra, 1997; Melick & Thomas, 1997). By focusing on the bond market expectations, this article provides new evidence on the impact of macroeconomic news announcements on financial markets.

The results of this article show that option-implied bond market expectations are significantly affected by macroeconomic news announcements. The empirical findings indicate that bond market expectations are mostly affected by surprises in inflation and unemployment announcements. These findings are consistent with the existing literature on the impact of macroeconomic announcements on bond prices and volatilities. Furthermore, the results indicate that expected bond market volatilities increase in response to higher-than-expected inflation and unemployment announcements. This finding is inconsistent with the previous studies (see, e.g., Ederington & Lee, 1996; Heuson & Su, 2003), which ignore the information content of the announcements, and find that implied volatilities decrease on macroeconomic announcement days. However, the finding of increasing implied volatilities after certain macroeconomic announcements is consistent with existing evidence from the foreign exchange and stock markets (see Madura & Tucker, 1992; Nofsinger & Prucyk, 2003).

Regarding the asymmetries in market expectations, the results show that surprises in inflation and economic production figures have the largest impact on market expectations. In particular, it is found that higher-than-expected inflation announcements cause option-implied bond return distributions to become more negatively skewed or less positively skewed, implying a shift in market participants' perceptions toward future increases in interest rates. Finally, the results indicate that market expectations of future extreme movements in bond prices, as measured by implied kurtosis, are virtually unaffected by macroeconomic news releases. However, some evidence is found suggesting that after extreme surprises in inflation announcements market participants attach higher probabilities for extreme movements in bond prices.

The results of this article have important implications for financial market practitioners, academics, and monetary policy makers alike. Given that German government bond futures and futures options are the most actively traded derivatives in the world and also the most widely used instruments for managing interest-rate risk in the euro area, the characterization of the impact of macroeconomic announcements on these instruments is naturally of high importance for market participants. The results of this article may be of interest to market practitioners and central banks for understanding how the realization of a certain macroeconomic announcement may change market expectations about the future development of bond prices. From an academic point of view, the findings of this article demonstrate that the actual content of the macroeconomic news announcements needs to be taken into account when the impact of information releases on financial markets is being examined. Finally, as the results signify the importance of inflationary news on bond market expectations, they may be of interest to monetary policy makers pursuing inflation targeting.

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