Extracting Market Expectations on Macroeconomic Announcements from Bond Prices*

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Abstract

Event studies measuring the impact of macroenomic announcements rely on surveys as a measure of market expectations. However, these survey measures are noisy indicators of actual market expectations as they are collected with a time lag and not among actual market participants. Based upon a Hellwig (1980) type market microstructure model, a market-based survey measure is proposed that takes into account orderflow/price movements prior to release in order to capture changes in market expectations. The model is tested on US and German 10-year bond futures contracts for 6 US and 2 German macroeconomic announcements and confirms the presence of expectation adjustments for the most important releases. Furthermore, the market-based survey measure captures the directionality of the surprise better than the standard Bloomberg survey measure.

Keywords: Macroeconomic announcements; price formation; market microstructure

JEL classification: E43, E44, G14

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Introduction

There are significant market price movements following the release of macroeconomic announcements across most major asset markets, where prices adjust to reflect the unanticipated news component in these releases. The use of accurate measures for market expectations, which per definition measure the anticipated news component, is therefore crucial in any study exploring the market impact of macroeconomic releases. The existing literature on macroeconomic announcements has traditionally measured the surprise content of a given release as the difference between the actual release and published survey expectations. However, these survey expectations are not perfect.

Gauging market expectations by static survey measures does seem prone to induce measurement errors for the unanticipated news component for at least two reasons. Firstly, the survey expectations are typically polled over several days before the announcement. Secondly, the typical respondents are the research units in the investment banks and other researchers, but rarely actual traders. Hence, any new information may not have been taken into account by all respondents and the expectation may differ between traders, who set the price, and market analysts. Consequently, the lack of survey expectations that are dynamically updated and conducted among actual traders may lead to differences between actual market expectations and survey measures.

This paper adopts a market-based expectation measure which is based on a theoretical market microstructure model. The model indicates that the information contained in the orderflow prior to release of macroeconomic announcements should be taken into account. Specifically, if financial market prices reflect additional information beyond what is contained in survey expectations, this is likely to be reflected in price movements prior to releases. These price movements may reflect expectation adjustments taking place.

The theoretical model allows a formalization of the linkages between price movements prior to and after announcement. In addition, two important testable implications of the theoretical model are derived. Firstly, it proposes a direct test of whether an expectations adjustment does take place. Secondly, a market-based expectation measure can be derived which can be compared with the survey measures.

The empirical evidence presented in this paper confirms that expectations adjustments are actually taking place.The price movements prior to release are statistically significant for the most important releases, i.e. the price movements does contain information about the upcoming release. In the US, announcements of non-farm payroll and the ISM manufacturing survey and in Germany, the IFO and ZEW indicators tend to experience significant price movements prior to release - indicating the presence of expectations adjustments. The fact that expectations adjustments can only be confirmed for the most important releases suggests that the costs related to information search therefore must exceed a minimum gain. The information search and active position taking thereby only appears to take place for the announcements with the highest profit potential.

The market-based expectation measure does not give lower forecast errors, but captures the directionality better. The measure is therefore somewhat better at forecasting whether the surprise is positive or negative. Hence, adopting a market-based measure appears to give more noisy measures, as these tend to over- and undershoot more often. The market-based measure nonetheless allows for dynamic updating of expectations among actual traders. All in all, the market-based measure outperforms static survey measures as directionality is captured somewhat better.

The structure of the paper is as follows. Section 1 takes a look at the related literature. In section 2, a standard theoretical market microstructure model along the lines of Hellwig (1980) explains how prices and expectations around macroeconomic announcements interact in a theoretical setting. Section 3 examines the issue empirically. Specifically section 3.1 discusses the data and the considerations about formulating a test that builds on the theoretical framework in section 2. Section 3.2 tests whether market prices contain information about the expectations of upcoming macroeconomic announcements. This is done in a standard event study model. In section 3.3 a measure for market-adjusted expectations for the macroeconomic announcements is derived and forecast errors are compared with standard survey expectation measures. Section 4 concludes.

1 Related literature

The event studies on macroeconomic releases, such as Andersen and Bollerslev (1997), Andersen, Bollerslev, Diebold, and Vega (2003) and Fleming and Remolona (1999), all find significant market reactions to macroeconomic releases. However, as Rigobon and Sack (2006) note, the response coefficients appear rather small and only to a lesser extent explain the market movements around releases. This suggests that other factors around releases are at play.

Rigobon and Sack (2006) explain this by poor survey quality data, which can be attributed to issues such as time lag and surveys being analyst expectations rather than market participant expectations. In addition they note that the "true" macroeconomic news in a given release is not necessarily given by actual releases, as actual releases are noisy signals of the underlying news.

The explanation of Rigobon and Sack (2006) is in part examined by Campbell and Sharpe (2007) who show that behavioral biases may exist in surveys. Specifically they show that surveys are centered around the actual release of the previous month and that this anchoring bias in some cases results in sizable forecast errors. Hence, they confirm the poor survey quality.

Gürkaynak and Wolfers (2007) consider improved expectation measures. They use the market for macroeconomic derivatives to derive measures of market expectations and show that macroeconomic derivatives provide more accurate estimates of actual market outcomes. This also confirms the apparent lacks of existing survey measures.

A more theoretically appealing approach is given in Hautsch and Hess (2007) and Hautsch, Hess, and Müller (2007). They find that the price impact is significantly stronger with higher-precision information, as predicted by Bayesian learning models, on applications on US employment announcements. They show this by including a richer information set and hence improve the differing value/precision of the individual release. Consequently, they show that additional information beyond the actual release probably also plays an important role.

In a similar Bayesian spirit Andersson, Ejsing, and von Landesberger

(2007) use the information content of previously announced, but related releases, extracted through Kalman filtering, to derive more precise expectation measures. They consequently show the importance of learning from previous releases.

This paper also implements a Bayesian motivated approach by adopting a standard market microstructure approach. However, the approach differs in one important aspect. Instead of using a richer information set, for instance from similar announcements, this paper uses the information contained in prices.

2 Model

The interaction between price movements before and after announcement releases can be illustrated in a standard market microstructure model, in which prices reflect information conveyed by the trade actions of informed investors. The model is specified to resemble the typical econometric set-up used in macroeconomic event studies. Consequently the empirical results later in this paper can be directly linked to the theoretical model implications.

The chosen specification originates from Hellwig (1980), the exact implementation is however based on Vives (2008). Some modifications have been introduced to the model in order to better capture the pricing mechanics surrounding macroeconomic releases.

The model builds on market efficiency principles as the trade actions of investors in part or fully reveals their private information. However, the model departs from the majority of market microstructure models in one crucial assumption. The market expectations of the outcome of the macroeconomic release are based on a linear updating rule instead of using the conventional approach of conditional expectations. This implies that the expectations of the market participants may not be fully rational, but capture noise in their expectation formation. The use of a plausible linear updating rule for expectations introduces correlation between market expectations and the actual realization of the macroeconomic release.

We consider a two-period model with a single risky asset and a riskless and interest free borrowing/lending asset, with rational investors and noise traders. There is a continuum of investors indexed in the interval $i \in [0,1]$ with CARA-type utility functions, $U(\pi_i) = -\exp^{-\rho\pi_i}$, that participate in the market together with noise traders.

The investors utility is a function of profits, $\pi_i = (p_t - p_{t-1})x_i$, which naturally depends on prices p_{t-1} and p_t in respectively the first period, $t-1$, and the second period, t, in addition to their position in the risky asset x_i. As usual, $\rho > 0$ is the constant risk aversion coefficient. The noise traders demand a stochastic amount u of the risky asset, where $u \sim N(0, 1/\tau_u)$.

In the first period, $t-1$, the outcome of some event ζ is realized, for our purposes a macroeconomic release, but not made publicly available before period t. We assume $\zeta \sim N(\bar{v}, 1/\tau_\zeta)$, where we may informally call $\bar{v}$ the survey expectation which is the a priori or unconditional expectation about the event. τ_ζ is a measure of the uncertainty related to the outcome.

All investors receive private signals about the outcome of the event ζ at time $t-1$. Their signal, $s_i = \zeta + \varepsilon_i$ is a noisy measure of the actual outcome of ζ as $\varepsilon_i \sim N(0, 1/\tau_\varepsilon)$. τ_ε measures the precision of the signal. Based on the unconditional expectation and their private signals, the investors optimize their utility and thereby make their investment decision x_i.

At period t, the realization of ζ is announced and prices are determined. The pricing dynamic in this model is assumed to be given by

$$p_t = \alpha(\zeta - \tilde{v}). \tag{1}$$

The price depends on the non-anticipated information from the event ζ multiplied by some coefficient α - in macroeconomic event studies this coefficient is denoted the price impact coefficient. The anticipated information/market expectation is denoted by $\tilde{v}$, which may differ from the survey expectation $\bar{v}$. Note we have normalized prices of the intrinsic value of the asset to be 0 and solely let the price depend on the outcome of the event and market expectations. Prices can therefore be interpreted as returns, which will be done later in the empirical part.

The market expectation, $\tilde{v}$, is formulated in the form

$$\tilde{v} = \bar{v} + \beta(\zeta - \bar{v}). \tag{2}$$

The chosen specification of expectations is crucial for understanding the model. It states that market expectations are based on the survey expectation $\bar{v}$, but at the same time allows market expectations to be correlated with the actual outcome with some coefficient β.

Consider two extreme cases. Firstly, the case of $\beta = 0$ captures the case when the survey expectation includes all available information in the market, as we then obtain $\tilde{v} = \bar{v}$. Secondly, $\beta = 1$ captures the case of perfect forecast abilities as $\tilde{v} = \zeta$. It therefore seems reasonable to impose the restriction of $0 < \beta < 1$, which we will use later.

The specification, however, introduces the possibility of non-rationality in the expectation formation, as $\tilde{v}$ is not necessarily the conditional expectation of ζ. Nonetheless, the specification appears to be suited for capturing the market expectation as it seems to crudely capture the uncertainties related to the expectation formation process. The specification for the market expectation therefore appears to be a plausible approximation.

Finally we impose that aggregate supply should equal aggregate demand for the risky asset in a market clearing condition:

$$X = \int_0^1 x_i di + u = 0. \tag{3}$$

Theorem 1 *Given the model above, there is a unique Bayesian linear equilibrium characterized by conditions:*

$$\text{(i) } x_i = ap_{t-1} + b\left(s_i - \bar{v}\right),$$

$$\text{(ii) } p_{t-1} = \tfrac{1}{a}\left(b(\zeta - \bar{v}) + u\right).$$

where $a = \frac{\rho^{-1}\left(\tau_\zeta + b^2\tau_u + \tau_\varepsilon\right)}{1+\rho^{-2}\alpha^2(1-\beta)^2\tau_\varepsilon\tau_u}$ *and* $b = \rho^{-1}\alpha(1-\beta)\tau_\varepsilon$.

Proof. See appendix. ■

The theorem gives an explicit solution for the price dynamics at period $t-1$. This can be used to find the pricing dynamics after the announcement, i.e. at period t. To see this, note that (*ii*) from Theorem 1 can be re-written as

$$\zeta - \bar{v} = \frac{1}{b}\left(ap_{t-1} - u\right).$$

Inserting this into (2) gives

$$\tilde{v} = \bar{v} + \beta \frac{1}{b} \left(a p_{t-1} - u \right). \tag{4}$$

Finally substitute this into (1) to obtain

$$p_t = \alpha \left(\zeta - \bar{v} \right) - \frac{\alpha \beta}{b} \left(a p_{t-1} - u \right). \tag{5}$$

This shows that the pricing dynamics following the announcement are determined by two factors. Firstly, there is an impact from the deviation from the survey expectation. Secondly, there is a component related to the updating of expectations, which is revealed through prices, but blurred by the noise trading shock. Hence, the second term capture the market impact of investors, as prices change to reflect their expectations.

The model has some testable implications, which will be considered in the following section. For this use, the following lemma is useful.

Lemma 2 *For* $\alpha < 0$ *and* $0 < \beta < 1$ *then* $a > 0$ *and* $b < 0$.

Proof. *See appendix.* ■

The assumption of $\alpha < 0$ in Lemma 2 is consistent with empirical observations from the bond market, as documented later in this paper. For instance a stronger-than-expected GDP report is likely to make market participants revise up their expectations for future growth and induce higher bond yields, thereby causing negative bond market returns. For $\alpha < 0$, we observe that $b < 0$ and $a > 0$, hence the expectation adjustment term, the second term in (5), is negative as $-\frac{\alpha\beta a}{b} < 0$.

The negative expectation adjustment term implies a negative relationship between prices after and before the announcement of ζ, when adjusting for the impact of the surprise. For instance, in the case of a better-than-expected outcome compared to survey expectations, that is $\zeta - \bar{v} > 0$, we should observe decreasing prices prior to release, i.e. $p_{t-1} < 0$, in anticipation of this outcome. The implication of a negative relationship between prices before and after release, when adjusting for the surprise as measured by the deviation from the survey expectation, is testable. This is done in the following section.

3 Econometric framework

Two important implications can be drawn from the model, which is important to our empirical study. Firstly, a negative and significant coefficient on the price change prior to the release of a given macroeconomic announcement in a regression along the lines of (5) is consistent with the hypothesis of expectation adjustments. Secondly, by including price movements prior to release in order to capture expectation adjustments, a market based measure of market expectations for upcoming macroeconomic releases can be derived. Using high-frequency futures contract data from US and Euro Area long-term bond markets, a standard event study model built upon (5) is implemented.

The theoretical model does, however, leave two important answers unsolved, even if the implications of the model are taken at face value. Firstly, the length of the intraday periods to be used are not indicated. In this paper the 5-minute return after release of the announcement and the 10-, 15-, 30- and 60-minute intervals prior to release are considered. The 5-minute interval after release has in previous studies, as for instance Andersen, Bollerslev, Diebold, and Vega (2003), been found to be adequate for measuring the market reaction.

The chosen 10-, 15-, 30- and 60-minute intervals prior to release capture the period in which private information is disseminated into prices. The considered intervals may be considered relatively short windows, but, using longer windows implies the risk of incorporating the impact from other events. Furthermore, it is plausible that only investors with superior information or forecasting skills, who are so to speak, placing their bets on a specific outcome, are likely to trade shortly prior to announcement and the price impact is likely to be largest in this relatively short interval. Therefore, it is on the one hand very likely that some investors have put on positions prior to the considered time interval, which are not incorporated into the considered priceflow, but on the other hand, those actually putting on a position are likely to have information and give a clear signal. The chosen interval size is therefore a trade-off between have a clear signal and extracting most possible information.

Secondly, it must be kept in mind that it is a well-known fact in the literature that high-frequency return series are negatively correlated. Roll (1984) shows that the bid-ask bounce may induce this behavior. Therefore, the negative correlation may not only arise from the re-pricing of market expectations but also from the bid-ask bounce. The empirical implementation therefore has to disentangle the effects from market microstructure noise and re-pricing of market expectations. In order to capture the bid-ask induced negative correlation and the re-pricing of market expectations at the same time, it appears appropriate to estimate a simultaneous estimation.

In the final part of the paper, a market-based expectation measure is derived, based on the estimations of the event study model. Forecast errors of the market based expectation measure are compared with standard survey measures.

3.1 Data

Data from US and German bond markets are used, as bond market data appear to be most receptive to economic news. In principle, data from the equity market and the foreign exchange markets could be used as well. However, as regards the equity market, macroeconomic news may have an ambiguous effect on equity prices and the impact of macroeconomic news may therefore not be obvious. For instance, a better-than-expected GDP report may, on the one hand, lead to more positive growth prospects for companies. On the other hand, this also induces higher bond yields, which lowers the net present value of companies future cash flows and increases the borrowing costs of companies. Similarly, but less restrictive, is the impact on foreign exchange markets, where some sort of ambiguity may also exist. A strong US number is likely to have the opposite effect compared to a strong euro area release on the EURUSD exchange rate. As we consider announcements on US and German macroeconomic announcements, the analysis is restricted to bond markets.

We use bond market futures data which has the fastest price discovery and most liquidity, see for instance Upper and Werner (2006). The bond market data is prices on leading bond futures contracts in the US and the euro area at 10-year maturities. The data is provided by TickData Inc and covers the period July 2003 - March 2008.

The macroeconomic data predominantly covers important US macroeconomic releases, see for instance the selection by Bartolini, Goldberg, and Sacarny (2008), and in addition to two important German survey indicators, which are found to have importance for euro area bond market developments in Andersson, Overby, and Sebestyén (2009). We use the following eight monthly macroeconomic announcements: US non-farm payroll, US CPI (MoM), US industrial production, US ISM manufacturing confidence, US ISM non-manufacturing confidence, US Retail Sales, GE IFO business sentiment indicator and GE ZEW indicator.[1] The announcement data, both the actual release and survey expectations, is collected from Bloomberg.

3.2 Testing for pre-announcement market reactions

The theoretical model implies that expectation adjustments should be tested in a regression of the form:

$$r_t = \hat{\gamma} r_{t-1} + \hat{\alpha}(\zeta - \bar{v}) + \varepsilon_t, \tag{6}$$

where r_t is returns after the announcement, ζ is the announcement, and $\bar{v}$ is the survey-based market expectation, i.e. $\zeta - \bar{v}$ measures the surprise content of the announcement. Significance of the $\hat{\gamma}$ parameter hence indicates that some expectation adjustment does take place, as market movements prior to release has information content. It is not possible to identify the parameters of the theoretical model, hence we do not perform a structural estimation. Compared to the theoretical model, the $\hat{\gamma}$ parameter corresponds to $\frac{\alpha\beta}{b}a$, where we can only identify α.

One possibility is to adopt the approach of Andersen, Bollerslev, Diebold, and Vega (2003)[2] where all intraday returns, not only those around macroeconomic announcements, are modelled. Their approach is very suited for

[1] Originally a slightly larger set of releases was considered. However, the GDP Advance and the Chicago PMI releases were not included in the final results. The GDP Advance is only released quarterly and hence only 18 observations were available in the considered sample. Chicago PMI is according to market participants made available to subscribers prior to release, which also appears to be confirmed in the data, as most of the market reaction appears to take place prior to release.

[2] For adoptions of their approach, see for instance Andersson, Overby, and Sebestyén (2009) for an application on German bond market data, Sebestyén (2006) on money market announcements and Fatum and Pedersen (2007) for measuring the impact of F/X interventions.

capturing intraday volatility patterns. However, as we are not particularly interested in intraday volatility patterns, we utilize that macroeconomic announcements are announced at pre-specified times, for instance 08.30 EST, and only examine returns on announcement and non-announcement days around the release time.[3]

The event study approach is more simplistic, but still accounts for structural patterns around release time on non-announcement days, for instance induced by market microstructure noise. The regressions are performed individually for each announcement for 4 different return intervals prior to release, i.e. 10-, 15-, 30- and 60-minute returns. The length of the return after release is, as earlier mentioned, kept constant at 5 minutes.

The conditional mean regression for each of the 8 macroeconomic announcements, denoted by k =CPI, Industrial Production, ISM manufacturing Survey, ISM non-manufacturing Survey Non Farm Payroll, Retail Sales, IFO and ZEW, is specified as

$$r_t = \alpha_0 + \gamma_k \tilde{r}_{t-1}^N + \gamma_k^{EA} D_k \tilde{r}_{t-1}^N + \alpha_k^{MA}(\zeta_t^k - \bar{v}_t^k) + \varepsilon_t, \qquad (7)$$

where the 5-minute bond return after release[4], r_t, is regressed on a *constant*; the lagged N =10-, 15-, 30- and 60-*minute return* $\tilde{r}_{t-1}^N$; the *return prior to announcements* as D_k is a dummy taking the value 1 when announcement k is released in order to account for expectation adjustments and the *surprise* $\zeta_t^k - \bar{v}_t^k$ of the considered announcement. This specification allows us to disentangle the effects of the bid-ask bounce, which is accounted for by γ_k, as this coefficient will be estimated on information from all days, i.e. both announcement and non-announcement days.

It is wel known that volatility in financial returns is time-varying and increases around macroeconomic announcements. To account for these effects, a conditional volatility equation is fitted as well. The conditional volatility equation is specified with a GARCH(1,1) process amended with a dummy indicating whether an announcement took place.[5]

[3] In order to exclude the impact from other announcements, days with other announcements than the 8 announcements considered in this paper are also removed. In addition, two days with FOMC intermeeting rate cuts are removed.

[4] Returns are calculated from 1 minute before release to 4 minutes after release. This is to avoid discrepancies in the time measurement between the announcement and price data.

[5] The GARCH specification is unusual, as the daily volatility only relates to the volatil-

$$\sigma_t^2 = \beta_o + \beta\varepsilon_{t-1}^2 + \beta_2\sigma_{t-1}^2 + \beta_3 D_k. \tag{8}$$

In the conditional mean equation, γ_k measures the microstructure noise from the previous period, γ_k^{EA} measures the expectation adjustment and α_k^{MA} measures the contemporaneous impact coefficient. Hence a negative and significant γ_k^{EA} coefficient is supportive of some sort of expectation adjustment taking place.

The results are shown in the tables below for the German Bunds and the T-note futures contracts. For brevity only the test results for γ_k^{EA} are shown. The full estimation results for the two markets and 8 announcements are given in Appendix A.

Several features can be noted from Tables 1 and 2. The results show that for some macroeconomic releases, we do observe a statistical significant market adjustment prior to release. Hence the hypothesis of price movements signalling true market expectations appears to be well supported for some, but not all macroeconomic announcements. There are significantly negative γ_k^{EA} parameters for non-farm payroll and ISM Management and the German ZEW indicator from the US and German bond market data, and also for the IFO indicator in the German data. In addition, the coefficients are generally negative, albeit insignificantly, for most other releases. All in all, financial prices therefore do exhibit signs of expectations adjustment prior to the release of macroeconomic releases.

The strongest signs of expectations adjustment appears in the 10- and 15-minute intervals. The γ_k^{EA} coefficients tend to decrease, when extending the event window, which appears to suggest that the closer the release is, the more likely the trades are to reflect some information about the upcoming release. Extending the prior return window seems to decrease the release-related trading and introduces more noise.

The magnitude of the coefficients also deserves some attention, as these suggest that some sort of price reversal is taking place. The significant coefficients are mostly statistically indistinguishable from -1, which suggests that any prior price movements are simply reversed subsequently after the

ity around the announcement time, such as 08.30 EST. Other volatility specifications have been attempted, such as a constant volatility with a dummy for announcement days. Results are robust to this specification.

release, when taking into the account the information conveyed to the market by the surprise. The impact of the expectations adjustment in some sense disappears, as the market response becomes lower (higher) when the surprise is in (out of) line with the prior price movement. For instance an increase in prices prior to release suggests a weaker macroeconimic announcement than suggested by survey expectations, which when realised causes the surprise to have a lower market impact. Such an effect may cause the omitted-variables bias suggested in Rigobon and Sack (2006).

Interestingly enough, the announcements that do exhibit signs of expectation adjustments, are the announcements for which market reactions, on average, tend to be the largest. Hence it may be hypothesized that market participants only engage in active position taking around the announcements which are likely to produce the largest price fluctuations, i.e. where the outcome of successful position taking is likely to lead to the biggest profits. It therefore appears that the costs related to forming independent expectations, such as information search, has to exceed some minimum gain.

Finally and not surprisingly, the information contained in bond prices on German announcements appears to be largest in the German bond market. However, the conclusion does not hold for US announcements. The information contained in US announcements, at least in terms of significance, appear to be almost the same in the German bond market data. This probably reflects the high importance of US announcements on German bond markets as discussed in Andersson, Overby, and Sebestyén (2009).

3.3 Extracting expectations

At least for some announcements there appear to be adjustments to market expectations. Obviously the adjusted market expectations are not directly observable, but it is possible to extract a market-adjusted expectation measure.

By re-arranging our conditional mean specification (7) we obtain

$$r_t = \alpha_0 + \gamma_k r_{t-1} + \alpha_k^{MA} \left(\zeta_t^k - \left(\bar{v}_t^k - \frac{\gamma_k^{EA}}{\alpha_k^{MA}} D_k r_{t-1} \right) \right) + \varepsilon_t, \tag{9}$$

which gives an estimator for the market-adjusted expectation for announcement k at time t, $v^k_{market,t} = \bar{v}^k_t - \frac{\gamma^{EA}_k}{\alpha^{MA}_k} D_k r_{t-1}$. Note that this estimator corresponds to our theoretical estimate of the market-adjusted expectation, as $\frac{\gamma^{EA}_k}{\alpha^{MA}_k}$ is the empirical counterpart of $\frac{a\beta}{b}$ in (4) and hence appears a natural estimator for actual market expectations.

	γ_k^{EA}			
	10-minute	15-minute	30-minute	60-minute
CPI	0.3693	-0.4279	-0.3825	0.2963
	(0.4412)	*(0.4250)*	*(0.3953)*	*(0.2826)*
Ind. Prod.	-0.0349	-0.1360	0.0591	0.0102
	(0.1709)	*(0.1121)*	*(0.0955)*	*(0.0572)*
ISM Man.	-0.6535*	-0.1544	-0.6139***	-0.1454
	(0.3599)	*(0.3279)*	*(0.1739)*	*(0.1873)*
ISM Non-Man.	-0.1192	-0.1012	-0.0879	-0.1187
	(0.2421)	*(0.2315)*	*(0.1154)*	*(0.1006)*
Non-farm payroll	-1.4065***	-1.1396***	-1.0712***	-0.8921***
	(0.2347)	*(0.2160)*	*(0.2068)*	*(0.2883)*
Retail Sales	-0.1255	-0.2270	-0.0076	-0.0104
	(0.5921)	*(0.4425)*	*(0.3061)*	*(0.2152)*
IFO (GE)	-1.2399***	-0.9802**	-0.7288**	-0.4900**
	(0.4349)	*(0.4093)*	*(0.3200)*	*(0.2127)*
ZEW (GE)	-0.4829***	-0.4685***	-0.2450	-0.0773
	(0.1660)	*(0.1453)*	*(0.1426)*	*(0.1000)*

Table 1: Test of expectations adjustments taking place prior to release for 8 macroeconomic announcements based on the German Bunds futures contract. The table shows the γ^{EA} parameter for each of the announcements, estimated using N=10-, 15-, 30- and 60-minute return intervals prior to announcement on the German Bunds futures contract. The hypothesis of expectations adjustments corresponds to a significantly negative γ^{EA} parameter in the conditional mean, which is estimated for each announcement as $r_t = a_0 + \gamma_k \tilde{r}_{t-1} + \gamma_k^{EA} D_k \tilde{r}_{t-1} + \alpha_k^{MA}(\zeta_t^k - v_t^k) + u_t$. r_t is the 5-minute return after release of the announcement, $\tilde{r}_{t-1}$ is the N-minute return before release and $(\zeta_t^k - v_t^k)$ is the surprise of the announcement. Full estimation results can be found in the appendix. Bollerslev-Wooldridge robust standard errors are reported in parentheses. *, ** and *** denote significance at respectively the 10%, 5% and 1% level.

	γ_k^{EA}			
	10-minute	15-minute	30-minute	60-minute
CPI	-0.2616	-0.6163	-0.4011	0.1158
	(0.6697)	*(0.5647)*	*(0.3623)*	*(0.2070)*
Ind. Prod.	-0.0319	-0.0486	0.1052	0.0431
	(0.1820)	*(0.1354)*	*(0.0946)*	*(0.0490)*
ISM Man.	-1.0313***	-0.7215***	-0.3541	-0.1406
	(0.3331)	*(0.0910)*	*(0.2097)*	*(0.1900)*
ISM Non-Man.	-0.0968	-0.0906	-0.2284*	-0.2136
	(0.2742)	*(0.1740)*	*(0.1198)*	*(0.1189)*
Non-farm payroll	-1.1739***	-1.1696***	-1.1798***	-1.0858***
	(0.3150)	*(0.3019)*	*(0.2611)*	*(0.3897)*
Retail Sales	-0.7940	-0.7075	-0.3478	-0.4403
	(0.5991)	*(0.5346)*	*(0.3564)*	*(0.2952)*
IFO (GE)	-0.3600	-0.0301	-0.1152	-0.0475
	(0.2219)	*(0.1654)*	*(0.1390)*	*(0.0742)*
ZEW (GE)	-0.4217***	-0.1979	-0.0490	-0.0273
	(0.1427)	*(0.1121)*	*(0.0860)*	*(0.0569)*

Table 2: Test of expectations adjustments taking place prior to release for 8 macroeconomic announcements based on the US T-note futures contract. The table shows the γ^{EA} parameter for each of the announcements, estimated using N=10-, 15-, 30- and 60-minute return intervals prior to announcement on the US T-note futures contract. The hypothesis of expectations adjustments corresponds to a significantly negative γ^{EA} parameter in the conditional mean, which is estimated for each announcement as $r_t = a_0 + \gamma_k \tilde{r}_{t-1} + \gamma_k^{EA} D_k \tilde{r}_{t-1} + \alpha_k^{MA}(\zeta_t^k - v_t^k) + u_t$. r_t is the 5-minute return after release of the announcement, $\tilde{r}_{t-1}$ is the N-minute return before release and $(\zeta_t^k - v_t^k)$ is the surprise of the announcement. Full estimation results can be found in the appendix. Bollerslev-Wooldridge robust standard errors are reported in parentheses. *, ** and *** denote significance at respectively the 10%, 5% and 1% level.

	Bloomberg	Bunds				T-notes			
		10-minute	15-minute	30-minute	60-minute	10-minute	15-minute	30-minute	60-minute
CPI	0.0010	0.0034	0.0011	0.0011	0.0015	0.0011	0.0012	0.0011	0.0011
Ind. Prod.	0.0025	0.0025	0.0027	0.0026	0.0025	0.0025	0.0025	0.0026	0.0026
ISM Man.	1.4373	1.5418	1.4334	**1.6753**	1.4342	**1.6975**	**1.5356**	1.4822	1.4822
ISM Non-Man.	2.5093	2.5047	2.5021	2.5239	2.5424	2.4851	2.4957	2.4936	2.4936
Non-farm payroll	**61.5283**	**62.9793**	**63.9185**	**64.5375**	**64.8844**	**61.1402**	**61.6214**	**62.3499**	**62.3499**
Retail Sales	0.0032	0.0032	0.0032	0.0032	0.0032	0.0035	0.0035	0.0031	0.0031
IFO (GE)	0.9179	**0.8576**	**0.9071**	**0.9205**	**0.9260**	0.9158	0.9085	0.9347	0.9347
ZEW (GE)	6.4667	**6.2163**	**6.1792**	6.2832	6.3615	**6.9133**	6.3695	6.2566	6.2566

Table 3: Forecast errors of the market-adjusted expectation and Bloomberg survey measures. The forecast error is measured as the absolute average forecast deviation.

	Bunds				T-notes			
	10-minute	15-minute	30-minute	60-minute	10-minute	15-minute	30-minute	60-minute
CPI	0.43	0.38	0.42	0.26	0.41	0.36	0.40	0.33
Ind. Prod.	0.41	0.44	0.49	0.33	0.51	0.48	0.43	0.35
ISM Man.	0.49	0.52	**0.48**	0.53	**0.54**	**0.60**	0.58	0.54
ISM Non-Man.	0.48	0.48	0.50	0.44	0.55	0.46	0.53	0.51
Non-farm Payroll	**0.53**	**0.57**	**0.49**	**0.53**	**0.52**	**0.54**	**0.50**	**0.50**
Retail Sales	0.45	0.55	0.26	0.33	0.51	0.53	0.60	0.63
IFO (GE)	**0.60**	**0.52**	**0.54**	**0.57**	0.55	0.49	0.42	0.42
ZEW (GE)	**0.54**	**0.60**	0.57	0.61	**0.53**	0.54	0.55	0.64

Table 4: Hit ratio of the market-adjusted expectation and Bloomberg survey measures. The hit ratio is defined as the share of sucessful hits, i.e. better directional forecasts than the Bloomberg survey measure.

In order to compare the performance of respectively the market adjusted expectations measure, v^k_{market}, the standard Bloomberg survey expectations is compared in terms of its forecast error. The forecast error is measured as the absolute forecast deviation for the n announcements, i.e.

$$FE_k = \frac{1}{n}\textstyle\sum_{t=1}^{n}\left|\zeta^k_t - v^k_t\right|$$

for announcement k with n announcements using respectively $v^k_t = v^k_{market,t}$ and $v^k_t = \bar{v}^k_t$ for the market-adjusted expectation and the Bloomberg survey. The forecasts errors are shown in Table 3.

A bit disappointingly the forecast errors in Table 3 show no convincing outperformance over the traditional Bloomberg survey measure. If there is any tendency in Table 3, then the forecast errors are either similar or even higher for most US announcements. Not even the variables, which came out significant in our earlier test, exhibit any meaningful outperformance. Both the ISM Management Survey and the very important non-farm payroll release fare slightly worse. For the German releases, the market expectation measure fare slightly better, at least based on the German bond market data. Therefore, at first glance, the information of the informed traders does appear limited.

However, the objective of the market investor is not, perhaps a bit surprisingly, to obtain low forecast errors. The investor is rather concerned about getting the directionality in the surprise correctly, i.e. whether the given release was above or below consensus. As noted earlier a positive surprise is linked with negative returns and vice versa for negative surprises. Hence having made a larger forecast error is not important, as long as the investor captured whether the release was above or below consensus. In other words, the success or hit ratio for the forecast is of interest.

The hit ratio is measured as

$$H = \frac{1}{n}\sum_{i=1}^{n}\left(\mathbf{1}_{\left\{\left(\bar{v}^k_i - v^k_{market,i}\right)>0 \wedge \left(\zeta^k_i - \bar{v}^k_i\right)<0\right\}} + \mathbf{1}_{\left\{\left(\bar{v}^k_i - v^k_{marke,it}\right)<0 \wedge \left(\zeta^k_i - \bar{v}^k_i\right)>0\right\}}\right)$$

The hit ratio consequently counts the total share of 'hits', i.e. where the market-adjusted expectation measure indicated a higher or similar release compared to the Bloomberg measure and the release actually surprised positively and similarly where the expectation measure indicated a lower number and the release surprised negatively, out of the total number of announcements. The results of this is reported in Table 4.

The results in Table 4 show that the hit-ratio is above 50 per cent in almost all cases where we previously found signs of expectations adjustments. The forecast error may be higher, but the market on average gets the directionality of their forecast correctly. Therefore, as seen from the perspective of an investor, their forecasting skills are above average.

It appears that the market-adjusted expectation measure often tends to under- or overshoot, even though the directionality more often is correct. Therefore market participants' forecasting skills appear better than the Bloomberg measure, but with a strong tendency to under- or overshoot

4 Concluding remarks

There are clear indications from the analysis that markets adjust prices prior to releases, in the sense of an expectations adjustment. The chosen approach of using information from price movements at 10-, 15-, 30- and 60-minute intervals prior to release to supplement existing survey measures therefore appears justified. Markets appear to adjust prices to reflect true market expectations and the market-based measure therefore appears superior compared to static survey measures.

The estimations are theoretically underpinned and offer a simple solution for obtaining improved expectation measures. The paper therefore demonstrates the soundness of a market microstructure based approach and demonstrates an economically justified method of extracting information. The approach is rather general and may be extended to improve survey measures to for instances market expectations about earnings releases in equity markets.

The econometric analysis suggests four important implications. Firstly, the analysis, as could be expected, that domestic markets contain most information about domestic releases, although US releases do appear to impact German/European bond markets almost in equal effect. This result does confirm the worldwide importance of US announcements.

Secondly, announcements that have the highest market impact are also those that exhibit the strongest degree of expectations adjustment. It therefore appears that investors do demand some sort of minimum return in order to engage in individual information collection.

Thirdly, measures of expectation adjustment increase in precision as the announcement gets closer. The precision of the expectations adjustment therefore appears the highest relatively close to the announcement, as those trades entered at that time do appear to have the highest information content about the upcoming release.

Finally, the forecast errors of the market-adjusted expectation measure is not improved, but it does appear to be somewhat better at capturing the directionality of the surprise, i.e. whether the release surprises positively or negatively. Consequently, the market-adjusted measure does seem to outperform standard survey measures.

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Appendix

Proof of Theorem 1

We assume that the informed investors follow a linear strategy of the type $X = -ap_{t-1} + b(s_i - \bar{v})$. We then insert the linear strategy in the market clearing condition (3) and solve for p_{t-1} and obtain

$$p_{t-1} = \frac{1}{a}\left(b(\zeta - \bar{v}) + u\right), \tag{10}$$

where we have used that $\int_0^\omega s_i di = \zeta$. This gives us (ii).

Optimizing the investor's CARA utility function with respect to x_i, gives

$$x_i = \rho^{-1}\frac{\mathrm{E}[p_t|p_{t-1}, s_i] - p_{t-1}}{\mathrm{Var}[p_t|p_{t-1}, s_i]}. \tag{11}$$

We define $\hat{p}_{t-1} = \frac{a}{b}p_{t-1} + \bar{v}$, hence $\hat{p}_{t-1} = \zeta + \frac{1}{b}u$. We now note that

$$E[p_t|p_{t-1}, s_i] = E[p_t|\hat{p}_{t-1}, s_i].$$

Inserting the expression in (10) and the expression for $\hat{p}_{t-1}$ we obtain

$$\begin{aligned}
E[p_t|\hat{p}_{t-1}, s_i] &= E[\alpha(1-\beta)(\zeta - \bar{v})|\zeta + \frac{1}{b}u, \zeta + \varepsilon_i] \\
&= \alpha(1-\beta)\left(E[\zeta|\zeta + \frac{1}{b}u, \zeta + \varepsilon_i] - \bar{v}\right) \\
&= \alpha(1-\beta)\left(\frac{\tau_\zeta \bar{v} + b^2\tau_u \hat{p}_{t-1} + \tau_\varepsilon s_i}{\tau_\zeta + b^2\tau_u + \tau_\varepsilon} - \bar{v}\right)
\end{aligned}$$

In the final line we use Bayes formula. Then we substitute the expression for $\hat{p}_{t-1}$ and find that

$$\begin{aligned}
E[p_t|p_{t-1}, s_i] &= \alpha(1-\beta)\frac{\tau_\zeta \bar{v} + b^2\tau_u\left(\frac{a}{b}p_{t-1} + \bar{v}\right) + \tau_\varepsilon s_i - \left(\tau_\zeta + b^2\tau_u + \tau_\varepsilon\right)\bar{v}}{\tau_\zeta + b^2\tau_u + \tau_\varepsilon} \\
&= \alpha(1-\beta)\frac{\left(\tau_\zeta + b^2\tau_u\right)\bar{v} + ab\tau_u p_{t-1} + \tau_\varepsilon s_i - \left(\tau_\zeta + b^2\tau_u + \tau_\varepsilon\right)\bar{v}}{\tau_\zeta + b^2\tau_u + \tau_\varepsilon} \\
&= \alpha(1-\beta)\frac{ab\tau_u p_{t-1} + \tau_\varepsilon(s_i - \bar{v})}{\tau_\zeta + b^2\tau_u + \tau_\varepsilon}
\end{aligned}$$

Similarly we find that $Var[p_t|p_{t-1}] = \tau_\zeta + b^2\tau_u + \tau_\varepsilon$.

Inserting these expressions into (11) gives us

$$\begin{aligned} x_i &= \rho^{-1}\left(\tau_\zeta + b^2\tau_u + \tau_\varepsilon\right)^{-1}\left(\alpha(1-\beta)\frac{ab\tau_u p_{t-1} + \tau_\varepsilon(s_i - \bar{v})}{\tau_\zeta + b^2\tau_u + \tau_\varepsilon} - p_{t-1}\right) \\ &= \rho^{-1}\left(\alpha(1-\beta)\left(ab\tau_u p_{t-1} + \tau_\varepsilon(s_i - \bar{v})\right) - \left(\tau_\zeta + b^2\tau_u + \tau_\varepsilon\right)p_{t-1}\right) \end{aligned}$$

This indicates directly that $b = \rho^{-1}\alpha(1-\beta)\tau_\varepsilon$. It also follows that for $\rho > 0$, $0 < \beta < 1$, $\alpha < 0$ and positive variance $\tau_\varepsilon > 0$ we obtain $b < 0$.

In addition we get

$$a = -\rho^{-1}\left(\alpha(1-\beta)ab\tau_u - \left(\tau_\zeta + b^2\tau_u + \tau_\varepsilon\right)\right)$$

which, using the expression for b, can be re-arranged to

$$a = \frac{\rho^{-1}\left(\tau_\zeta + b^2\tau_u + \tau_\varepsilon\right)}{1 + \rho^{-2}\alpha^2(1-\beta)^2\tau_\varepsilon\tau_u}$$

Again noting that for $\rho > 0$ and positive variances $\tau_\varepsilon, \tau_\zeta, \tau_u > 0$, we obtain $a > 0$. The expressions of a and b gives us (i), which concludes the proof. ∎

	CPI	Ind. Prod	ISM Man.	ISM Non-Man.	Non Farm Payroll	Retail Sales	IFO (GE)	ZEW (GE)
				Conditional Mean Equation				
α_0	0.0056	-0.0311	0.2409**	0.1853	-0.0027	-0.0646	-0.0558	0.1467**
	(0.0558)	*(0.0728)*	*(0.1135)*	*(0.1128)*	*(0.0880)*	*(0.0884)*	*(0.0630)*	*(0.0626)*
γ	-0.0643*	-0.0280	-0.0448	-0.0390	-0.0525	-0.0530	-0.0303	-0.0841***
	(0.0345)	*(0.0264)*	*(0.0331)*	*(0.0337)*	*(0.0356)*	*(0.0317)*	*(0.0283)*	*(0.0333)*
γ^{EA}	0.3693	-0.0349	-0.6535*	-0.1192	-1.4065***	-0.1255	-1.2399***	-0.4829***
	(0.4412)	*(0.1709)*	*(0.3599)*	*(0.2421)*	*(0.2347)*	*(0.5921)*	*(0.4349)*	*(0.1660)*
α^{MA}	-257.6143	-720.7528***	-2.8229***	-1.1666***	-0.2776***	-915.8615***	-6.4119***	-0.6343***
	(908.0982)	*(207.2484)*	*(0.3760)*	*(0.1875)*	*(0.0225)*	*(157.5098)*	*(0.8698)*	*(0.0625)*
				Conditional Volatility Equation				
β_0	4.8212***	3.4030	10.0485***	3.8737***	4.8007***	7.8104***	4.5878***	-0.2137***
	(0.0859)	*(2.0433)*	*(1.3768)*	*(1.3291)*	*(0.3837)*	*(1.3703)*	*(0.3557)*	*(0.0428)*
β_1	-0.0084***	-0.0122	-0.0214**	0.0124	0.0017	-0.0256	0.0202	-0.0139***
	(0.0011)	*(0.0072)*	*(0.0099)*	*(0.0267)*	*(0.0037)*	*(0.0340)*	*(0.0179)*	*(0.0036)*
β_2	-0.0075	0.4508	-0.0311	0.5745***	-0.0091*	0.5285***	-0.0194	1.0027***
	(0.0045)	*(0.3256)*	*(0.1072)*	*(0.1295)*	*(0.0047)*	*(0.0975)*	*(0.0254)*	*(0.0038)*
β_3	87.1949***	10.2789***	22.9786***	2.6741	202.9726***	1.3006	37.6372***	5.2421***
	(14.8918)	*(3.0917)*	*(7.3220)*	*(2.6323)*	*(39.0083)*	*(12.5883)*	*(8.6485)*	*(0.7393)*
R^2	0.0126	0.0321	0.1694	0.1058	0.6618	0.1306	0.2624	0.1828
No. observations	642	1214	770	773	641	643	1188	1113
No. announcements	54	55	51	54	53	55	56	57

Table 5: Estimation results for 8 macroeconomic announcements on the German Bunds futures contract using 10-minute prior return intervals. The conditional mean is for each announcement estimated as $r_t = a_0 + \gamma_k \tilde{r}_{t-1} + \gamma_k^{EA} D_k \tilde{r}_{t-1} + \alpha_k^{MA}(\zeta_t^k - v_t^k) + u_t$, where r_t is the 5-minute return after release of the announcement, $\tilde{r}_{t-1}$ is the 10-minute return before release and $(\zeta_t^k - v_t^k)$ is the surprise of the announcement. The conditional volatility is specified as a GARCH(1,1) augmented with a dummy indicating whether the announcement was released in this period, i.e. $\sigma_t^2 = \beta_0 + \beta_1 u_{t-1}^2 + \beta_2 \sigma_{t-1}^2 + \beta_3 D_k$. The hypothesis of expectations adjustments corresponds to a significantly negative γ^{EA} parameter. Bollerslev-Wooldridge robust standard errors are reported in parentheses. *, ** and *** denote significance at respectively the 10%, 5% and 1% level.

	CPI	Ind. Prod	ISM Man.	ISM Non-Man.	Non Farm Payroll	Retail Sales	IFO (GE)	ZEW (GE)
				Conditional Mean Equation				
α_0	-0.3222**	0.0260	0.1683	0.2183	-0.3301**	-0.3330**	0.0070	0.0515
	(0.1360)	*(0.0956)*	*(0.1326)*	*(0.1448)*	*(0.1375)*	*(0.1356)*	*(0.0457)*	*(0.0492)*
γ	-0.0775**	-0.0023	-0.0324	-0.0347	-0.0739**	-0.0782**	-0.0800***	-0.0989**
	(0.0345)	*(0.0319)*	*(0.0194)*	*(0.0325)*	*(0.0348)*	*(0.0351)*	*(0.0279)*	*(0.0491)*
γ^{EA}	-0.2616	-0.0319	-1.0313***	-0.0968	-1.1739***	-0.7940	-0.3600	-0.4217***
	(0.6697)	*(0.1820)*	*(0.3331)*	*(0.2742)*	*(0.3150)*	*(0.5991)*	*(0.2219)*	*(0.1427)*
α^{MA}	-3616.0765*	-1171.9525***	-5.0946***	-2.0009***	-0.5708***	-1711.0849***	-2.1351***	-0.1906***
	(1876.9629)	*(298.2464)*	*(0.7414)*	*(0.3342)*	*(0.0475)*	*(290.8816)*	*(0.3045)*	*(0.0284)*
				Conditional Volatility Equation				
β_0	11.0772***	8.3167***	16.3734***	12.5829**	10.9715***	11.4274***	2.5351***	0.0689
	(0.9475)	*(1.3931)*	*(6.2062)*	*(5.9910)*	*(0.9908)*	*(1.1046)*	*(0.2896)*	*(0.0454)*
β_1	-0.0035***	0.0490	-0.0514***	-0.0139	-0.0015***	0.0080	0.0661*	0.0119*
	(0.0004)	*(0.0436)*	*(0.0000)*	*(0.0097)*	*(0.0002)*	*(0.0071)*	*(0.0346)*	*(0.0063)*
β_2	-0.0055**	0.1353	0.5120***	0.2064	-0.0021	-0.0391***	-0.0745	0.9580***
	(0.0024)	*(0.1181)*	*(0.1902)*	*(0.3363)*	*(0.0033)*	*(0.0146)*	*(0.0791)*	*(0.0152)*
β_3	343.8409***	24.9723***	0.0584	16.3152**	735.0327***	143.5962***	5.3551***	0.0633
	(59.6559)	*(7.7233)*	*(10.8867)*	*(6.9129)*	*(145.9443)*	*(32.4008)*	*(1.9463)*	*(0.4237)*
R^2	0.0448	0.0451	0.3029	0.1392	0.6776	0.2204	0.0989	0.0711
No. observations	614	1216	768	769	614	615	1167	1092
No. announcements	54	55	53	54	54	55	53	57

Table 6: Estimation results for 8 macroeconomic announcements on the US T-note futures contract using 10-minute prior return intervals. The conditional mean is for each announcement estimated as $r_t = a_0 + \gamma_k \tilde{r}_{t-1} + \gamma_k^{EA} D_k \tilde{r}_{t-1} + \alpha_k^{MA}(\zeta_t^k - v_t^k) + u_t$, where r_t is the 5-minute return after release of the announcement, $\tilde{r}_{t-1}$ is the 10-minute return before release and $(\zeta_t^k - v_t^k)$ is the surprise of the announcement. The conditional volatility is specified as a GARCH(1,1) augmented with a dummy indicating whether the announcement was released in this period, i.e. $\sigma_t^2 = \beta_0 + \beta_1 u_{t-1}^2 + \beta_2 \sigma_{t-1}^2 + \beta_3 D_k$. The hypothesis of expectations adjustments corresponds to a significantly negative γ^{EA} parameter. Bollerslev-Wooldridge robust standard errors are reported in parentheses. *, ** and *** denote significance at respectively the 10%, 5% and 1% level.

	CPI	**Ind. Prod**	**ISM Man.**	**ISM Non-Man.**	**Non Farm Payroll**	**Retail Sales**	**IFO (GE)**	**ZEW (GE)**
	Conditional Mean Equation							
α_0	0.0064	-0.0324	0.2424**	0.1881	-0.0047	-0.0564	-0.0568	0.0788
	(0.0879)	*(0.0730)*	*(0.1136)*	*(0.1129)*	*(0.0875)*	*(0.0774)*	*(0.0634)*	*(0.0731)*
γ	-0.0475	-0.0294	-0.0397	-0.0362	-0.0476	-0.0426	-0.0206	-0.0546
	(0.0304)	*(0.0198)*	*(0.0257)*	*(0.0259)*	*(0.0303)*	*(0.0268)*	*(0.0229)*	*(0.0358)*
γ^{EA}	-0.4279	-0.1360	-0.1544	-0.1012	-1.1396***	-0.2270	-0.9802**	-0.4685***
	(0.4250)	*(0.1121)*	*(0.3279)*	*(0.2315)*	*(0.2160)*	*(0.4425)*	*(0.4093)*	*(0.1453)*
α^{MA}	-1751.7417*	-718.9266***	-2.8307***	-1.1693***	-0.2750***	-937.5165***	-5.9279***	-0.6364***
	(960.2399)	*(210.7684)*	*(0.4270)*	*(0.1908)*	*(0.0238)*	*(157.8492)*	*(0.8226)*	*(0.0696)*
	Conditional Volatility Equation							
β_0	4.8090***	3.3646	9.8719***	3.6984***	4.8098***	7.8372***	4.5906***	5.3403
	(0.3990)	*(2.0819)*	*(1.3656)*	*(1.2529)*	*(0.3832)*	*(0.7139)*	*(0.3538)*	*(3.6684)*
β_1	-0.0047***	-0.0121	-0.0156*	0.0088	0.0022	-0.0270	0.0200	0.0061
	(0.0014)	*(0.0070)*	*(0.0078)*	*(0.0259)*	*(0.0032)*	*(0.0300)*	*(0.0164)*	*(0.0155)*
β_2	-0.0094	0.4566	-0.0217	0.5962***	-0.0096**	0.5329***	-0.0195	0.0604
	(0.0087)	*(0.3322)*	*(0.1049)*	*(0.1232)*	*(0.0043)*	*(0.0294)*	*(0.0239)*	*(0.5508)*
β_3	82.6484***	9.8425***	24.9901***	2.5236	213.7197***	1.6734	39.5522***	4.1787
	(15.1201)	*(3.0286)*	*(8.9077)*	*(2.5823)*	*(40.7970)*	*(12.0343)*	*(9.3535)*	*(2.4063)*
R^2	0.0565	0.0368	0.1605	0.1047	0.6476	0.1323	0.2517	0.1901
No. observations	642	1214	770	773	641	643	1188	1113
No. announcements	54	55	51	54	53	55	56	57

Table 7: Estimation results for 8 macroeconomic announcements on the German Bunds futures contract using 15-minute prior return intervals. The conditional mean is for each announcement estimated as $r_t = a_0 + \gamma_k \tilde{r}_{t-1} + \gamma_k^{EA} D_k \tilde{r}_{t-1} + \alpha_k^{MA}(\zeta_t^k - v_t^k) + u_t$, where r_t is the 5-minute return after release of the announcement, $\tilde{r}_{t-1}$ is the 15-minute return before release and $(\zeta_t^k - v_t^k)$ is the surprise of the announcement. The conditional volatility is specified as a GARCH(1,1) augmented with a dummy indicating whether the announcement was released in this period, i.e. $\sigma_t^2 = \beta_0 + \beta_1 u_{t-1}^2 + \beta_2 \sigma_{t-1}^2 + \beta_3 D_k$. The hypothesis of expectations adjustments corresponds to a significantly negative γ^{EA} parameter. Bollerslev-Wooldridge robust standard errors are reported in parentheses. *, ** and *** denote significance at respectively the 10%, 5% and 1% level.

	CPI	Ind. Prod	ISM Man.	ISM Non-Man.	Non Farm Payroll	Retail Sales	IFO (GE)	ZEW (GE)
				Conditional Mean Equation				
α_0	-0.2677*	0.0233	0.2068	0.1347	-0.3155**	-0.3174**	0.0020	0.0469
	(0.1455)	*(0.0956)*	*(0.2940)*	*(0.1441)*	*(0.1374)*	*(0.1353)*	*(0.0455)*	*(0.0493)*
γ	-0.0445	0.0074	-0.0191	-0.0162	-0.0467	-0.0487	-0.0632***	-0.0732*
	(0.0311)	*(0.0243)*	*(0.0483)*	*(0.0276)*	*(0.0298)*	*(0.0298)*	*(0.0217)*	*(0.0373)*
γ^{EA}	-0.6163	-0.0486	-0.7215***	-0.0906	-1.1696***	-0.7075	-0.0301	-0.1979
	(0.5647)	*(0.1354)*	*(0.0910)*	*(0.1740)*	*(0.3019)*	*(0.5346)*	*(0.1654)*	*(0.1121)*
α^{MA}	-3449.0707*	-1182.8037***	-5.2897***	-1.7052***	-0.5645***	-1705.0143***	-2.0801***	-0.1945***
	(1878.9832)	*(302.5574)*	*(0.2068)*	*(0.2737)*	*(0.0494)*	*(287.1291)*	*(0.2932)*	*(0.0339)*
				Conditional Volatility Equation				
β_0	8.6139***	7.8639***	17.8663	1.0889**	11.0231***	11.3476***	2.5940***	0.0644
	(1.0311)	*(1.3993)*	*(13.0423)*	*(0.4483)*	*(0.9763)*	*(1.0752)*	*(0.2610)*	*(0.0415)*
β_1	-0.0126***	0.0586	-0.0346***	-0.0037	-0.0013***	0.0135	0.0844**	0.0091
	(0.0048)	*(0.0461)*	*(0.0042)*	*(0.0096)*	*(0.0002)*	*(0.0081)*	*(0.0363)*	*(0.0053)*
β_2	0.1381***	0.1689	0.5279	0.9361***	-0.0024	-0.0387***	-0.1084	0.9631***
	(0.0347)	*(0.1223)*	*(0.3584)*	*(0.0128)*	*(0.0035)*	*(0.0143)*	*(0.0605)*	*(0.0128)*
β_3	166.2344***	23.9756***	4.5358	-0.7908	732.4490***	149.7454***	6.4610***	0.0491
	(66.3032)	*(7.6243)*	*(283.8911)*	*(4.2869)*	*(146.9193)*	*(32.8855)*	*(2.2425)*	*(0.4192)*
R^2	0.0585	0.0447	0.2652	0.1310	0.6784	0.2024	0.0862	0.0605
No. observations	614	1216	768	769	614	615	1167	1092
No. announcements	54	55	53	54	54	55	53	57

Table 8: Estimation results for 8 macroeconomic announcements on the US T-note futures contract using 15-minute prior return intervals. The conditional mean is for each announcement estimated as $r_t = a_0+\gamma_k\tilde{r}_{t-1}+\gamma_k^{EA}D_k\tilde{r}_{t-1}+\alpha_k^{MA}(\zeta_t^k-v_t^k)+u_t$, where r_t is the 5-minute return after release of the announcement, $\tilde{r}_{t-1}$ is the 15-minute return before release and $(\zeta_t^k - v_t^k)$ is the surprise of the announcement. The conditional volatility is specified as a GARCH(1,1) augmented with a dummy indicating whether the announcement was released in this period, i.e. $\sigma_t^2 = \beta_0 + \beta_1 u_{t-1}^2 + \beta_2\sigma_{t-1}^2 + \beta_3 D_k$. The hypothesis of expectations adjustments corresponds to a significantly negative γ^{EA} parameter. Bollerslev-Wooldridge robust standard errors are reported in parentheses. *, ** and *** denote significance at respectively the 10%, 5% and 1% level.

	CPI	**Ind. Prod**	**ISM Man.**	**ISM Non-Man.**	**Non Farm Payroll**	**Retail Sales**	**IFO (GE)**	**ZEW (GE)**
				Conditional Mean Equation				
α_0	-0.0050	-0.0282	0.2549**	0.1910	-0.0148	-0.0198	-0.0611	0.0920
	(0.0870)	*(0.0728)*	*(0.1128)*	*(0.1135)*	*(0.0864)*	*(0.0862)*	*(0.0642)*	*(0.0733)*
γ	-0.0537***	-0.0163	0.0018	0.0113	-0.0576***	-0.0530***	0.0110	-0.0560**
	(0.0194)	*(0.0149)*	*(0.0192)*	*(0.0198)*	*(0.0196)*	*(0.0193)*	*(0.0162)*	*(0.0239)*
γ^{EA}	-0.3825	0.0591	-0.6139***	-0.0879	-1.0712***	-0.0076	-0.7288**	-0.2450
	(0.3953)	*(0.0955)*	*(0.1739)*	*(0.1154)*	*(0.2068)*	*(0.3061)*	*(0.3200)*	*(0.1426)*
α^{MA}	-1830.8131*	-721.6998***	-2.7624***	-1.1522***	-0.2704***	-917.4630***	-5.9981***	-0.6107***
	(1015.0247)	*(202.2936)*	*(0.3656)*	*(0.1841)*	*(0.0235)*	*(159.7674)*	*(0.8913)*	*(0.0734)*
				Conditional Volatility Equation				
β_0	4.7680***	3.4521	10.4041***	4.2119***	4.7867***	4.7442***	4.5991***	6.1897***
	(0.3987)	*(2.0818)*	*(1.2235)*	*(1.5638)*	*(0.3823)*	*(0.4073)*	*(0.3450)*	*(2.3878)*
β_1	-0.0043	-0.0119	-0.0343***	0.0219	0.0023	0.0180	0.0087	0.0116
	(0.0036)	*(0.0075)*	*(0.0043)*	*(0.0290)*	*(0.0035)*	*(0.0154)*	*(0.0129)*	*(0.0191)*
β_2	-0.0093	0.4431	-0.0436	0.5301***	-0.0106**	-0.0328	-0.0098	-0.0911
	(0.0121)	*(0.3320)*	*(0.0776)*	*(0.1513)*	*(0.0043)*	*(0.0226)*	*(0.0252)*	*(0.2957)*
β_3	83.2351***	10.2518***	21.0016***	2.9588	202.1111***	54.7979***	41.7450***	6.3199**
	(15.1281)	*(3.0986)*	*(5.9698)*	*(2.7008)*	*(37.6313)*	*(14.0681)*	*(9.9364)*	*(2.5453)*
R^2	0.0557	0.0329	0.1759	0.1032	0.6636	0.1320	0.2387	0.1863
No. observations	642	1214	770	773	641	643	1188	1113
No. announcements	54	55	51	54	53	55	56	57

Table 9: Estimation results for 8 macroeconomic announcements on the German Bunds futures contract using 30-minute prior return intervals. The conditional mean is for each announcement estimated as $r_t = a_0+\gamma_k\tilde{r}_{t-1}+\gamma_k^{EA}D_k\tilde{r}_{t-1}+\alpha_k^{MA}(\zeta_t^k-v_t^k)+u_t$, where r_t is the 5-minute return after release of the announcement, $\tilde{r}_{t-1}$ is the 30-minute return before release and $(\zeta_t^k - v_t^k)$ is the surprise of the announcement. The conditional volatility is specified as a GARCH(1,1) augmented with a dummy indicating whether the announcement was released in this period, i.e. $\sigma_t^2 = \beta_0 + \beta_1 u_{t-1}^2 + \beta_2\sigma_{t-1}^2 + \beta_3 D_k$. The hypothesis of expectations adjustments corresponds to a significantly negative γ^{EA} parameter. Bollerslev-Wooldridge robust standard errors are reported in parentheses. *, ** and *** denote significance at respectively the 10%, 5% and 1% level.

	CPI	Ind. Prod	ISM Man.	ISM Non-Man.	Non Farm Payroll	Retail Sales	IFO (GE)	ZEW (GE)
				Conditional Mean Equation				
α_0	0.1806	0.0276	0.2546	0.2157	-0.3621***	-0.3344**	0.0085	0.0457
	(0.2841)	*(0.0955)*	*(0.1444)*	*(0.1450)*	*(0.1431)*	*(0.1341)*	*(0.0456)*	*(0.0493)*
γ	0.1272***	0.0031	0.0295	0.0305	-0.0415	-0.0503**	-0.0436***	-0.0494*
	(0.0327)	*(0.0170)*	*(0.0172)*	*(0.0182)*	*(0.0244)*	*(0.0234)*	*(0.0164)*	*(0.0259)*
γ^{EA}	-0.4011	0.1052	-0.3541	-0.2284*	-1.1798***	-0.3478	-0.1152	-0.0490
	(0.3623)	*(0.0946)*	*(0.2097)*	*(0.1198)*	*(0.2611)*	*(0.3564)*	*(0.1390)*	*(0.0860)*
α^{MA}	-3552.9254*	-1115.8091***	-5.0865***	-1.9964***	-0.5488***	-1843.4857***	-2.0351***	-0.1901***
	(1939.7674)	*(284.2825)*	*(0.8241)*	*(0.3468)*	*(0.0246)*	*(332.0452)*	*(0.2886)*	*(0.0337)*
				Conditional Volatility Equation				
β_0	20.7506***	8.0850***	17.1444***	12.0408**	9.2602***	11.3334***	2.5539***	0.0722
	(7.3170)	*(1.4043)*	*(2.4976)*	*(5.9964)*	*(1.3945)*	*(1.0758)*	*(0.2639)*	*(0.0429)*
β_1	-0.0234	0.0535	-0.0066**	-0.0138	-0.0132***	0.0073	0.0877**	0.0094
	(0.0264)	*(0.0452)*	*(0.0028)*	*(0.0099)*	*(0.0001)*	*(0.0083)*	*(0.0373)*	*(0.0055)*
β_2	0.5665***	0.1528	-0.0585	0.2399	0.1566**	-0.0342**	-0.0963	0.9603***
	(0.1854)	*(0.1219)*	*(0.0663)*	*(0.3445)*	*(0.0781)*	*(0.0143)*	*(0.0634)*	*(0.0135)*
β_3	4.7611	23.9480***	0.8051**	13.7698**	258.2338*	154.8171***	5.9851***	0.0322
	(59.1599)	*(7.7169)*	*(0.3486)*	*(6.4911)*	*(136.6992)*	*(30.9845)*	*(2.1288)*	*(0.4194)*
R^2	0.0302	0.0480	0.2529	0.1413	0.6858	0.1878	0.0896	0.0535
No. observations	614	1216	768	769	614	615	1167	1092
No. announcements	54	55	53	54	54	55	53	57

Table 10: Estimation results for 8 macroeconomic announcements on the US T-note futures contract using 30-minute prior return intervals. The conditional mean is for each announcement estimated as $r_t = a_0 + \gamma_k \tilde{r}_{t-1} + \gamma_k^{EA} D_k \tilde{r}_{t-1} + \alpha_k^{MA}(\zeta_t^k - v_t^k) + u_t$, where r_t is the 5-minute return after release of the announcement, $\tilde{r}_{t-1}$ is the 30-minute return before release and $(\zeta_t^k - v_t^k)$ is the surprise of the announcement. The conditional volatility is specified as a GARCH(1,1) augmented with a dummy indicating whether the announcement was released in this period, i.e. $\sigma_t^2 = \beta_0 + \beta_1 u_{t-1}^2 + \beta_2 \sigma_{t-1}^2 + \beta_3 D_k$. The hypothesis of expectations adjustments corresponds to a significantly negative γ^{EA} parameter. Bollerslev-Wooldridge robust standard errors are reported in parentheses. *, ** and *** denote significance at respectively the 10%, 5% and 1% level.

	CPI	Ind. Prod	ISM Man.	ISM Non-Man.	Non Farm Payroll	Retail Sales	IFO (GE)	ZEW (GE)
				Conditional Mean Equation				
α_0	0.0170	-0.0325	0.2375**	0.1836	0.0001	-0.0583	-0.0570	0.0875
	(0.0873)	*(0.0730)*	*(0.1135)*	*(0.1124)*	*(0.0868)*	*(0.0464)*	*(0.0634)*	*(0.0733)*
γ	-0.0092	-0.0051	0.0172	0.0247*	-0.0113	-0.0094	0.0071	-0.0216
	(0.0156)	*(0.0092)*	*(0.0134)*	*(0.0134)*	*(0.0158)*	*(0.0153)*	*(0.0107)*	*(0.0152)*
γ^{EA}	0.2963	0.0102	-0.1454	-0.1187	-0.8921***	-0.0104	-0.4900**	-0.0773
	(0.2826)	*(0.0572)*	*(0.1873)*	*(0.1006)*	*(0.2883)*	*(0.2152)*	*(0.2127)*	*(0.1000)*
α^{MA}	-1203.3502	-718.6012***	-2.8371***	-1.1484***	-0.2709***	-921.9227***	-5.8502***	-0.6106***
	(915.1262)	*(210.4553)*	*(0.4360)*	*(0.1826)*	*(0.0261)*	*(165.2997)*	*(0.8732)*	*(0.0723)*
				Conditional Volatility Equation				
β_0	4.8235***	3.4244	10.1843***	4.8292**	4.8282***	7.8179***	4.5898***	6.0343***
	(0.3998)	*(2.0813)*	*(1.3554)*	*(2.0588)*	*(0.3819)*	*(0.2277)*	*(0.3470)*	*(2.2842)*
β_1	-0.0066	-0.0108	-0.0174**	0.0366	0.0015	-0.0258	0.0124	0.0112
	(0.0041)	*(0.0084)*	*(0.0073)*	*(0.0330)*	*(0.0034)*	*(0.0338)*	*(0.0140)*	*(0.0197)*
β_2	-0.0068	0.4465	-0.0459	0.4482**	-0.0086**	0.5275***	-0.0116	-0.0591
	(0.0134)	*(0.3322)*	*(0.1017)*	*(0.2023)*	*(0.0042)*	*(0.0171)*	*(0.0236)*	*(0.2802)*
β_3	83.1122***	10.3158***	24.7031***	3.4658	224.7196***	1.3283	41.4355***	6.8850**
	(13.7385)	*(3.0985)*	*(8.4007)*	*(2.8990)*	*(40.7916)*	*(12.3403)*	*(11.4483)*	*(2.8560)*
R^2	0.0519	0.0313	0.1610	0.1036	0.6330	0.1279	0.2404	0.1763
No. observations	642	1214	770	773	641	643	1188	1113
No. announcements	54	55	51	54	53	55	56	57

Table 11: Estimation results for 8 macroeconomic announcements on the German Bunds futures contract using 60-minute prior return intervals. The conditional mean is for each announcement estimated as $r_t = a_0 + \gamma_k \tilde{r}_{t-1} + \gamma_k^{EA} D_k \tilde{r}_{t-1} + \alpha_k^{MA}(\zeta_t^k - v_t^k) + u_t$, where r_t is the 5-minute return after release of the announcement, $\tilde{r}_{t-1}$ is the 60-minute return before release and $(\zeta_t^k - v_t^k)$ is the surprise of the announcement. The conditional volatility is specified as a GARCH(1,1) augmented with a dummy indicating whether the announcement was released in this period, i.e. $\sigma_t^2 = \beta_0 + \beta_1 u_{t-1}^2 + \beta_2 \sigma_{t-1}^2 + \beta_3 D_k$. The hypothesis of expectations adjustments corresponds to a significantly negative γ^{EA} parameter. Bollerslev-Wooldridge robust standard errors are reported in parentheses. *, ** and *** denote significance at respectively the 10%, 5% and 1% level.

	CPI	Ind. Prod	ISM Man.	ISM Non-Man.	Non Farm Payroll	Retail Sales	IFO (GE)	ZEW (GE)
				Conditional Mean Equation				
α_0	0.0749	0.0282	0.2575	0.2049	-0.3226**	-0.3098**	0.0018	0.0531
	(0.1121)	*(0.0975)*	*(0.1461)*	*(0.1447)*	*(0.1355)*	*(0.1337)*	*(0.0462)*	*(0.0488)*
γ	0.0164	0.0052	0.0260**	0.0217	-0.0181	-0.0165	-0.0165	-0.0187
	(0.0233)	*(0.0078)*	*(0.0123)*	*(0.0124)*	*(0.0238)*	*(0.0223)*	*(0.0114)*	*(0.0172)*
γ^{EA}	0.1158	0.0431	-0.1406	-0.2136	-1.0858***	-0.4403	-0.0475	-0.0273
	(0.2070)	*(0.0490)*	*(0.1900)*	*(0.1189)*	*(0.3897)*	*(0.2952)*	*(0.0742)*	*(0.0569)*
α^{MA}	-3124.0697**	-1133.0538***	-4.8608***	-1.9536***	-0.5553***	-1854.5930***	-2.0104***	-0.1960***
	(1477.3606)	*(299.1121)*	*(0.8357)*	*(0.3213)*	*(0.0511)*	*(339.1457)*	*(0.3025)*	*(0.0353)*
				Conditional Volatility Equation				
β_0	23.6530**	8.6676***	18.9217***	11.5987**	11.0437***	11.3282***	2.6221***	0.0818
	(9.6827)	*(1.4193)*	*(3.0988)*	*(5.3726)*	*(0.9693)*	*(1.0593)*	*(0.2768)*	*(0.0458)*
β_1	-0.0381***	0.0484	-0.0066**	-0.0161*	-0.0008	0.0141*	0.0672*	0.0106
	(0.0054)	*(0.0450)*	*(0.0027)*	*(0.0081)*	*(0.0009)*	*(0.0076)*	*(0.0340)*	*(0.0063)*
β_2	0.4107	0.1204	-0.0987	0.2712	-0.0025	-0.0366***	-0.0978	0.9542***
	(0.2445)	*(0.1169)*	*(0.1120)*	*(0.3085)*	*(0.0040)*	*(0.0132)*	*(0.0674)*	*(0.0148)*
β_3	55.2943	24.6217***	0.0538	11.9820	756.7569***	158.9628***	6.0422***	0.0947
	(37.9495)	*(7.5684)*	*(0.0371)*	*(6.8526)*	*(135.8532)*	*(31.6633)*	*(2.2000)*	*(0.4185)*
R^2	0.0310	0.0468	0.2451	0.1402	0.6691	0.1739	0.0830	0.0492
No. observations	614	1191	768	769	614	615	1167	1092
No. announcements	54	55	53	54	54	55	53	57

Table 12: Estimation results for 8 macroeconomic announcements on the US T-note futures contract using 60-minute prior return intervals. The conditional mean is for each announcement estimated as $r_t = a_0+\gamma_k\tilde{r}_{t-1}+\gamma_k^{EA}D_k\tilde{r}_{t-1}+\alpha_k^{MA}(\zeta_t^k-v_t^k)+u_t$, where r_t is the 5-minute return after release of the announcement, $\tilde{r}_{t-1}$ is the 60-minute return before release and $(\zeta_t^k - v_t^k)$ is the surprise of the announcement. The conditional volatility is specified as a GARCH(1,1) augmented with a dummy indicating whether the announcement was released in this period, i.e. $\sigma_t^2 = \beta_0 + \beta_1 u_{t-1}^2 + \beta_2\sigma_{t-1}^2 + \beta_3 D_k$. The hypothesis of expectations adjustments corresponds to a significantly negative γ^{EA} parameter. Bollerslev-Wooldridge robust standard errors are reported in parentheses. *, ** and *** denote significance at respectively the 10%, 5% and 1% level.