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Low Frequency Effects of Macroeconomic News on Government Bond Yields

Carlo Altavilla, Domenico Giannone, and Michele Modugno

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Abstract

In this study, we analyze the reaction of the U.S. Treasury bond market to innovations in macroeconomic fundamentals. We identify these innovations based on macroeconomic news, which are defined as differences between the actual releases and market expectations. We find that that macroeconomic news explain about one-third of the low frequency (quarterly) fluctuations in long-term bond yields. When we focus on the high frequency (daily) movements, this decrease to one-tenth. This is because macroeconomic news have a persistent effect on bond yields, whereas non-fundamental factors have substantial effects on the day-to-day movements of bond yields, although their effects are shorter lived.

Keywords: macroeconomic announcement, news, treasury bond yield

JEL classification: E43; E44; E47; G14.

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[a]European Central Bank, email: carlo.altavilla@ecb.int

[b]LUISS University of Rome, ECARES, EIEF and CEPR, email: dgiannon@ulb.ac.be

[c]Federal Reserve Board, email: michele.modugno@frb.gov

1 Introduction

We analyze the reaction of the U.S. Treasury bond market to innovations in macroeconomic fundamentals. We identify innovations in macroeconomic fundamentals based on macroeconomic news, which we define as the differences between the actual macroeconomic releases and the median market predictions by participants for those releases. Our analysis is based on the regression of the daily changes in bond yields on macroeconomic news, in the same manner as event studies. The fit of the regression and the corresponding residuals are defined as the fundamental and non-fundamental components of bond yield changes, respectively.

Identifying innovations in macroeconomic fundamentals based on macroeconomic news is a natural strategy. In most industrialized countries, various macroeconomic indicators are released by national statistical agencies and specialized private firms almost every calendar day. Policy makers, media commentators, and market participants monitor the real-time data flow constantly and somewhat obsessively. The market participants also make a prediction for almost every macroeconomic release and whenever they are surprised asset prices tend to move.

Focusing on high frequency changes can facilitate the correct identification of the causal effects of macroeconomic news by reducing the effects of confounding factors and by limiting reverse causality issues (see Gurkaynak and Wright, 2013; Kuttner, 2001; and Cochrane and Piazzesi, 2002). In agreement with previous studies, we find that several types of macroeconomic news are economically important and they have statistically significant impacts on daily changes in bond yields. However, their explanatory power is quite limited, i.e., the R^2 value of the regression is about 10% only. Thus, we develop a method to isolate the low frequency effects of macroeconomic news while preserving the information provided by the high frequency reaction of asset prices to the release of macroeconomic information in real-time. By summing the fit of the daily regressions over a month (quarter), we obtain the fit for the monthly (quarterly) changes in bond yields. The fundamental component become more important when focusing on these low-frequency changes; indeed, moving from daily to quarterly increases the R^2 value to over 30%. This is because macroeconomic news has a persistent effect on bond yields, whereas the effect of non-fundamental factors is less persistent and it tends to average out when focusing on longer horizon changes. In other words, the importance of macroeconomic factors might be hidden by the high frequency noise that dominates the daily fluctuations in bond yields.

Interestingly, the interaction between macroeconomic news and yields did not break apart after the zero lower bound became binding at the end of 2008. In agreement with Swansson and Williams (2014), we find that the high frequency effects remained stable. More interestingly, we show that macroeconomic news continued to exert an important influence at a low frequency on changes in bond yields. This evidence corroborates the view that the non-standard monetary policies adopted by the U.S. Federal Reserve, i.e., a combination of forward guidance and large-scale asset purchases, have been successful in keeping the bond yields anchored to macroeconomic news, thereby limiting non-fundamental fluctuations during a period of high economic uncertainty.

Our results reconcile some contrasting findings obtained in previous studies. As stressed above, event studies indicate that macroeconomic releases account for only a small proportion of the daily variation in bond yields (see Gurkainak, 2014). By contrast, macro-finance models estimated at monthly or quarterly frequencies can explain a significant fraction of the bond yield fluctuations with macroeconomic variables (see Ang and Piazzesi, 2003, Diebold et al., 2006, Coroneo et al., 2013). We rationalize this empirical evidence by identifying the role of the relative persistence of the fundamental and non-fundamental components in influencing bond yield fluctuations over different time spans.

The remainder of the paper is organized as follows. Section 2 describes macroeconomic news and its effects on bond yields at different frequencies. We discuss how our findings affect excess bond returns for investors with different investment horizons. Section 3 demonstrates the effect of macroeconomic news on stock price returns and exchange rates at different frequencies. Section 4 analyzes the impact of macroeconomic news before and during the zero lower bound period. Section 5 concludes this study.

2 Effects of Macroeconomic News on Bond Yields at High and Low Frequencies

The data used in this study came from various sources. We use the zero-coupon yields constructed by Gurkaynak, Sack, and Wright (2007) from 1-

to 10-year horizons.[1] This dataset also includes the parameters estimated for the model of Svensson (1994) to smooth the yield data. In principle, one can retrieve any desired maturity using these parameters. Section 2.3 reports the 3-month holding period excess returns computed using data generated with these parameters for the maturities that were not available in Gurkaynak, Sack, and Wright (2007) plus the 3-month Treasury bill.[2]

In order to simulate the macroeconomic information that is available in real time to market participants, we use the data contained in the Economic Calendars (ECO) provided by Bloomberg. For each macroeconomic release, this dataset contains the realized value and the predictions made by a panel of market participants for the same value. ECO survey forecasts normally start one to two weeks before each release and they are updated in real time until the macroeconomic variable is released officially. The survey value used in the empirical analysis is the median (consensus) forecast. Using both the official releases and the corresponding forecast for each macroeconomic variable allows us to reconstruct the size and direction of all news that hit the market at each point in time.

The first column of Table 1 provides an overview of the macroeconomic variables used in the analysis. The sample period is January 1, 2000 to January 28, 2014. We consider all U.S. macroeconomic news available for the entire sample, with a total of 41 variables. For some of the listed variables, Bloomberg collects more than one release. This is the case for the

[1]This dataset is publicly available on the website of the Federal Reserve Board. The daily data can be obtained at www.federalreserve.gov/pubs/feds/2006/.

[2]These data are publicly available on the website of the Federal Reserve of St Louis at www.research.stlouisfed.org/fred2/.

GDP annualized QoQ and GDP price index, for which we have advanced (A), second (S), and third (T) releases; and for nonfarm productivity, unit labor costs, and the University of Michigan Confidence, for which we have preliminary (P) and final (F) releases. We treat these releases as separate variables. The second column of Table 1 shows the relevance index. The value of this index corresponds to the percentage of Bloomberg users who set an alert for a particular event. For example, over 98% of the users set an alert to be notified before the scheduled release of the change in the nonfarm payrolls variable. This index gives an idea of the releases that are important to market participants. Note that the number of releases observed for each variable depends on its frequency. The third column indicates the frequency of each variable, i.e., whether it is released on a weekly (W), monthly (M), or quarterly (Q) basis. The fourth column reports the publication delay, i.e., the average number of days from the end of the period considered for each variable and the day of release. For example, the change in the nonfarm payrolls data is usually released 4 days after the end of the reference month. A negative entry, such as the University of Michigan Confidence, means that the variable is released before the end of the reference period.

2.1 Empirical analysis based on the daily frequency

First, we analyze the daily reaction of bond yields to macroeconomic news. Thus, we regress the daily change in a bond yield Δy_t^τ at maturity τ on day t on a constant and on the news released on day t, according to Equation (1). If variable i was not released at time t, we set $news_{i,t} = 0$.

$$\Delta y_t^\tau = c + \sum_{i=1}^{n} \beta_i^\tau news_{i,t} + \varepsilon_t^\tau \tag{1}$$

Table 1 shows the regression coefficients (β) based on the regression described in Equation (1) for the bond yields with 1-, 5-, and 10-year maturities.[3] We use boldface to denote coefficients that differ significantly from zero at the 5% confidence level. Three groups of variables are particularly important for explaining the daily changes in yields throughout the whole maturity spectrum: surveys (consumer confidence, ISM manufacturing and non-manufacturing, Philadelphia Fed. economic outlook, and University of Michigan Confidence preliminary), employment-related variables (change in nonfarm payrolls and initial jobless claims), and other macroeconomic variables (e.g., GDP annualized QoQ advanced and advanced retail sales). Surveys are important because of their timeliness, as they are the first types of information available regarding the economic condition in the current month. Jobless claims are released on a weekly basis. Similar to surveys, jobless claims are very timely, which makes them useful to market participants for understanding the labor market conditions. Finally, other variables such as GDP, nonfarm payrolls, and sales are important indicators of the state of the economy and they are monitored closely by the Federal Reserve in order to determine its monetary policy stance. Thus, these indicators are also relevant to market participants. The last row of Table 1 shows the R^2 values for the regression described in Equation (1). Some of the regression parameters

[3]Note that to facilitate the comparison, macroeconomic news were standardized by dividing the difference between the actual and the predicted value of each variable by the corresponding sample standard deviation.

are statistically significant, but macroeconomic news explains only a small fraction of the daily variation in bond yields, i.e., less than 10%.

INSERT TABLE 1 HERE

2.2 Empirical analysis at lower frequencies

Let us define the daily news index $\widehat{\Delta^1 y_t^\tau} = nix_t^{1,\tau}$ as the fitted value from Equation (1). To analyze the persistence of the effects of macroeconomic news on yield changes, we aggregate the yields and news indices over different time spans. Specifically, we aggregate the daily changes in bond yields to obtain longer horizon changes.

$$y_t^\tau - y_{t-h}^\tau := \Delta^h y_t^\tau = \sum_{j=0}^{h-1} \Delta y_{t-j}^\tau \tag{2}$$

Similarly, we sum the daily news indices to obtain longer horizon news indices at daily frequencies, as follows.

$$nix_t^{h,\tau} = \sum_{j=0}^{h-1} nix_{t-j}^{1,\tau} \tag{3}$$

The effect of these aggregations on the yields is to “cleanse” the series of high-frequency fluctuations and to give more weight to fluctuations with frequencies lower than h days.

The following analysis focuses on regression equations:

$$\Delta^h y_t^\tau = \gamma^{h,\tau} nix_t^{h,\tau} + \upsilon_t^{h,\tau}, \tag{4}$$

where $\gamma^{h,\tau}$ measures the impact of the sum of the news on the change in yields over h days and it enforces the orthogonality between the fundamental and non-fundamental components at any horizon.[4] The fitted value of Equation (4), $\widehat{\Delta^h y_t^\tau}$, represents the part of the $h-$days changes in the bond yields attributable to macroeconomic fundamentals. On average there are 22 trading days per month, thus $\Delta^{22} y_t^\tau$ and $\widehat{\Delta^{22} y_t^\tau}$ approximately correspond to the actual and fitted monthly changes in the bond yields at maturity τ, respectively. By contrast, $\Delta^{66} y_t^\tau$ and $\widehat{\Delta^{66} y_t^\tau}$ refer to quarterly changes. The residual, $\Delta^h y_t^\tau - \widehat{\Delta^h y_t^\tau}$, defines the component driven by non-fundamental factors. In the following, we refer to $\widehat{\Delta^h y_t^\tau}$ and $\Delta^h y_t^\tau - \widehat{\Delta^h y_t^\tau}$ as the fundamental and non-fundamental components of the $h-$days changes in the bond yields with maturity τ, respectively.

For simplicity, we define the part of the bond yields that is not explained by macroeconomic news as the non-fundamental part; however, we have to consider that this part includes fundamental innovations that we cannot extract. The types of macroeconomic news considered in this study are only a subsample of the innovations in macroeconomic fundamentals that may affect U.S. Treasury yields. We do not consider surprises related to policy announcements regarding monetary and fiscal policy interventions. Moreover, we only consider U.S. variables, but international factors could also have played important roles. Most importantly, we only control for partial measures of the news because Bloomberg collects the expectations for headline information whereas macroeconomic data releases include numerous disaggregated details. Recently, Gurkaynak (2014) showed that considering

[4]Note that all of these results can be confirmed qualitatively if we do not include γ.

unmeasured news greatly increases the explanatory power of macroeconomic releases that occur at a high frequency.

Figure 1 shows the actual and fitted values for the daily, monthly, and quarterly yield changes ($h = 1, 22, 66$) in government bond yields with $\tau = 1, 5, 10$-year maturities. Figure 2 shows the R^2 values for the regressions.

INSERT FIGURES 1 HERE

INSERT FIGURE 2 HERE

If we consider only the actual values, i.e., the actual changes in bond yields, we can explain the effect of filtering better. Thus, the more we filter, i.e., aggregate the daily changes into monthly and quarterly changes, the more we "cleanse" our series of high frequency noisy fluctuations, thereby highlighting the low frequency fluctuations. In other words, filtering identifies the long-term patterns or low-frequency fluctuations in our variables. If we consider the fitted values obtained from Equation (1), it is evident that the fit is quite poor for the daily changes. However, if we consider the monthly and quarterly changes, the fitted values can capture a larger fraction of the variation in the bond yield changes.

It is useful to introduce a measure of persistence to better understand what drives the observed increase in the R^2 value with the horizon of the changes. According to Cochrane (1988) and Cochrane and Sbordone (1988), the persistency of a series, such as x_t, can be assessed by considering $1/h$ times the variance in the h-period change, i.e., $1/h \ \text{var}(x_t - x_{t-h})$, as a function of h. If all the shocks to x_t tend to be incorporated immediately and permanently, then the series comprises white noise and $1/h$ var$(x_t - x_{t-h})$ is constant with respect to h. However, if the effect of shocks on x_t are partially reversed after some time, the reversion will be reflected in the decline of $1/h$ var$(x_t - x_{t-h})$ from a given horizon onward. By contrast, if it takes time for the shocks to be incorporated, then $1/h$ var$(x_t - x_{t-h})$ will tend to increase.

Since the R^2 for different horizons can be written as

$$R^2(h,\tau) := \frac{1/h \text{ var}\left(\widehat{\Delta^{\mathrm{h}}\mathrm{y}_{\mathrm{t}}^{\tau}}\right)}{1/h \text{ var}\left(\widehat{\Delta^{\mathrm{h}}\mathrm{y}_{\mathrm{t}}^{\tau}}\right) + 1/\mathrm{h} \text{ var}\left(\Delta^{\mathrm{h}}\mathrm{y}_{\mathrm{t}}^{\tau} - \widehat{\Delta^{\mathrm{h}}\mathrm{y}_{\mathrm{t}}^{\tau}}\right)},$$

it follows that the increased importance of macroeconomic news for changes in government bond yields over longer horizons can be explained by the relative persistence of the fundamental and non-fundamental components.

Figure 3 reports $1/h$ times the variance in the bond yields, and their fundamental and non-fundamental components at different maturities, for daily ($h = 1$), monthly ($h = 22$), and quarterly ($h = 66$) changes. It is evident that the change in $1/h$ times the variance in the h-period decreases for the non-fundamental part when moving from daily to monthly and from monthly to quarterly horizons. This decrease is particularly evident with medium and long maturities. By contrast, the change in $1/h$ times the variance in the h-period does not decline for the fundamental components. Therefore, we can conclude that the increase in the R^2 value is attributable to the fact that shocks to the fundamental components tend to be incorporated immediately with long-lasting effects, but less time tends to be needed for shocks to the non-fundamental components to be reverted.

INSERT FIGURE 3 HERE

In summary, these results indicate that after the high frequency fluctuations in yields are filtered out via aggregation, the macroeconomic news component has a strong explanatory power, i.e., up to 25% for the monthly aggregation and 35% for the quarterly aggregation. This is because although the effects of macroeconomic news on yields are persistent, the high-frequency fluctuations due to non-fundamental factors tend to be short-lived, thus they are aggregated and less evident within the course of one month (or quarter). The impact of macroeconomic news tends to be long-lasting, thus these type of news are more suitable for explaining low frequency fluctuations in government bond yields.

These results reconcile the findings of the high frequency event-study literature with the macro-finance literature. Ang and Piazzesi (2003), Diebold et al. (2006), and Coroneo et al., (2013) show that when estimating models at monthly or quarterly frequencies, significant proportions of the bond yield fluctuations are driven by macroeconomic variables that measure real activities and prices. Our findings explain why this correlation exists at low frequencies, i.e., macroeconomic news persistently affects the portfolio strategies of fixed-income market participants.

2.3 Implications for Excess Returns

The low frequency fluctuations in yields are closely related to bond returns for investors with holding periods longer than one day.

To observe this relationship, we define $rx_t^{\tau,k}$ as the k-day holding period excess bond return. We have:

$$rx_{t+k}^{k,\tau} = -(\tau - k)y_{t+k}^{\tau-k} + \tau y_t^{\tau} - y_t^{k}, \tag{5}$$

where $-(\tau - k)y_{t+k}^{\tau-k}$ is the (log) price at which the bond is sold at time $t+k$ for selling a bond with maturity $\tau - k$, $-\tau y_t^{\tau}$ is the (log) price paid at time t when the bond reaches maturity τ, and y_t^k is the interest paid for borrowing money for the period k. Thus, Equation (5) can be rewritten as:

$$rx_{t+k}^{k,\tau} = -(\tau - k)y_t^{\tau-k} - (\tau - k)\sum_{i=1}^{k} \Delta y_{t+i}^{\tau-k} + \tau y_t^{\tau} - y_t^{k}. \tag{6}$$

For $k = 66$, which is equivalent to one quarter, by substituting $\sum_{i=1}^{66} \Delta y_{t+i}$ with the fit obtained from Equation (4), we obtain the fitted k-days holding period excess bond return:

$$\hat{rx}_{t+66}^{66,\tau} = -(\tau - 66)y_t^{\tau-66} - (\tau - 66)\gamma^{q,\tau-66} nix_{t+66}^{q,\tau-66} + \tau y_t^{\tau} - y_t^{66}. \tag{7}$$

In order to compute the k-days holding period excess bond returns with maturities of τ= 12, 24, 36, 48, 60, 72, 84, 96, 108, and 120 months, we need to generate the yields with maturity $\tau - k$. These yields can be generated using the parameters of the model proposed by Svensson (1994), which are included in the dataset of Gürkaynak, Sack, and Wright (2007).

Figure 4 shows the excess returns based on a 3-month holding period for an equally weighted portfolio of bonds with maturities ranging from 1 to 10 years and the implied fitted value obtained from the regression described in Equation (7).[5]

We study the external validity of the model based on a pseudo-out-of-sample exercise. We compute the fitted return using the parameters estimated from the data up to December 15, 2008. The sample split is selected to coincide with the date when the monetary policy reached the Zero Lower Bound.[6] The fitted returns for the remaining part of the sample are computed using these parameters. The out-of-sample fit is shown in Figure 4, where the shaded area highlight the period used for the out-of-sample validation.

Figure 4 shows clearly that the macroeconomic fundamentals perform well in tracking the 3-month holding period excess bond return and they explain 35% of its fluctuations. The in-sample and out-of-sample fits are remarkably similar and almost undistinguishable, thereby indicating that the importance of macroeconomic news in driving bond returns is a robust result and not an artifact due to overfitting or to other spurious effects.

INSERT FIGURES 4 HERE

Empirical research into financial economics has shown that a significant fraction of the variation in excess bond returns is predictable. Fama and Bliss

[5] The return of this portfolio and the relative fit, respectively, are defined as: $\bar{rx}_t^{66} = \frac{1}{10}\sum_{\tau=[12,24,\ldots,120]} rx_t^{\tau,66}$ and $\bar{\hat{rx}}_t^{66} = \frac{1}{10}\sum_{\tau=[12,24,\ldots,120]} \hat{rx}_t^{\tau,66}$.

[6] We return to this issue in Section 4.

(1987) and Campbell and Shiller (1991) showed that excess returns can be predicted based on the forward rate spreads and yield spreads. Cochrane and Piazzesi (2005) found that about one-third of the variation in excess bond returns can be predicted using a linear combination of forward rates. Understanding the reasons and the sources of such predictability are important questions in economics and finance. The decomposition of the bond returns derived above may help to shed some new light on this old debate.

In the following, we show that the predictability of returns is due to non-fundamental fluctuations because the component of bonds returns driven by macroeconomic news is unpredictable. We construct a factor similar to that used by Cochrane and Piazzesi (2005), except it is for a 3-month holding period (we refer to this as the CP factor), and we find that it can only predict the non-fundamental part of the excess bond returns. We construct the CP factor from the available yields with maturities of 12 to 120 months and from the generated yields with maturities of 9, 21, 33, 45, 57, 69, 81, 93, 105, and 117 months. First, we compute the bond log prices:

$$p_t^\tau \equiv -\tau y_t^\tau$$

and then the log forward rate between time $t+\tau-66$ and $t+\tau$ as:

$$fw_t^\tau \equiv p_t^{\tau-66} - p_t^\tau.$$

We collect the intercept, the 3-month Treasury bill, and the forwards in the vector $\boldsymbol{g_t} = [1, y_t^3, fw_t^{12}, fw_t^{24}, ..., fw_t^{120}]'$, and estimate the parameters of the following equation:

$$\bar{rx}_t^{66} = \rho \boldsymbol{g_{t-66}} + \bar{\epsilon}_t,$$

where we define $CP_t = \hat{\rho}\boldsymbol{g_t}$. To understand how much of the excess bond returns can be predicted by the yield curve itself, we perform the following predictive regression:

$$x_t = c + \beta_2 CP_{t-66} + w_t, \tag{8}$$

where x_t is in turn $\bar{rx}_t^{66}$, the observed 66-day holding period excess bond return; $f_t^{66} \equiv -\frac{1}{10}\sum_{\tau=[12,24,\ldots,120]}(\tau - 66)\gamma^{q,\tau-66} nix_{t+66}^{q,\tau-66}$ is the fundamental part of the 66-day holding period excess bond return; and $nf_t^{66} = \bar{rx}_t^{66} - f_t^{66}$ is the non-fundamental part. Table 2 shows the coefficients and the relative R^2 values of these regressions for the three dependent variables.

The results show that the CP factor predicts a large proportion (20%) of the excess bond returns. Unsurprisingly, this proportion is related mainly to the non-macroeconomic news part, nf_t (18%), whereas the CP factor explains almost nothing about the news-related part. This result is not surprising if we consider the nature of the elements we are analyzing, where the forward prices are determined by market participants at time $t - 66$ given the information available at that time. By definition, macroeconomic news comprises surprises for market participants (i.e., innovations to their information set) that occur between time $t - 65$ and t, thus they cannot be predicted by forward rates that are based on the information available to market participants at time $t - 66$.

In summary, the predictable component of bond returns is non-fundamental because shocks to this component generate predictable dynamics, as they tend to be reverted.

INSERT TABLE 2 HERE

3 Macroeconomic News, Stock Prices, and Exchange Rates

The impact of macroeconomic news has been previously studied for other assets/markets. More precisely, several event studies have analyzed the daily and intra-daily fluctuations in stock prices and exchange rates (e.g., see Andersen et al. 2003b and 2007, and Faust et al. 2007). The general finding of these studies indicates that also these assets are sensitive to macroeconomic news. We analyze the impact of macroeconomic news on longer horizon changes in the trade-weighted U.S. dollar index (major currencies) and the $S\&P$ 500 stock price index to assess whether these assets have the same low frequency sensitivity to macroeconomic news as bond yields. We are aware that foreign macroeconomic news can have an important impact, especially on the exchange rate, thus our analysis is incomplete. Nevertheless, U.S. economic fundamentals should play a predominant role in determining these asset prices.

Table 3 shows the coefficients obtained from the regression of the daily returns of these assets on the macroeconomic news, which is equivalent to

Equation (1). The fits of the returns due to macroeconomic news over different horizons are shown in Figure (5)

INSERT TABLE 3 HERE

INSERT FIGURES 5 HERE

For the trade-weighted U.S. dollar index, six types of news have statistically significant impacts: changes in nonfarm payrolls, ISM manufacturing, producer price index (excluding energy and food), unemployment rate, advanced GDP, and the final release of nonfarm productivity. However, macroeconomic news do not have a persistent effect on the exchange rate. As shown in Table 3, the R^2 value for the daily changes, Equation (1), is equal to 2%, and the R^2 values became lower as we filter out more dependent variables, i.e., the monthly and quarterly R^2 values from Equations (4) are equal to zero.

In our analysis of $S\&P$ 500 returns, we find that only four types of macroeconomic news have coefficients that differ significantly from zero: capacity utilization, ISM manufacturing and non-manufacturing, and retail sales. However, in contrast to the exchange rate results, the effect of U.S. macroeconomic news on the $S\&P$ 500 stock price index, similar to bond yields, tends to increase with the horizon, where R^2 value is 2% for daily changes, 5% for monthly changes, and 15% for quarterly changes. Although the increase in the explanatory power of macroeconomic news with a longer horizon is qualitatively similar to that observed for bond yields, the effect of macroeconomic news on $S\&P$ 500 returns is quantitatively much smaller. It is likely that international macroeconomic news is more important for stock returns than for bond yields, but this is a topic for future research.

4 Government Bonds and Macroeconomic News at the Time of the Zero Lower Bound

The normal implementation of monetary policy provides a link between macroeconomic news and Treasury bond yields. In normal times, the central bank reacts to macroeconomic news by changing the short-term policy rate, thereby influencing a broad spectrum of fixed income asset classes. However, this mechanism cannot work at the zero lower bound because the interaction between macroeconomic news and yields may break apart, thus the low frequency effect of macroeconomic news might disappear. Therefore, we analyze whether our results change since the zero lower bound became binding. First, we estimate the regression model described in Equation (1) augmented with a zero lower bound dummies interacting with each type of news:

$$\Delta y_t^\tau = c + \sum_{i=1}^{n} \beta_i^\tau news_{i,t} + \sum_{i=1}^{n} \delta_i^\tau (zlb_t \times news_{i,t}) + \varepsilon_t^\tau, \qquad (9)$$

where zlb_t is an indicator variable that takes a value of 1 when the zero lower bound was binding, i.e., from December 16, 2008 to January 28, 2014, and 0 before, i.e., from January 1, 2000 to December 15, 2008. The coefficient δ_i^τ measures whether the impact of each type of news on the change in bond yields varied after the policy rate reached the zero lower bound.

The estimation results are shown in Table 4 for the maturities at $\tau = 1, 5, 10$ years. The results suggest that although some of these coefficients change quantitatively in the two subsamples, their differences are rarely statistically significant, especially for long maturities. The unchanged responsiveness of bond yields with long maturities at high frequency was recently interpreted by Swanson and Williams (2013) as evidence that unconventional policy actions appear to have helped offset the effects of the zero bound on medium- and longer-term rates. The fact that these effects have remained persistent and sizeable over longer horizons lends additional support to this view.

INSERT TABLE 4 HERE

INSERT FIGURES 6 HERE

Figure 6 shows the R^2 values computed during the pre-zero lower bound period and during the zero lower bound period. The three panels in the figure show the R^2 values for the daily changes, as in Equation (1), and monthly changes and quarterly changes, as in Equation (4). Interestingly, the interaction between macroeconomic news and yields did not break apart. These results provide evidence that the measures adopted by the Federal Reserve at the zero lower bound, i.e., forward guidance and large-scale asset purchases, did not weaken the relationship between macroeconomic news and bond yields at low frequencies. These results also suggest that the introduction of explicit macroeconomic targets in the central bank communication did not influence the sensitivity of sovereign bonds to macroeconomic news.[7] As a consequence, market participants continued to pay attention to macroeconomic news to understand the state of the economy and to anticipate the decisions of the Federal Reserve regarding the future monetary policy stance.[8]

5 Conclusions

Using high frequency data, we found that macroeconomic fundamentals have sizeable low frequency effects on sovereign bond yields. This feature cannot be detected by looking at high frequency fluctuations since the effect of macroeconomic fundamentals is persistent but low in terms of impact whereas the effect of non-fundamental factors is shorter lived but large in terms of impact.

An important implication of our results is that macroeconomic news has a considerable effect on the dynamics of excess bond returns when the holding period extends beyond a single day. Interestingly, this is a specific feature of bond yield returns. The explanatory power of macroeconomic factors for stock and exchange rate returns also remains low at low frequencies.

[7] For example, the FOMC Statement of August 2011 stated that "Committee currently anticipates that economic conditions [....] are likely to warrant exceptionally low levels for the federal funds rate at least through mid-2013." On December 12, 2012 the FOMC indicated that a federal funds rate close to zero would remain appropriate at least as long as the unemployment rate remained above 6.5 % and inflation expectations continued to be well anchored.

[8] These results are robust and they are not due to overfitting. Indeed, we obtained the same fit using the parameters estimated in the pre-zero lower bound period for the zero lower bound period.

Although we considered a large dataset of news, we probably underestimated the importance of macroeconomic fundamentals for bond yields for several reasons. First, fundamental events may have an immediate effect on bond yields, but they cannot be captured immediately by macroeconomic data. Second, Bloomberg does not collect market expectations for all of the released variables. Third, we only considered U.S. macroeconomic news, but innovations in the fundamentals of other countries could also be important for U.S. bond yields. Overall, these considerations suggest that we underestimated the effect of macroeconomic fundamentals on bond yields. Thus, it is highly likely that fundamentals explain more than one-third of the low-frequency fluctuations in bond yields.

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Figures

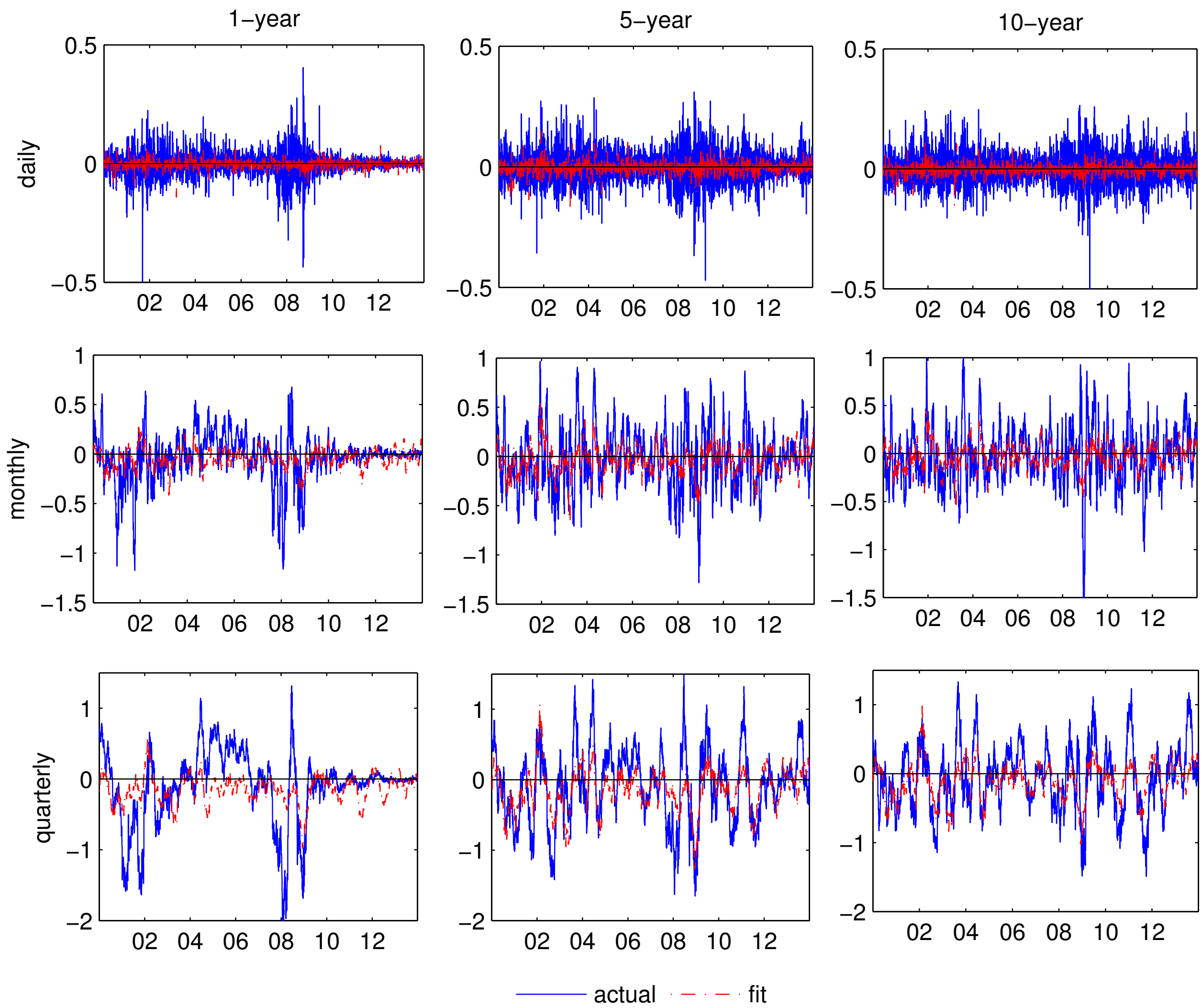

Figure 1: Daily, monthly, and quarterly bond yield changes

Notes: The figure shows the daily, monthly, and quarterly yield changes for 1-, 5- and 10-year maturities, where their fits were obtained using Equations (1) and (4) and estimated for the entire sample from January 1, 2000 to January 28, 2014.

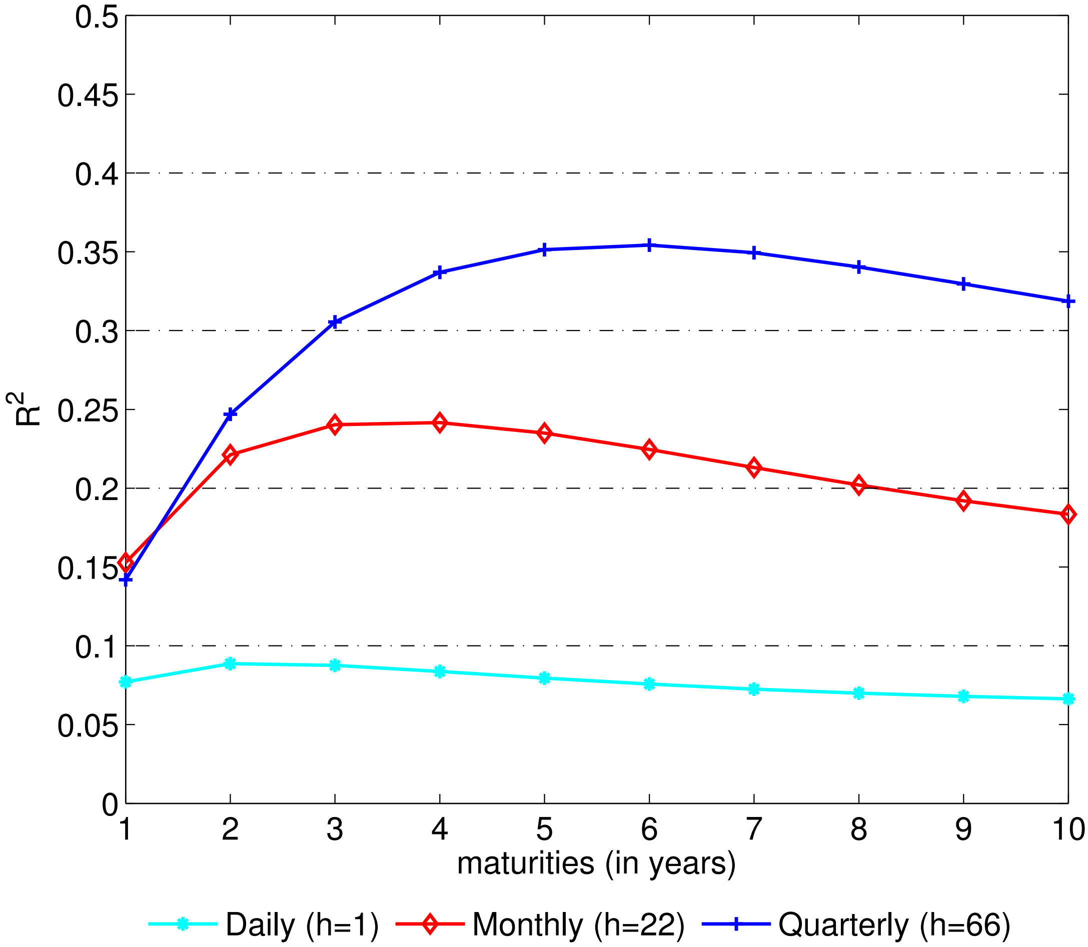

Figure 2: R^2 for the daily, monthly, and quarterly bond yield changes

Notes: The figure shows the R^2 values from the regressions of the daily, monthly, and quarterly changes in yield at different maturities based on the daily, monthly, and quarterly news indexes, as in Equations (1) and (4).

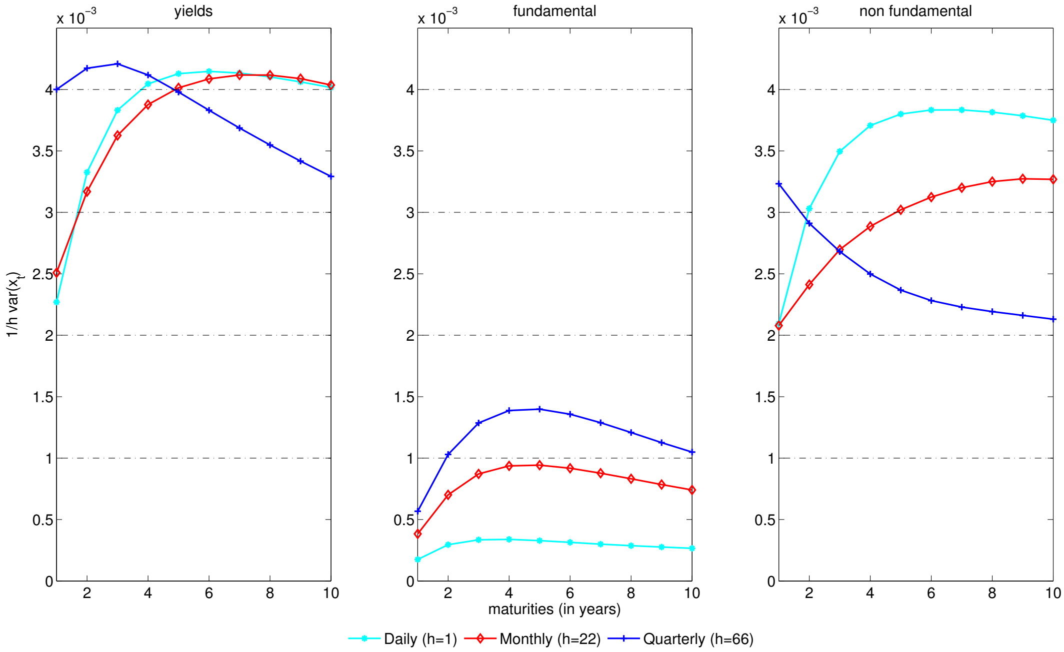

Figure 3: $1/h$ times variance of the h difference in bond yield, the fit, and the residuals.

Notes: The figure shows $1/h \ \text{var}\left(\Delta^{\text{h}}\text{y}_{\text{t}}^{\tau}\right)$ (left panel), $1/h \ \text{var}\left(\widehat{\Delta^{\text{h}}\text{y}_{\text{t}}^{\tau}}\right)$ (middle panel) and $1/h \ \text{var}\left(\Delta^{\text{h}}\text{y}_{\text{t}}^{\tau} - \widehat{\Delta^{\text{h}}\text{y}_{\text{t}}^{\tau}}\right)$ (right panel), multiplied by 100, for different maturities (τ) and different horizons: $h = 1$ (daily), $h = 22$ (monthly), and $h = 66$ (quarterly).

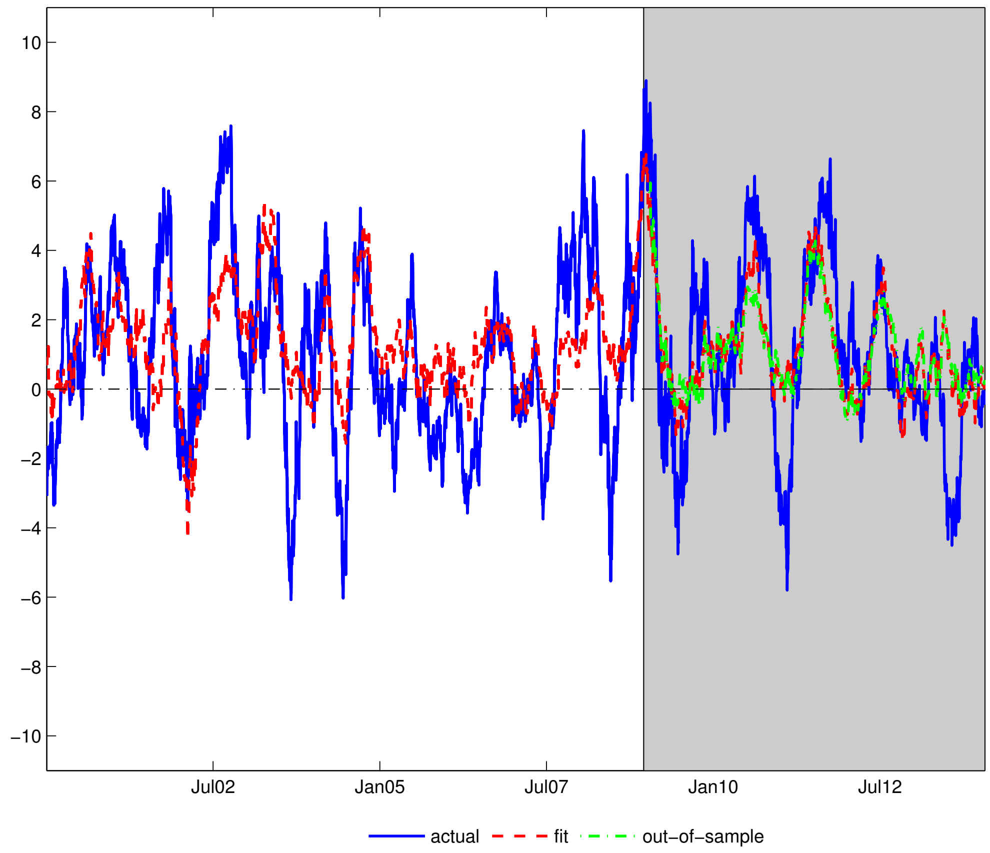

Figure 4: Three-month holding period excess bond returns

Notes: The figure shows the 3-month holding period excess bond returns average across maturities (blue line), the fit obtained with the macroeconomic news (red line) using Equation (7), and the out-of-sample (green line). The shaded area indicates the out-of-sample period.

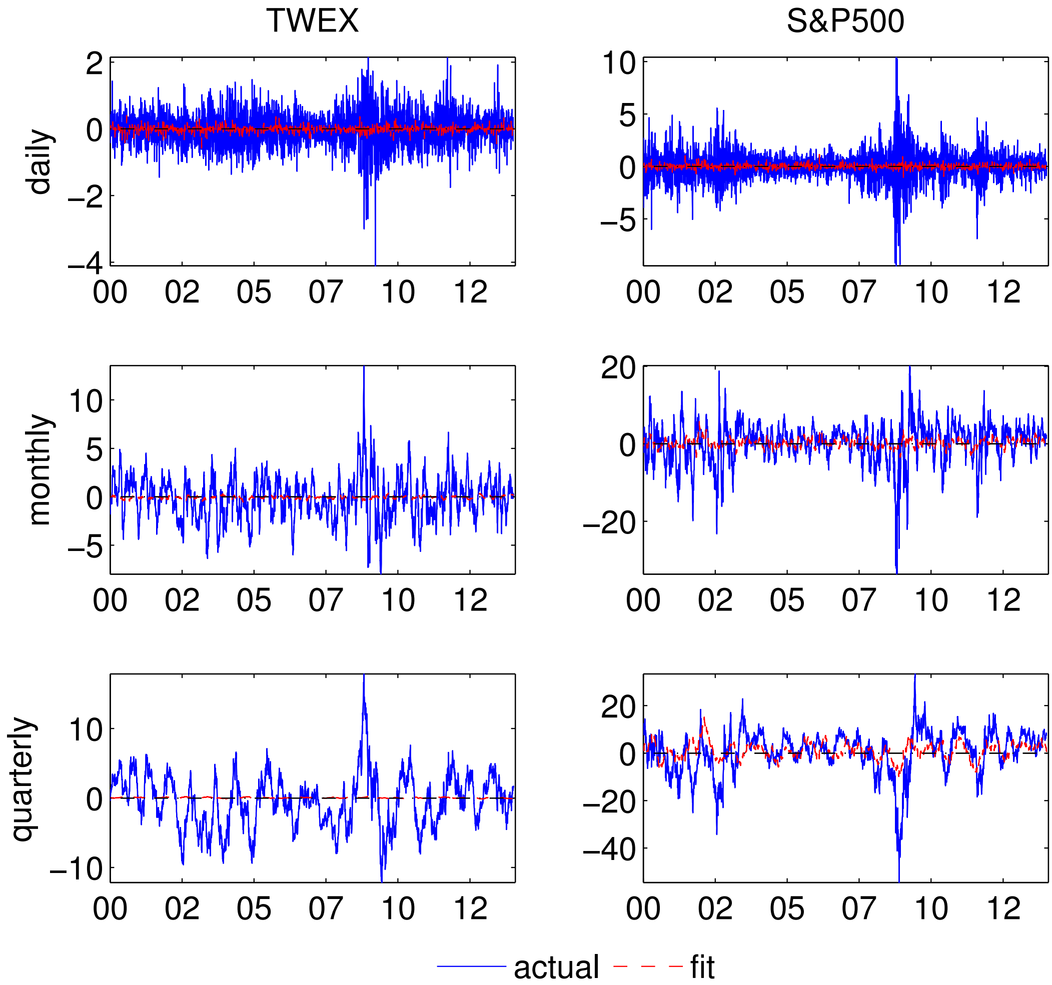

Figure 5: Other assets.

Notes: The figure shows the daily, monthly, and quarterly asset returns for the trade-weighted U.S. dollar index (TWEX) and the $S\&P$ 500, where their fits were obtained using Equations (1) and (4), and estimated based on the entire sample from January 1, 2000 to January 28, 2014.

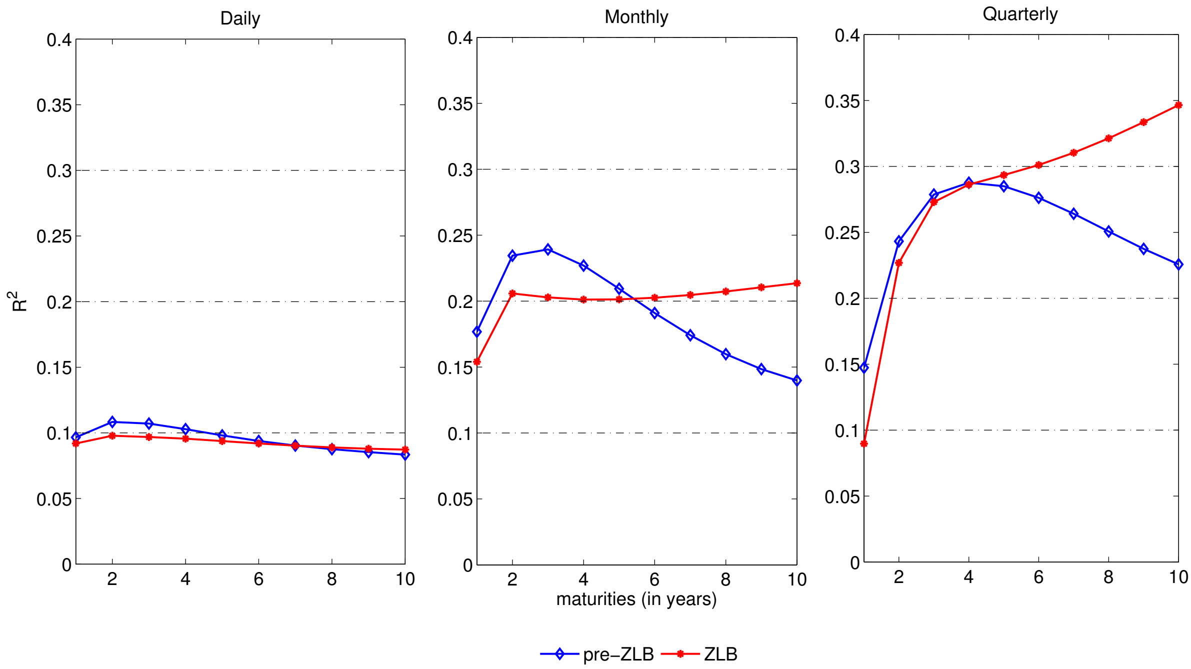

Figure 6: R^2 values for the pre-zero lower bound and zero lower bound.

Notes: The figure shows the R^2 values from the regressions of the daily (left-hand side panel), monthly (center panel), and quarterly (right-hand side panel) changes in yields based on the daily, monthly, and quarterly news indexes from the pre-zero lower bound and zero lower bound subsamples.

Tables

Table 1: Macroeconomic News and their Effects on Bond Yields

Releases	Relevance	Freq	Pub. Delay	1-year	5-year	10-year
Advance Retail Sales	89	M	15	**1.20**	**1.82**	**1.45**
Business Inventories	34	M	45	-0.18	-0.18	-0.03
Capacity Utilization	61	M	16	**1.20**	**1.52**	1.28
Change in Nonfarm Payrolls	98	M	4	**3.44**	**4.43**	**3.59**
Consumer Confidence	95	M	2	**0.87**	**0.96**	**0.94**
Consumer Credit	36	M	38	-0.16	-0.34	-0.38
Consumer Price Index (MoM)	93	M	18	0.36	0.58	0.21
CPI Ex Food & Energy (MoM)	75	M	18	0.48	0.38	0.31
Domestic Vehicle Sales	30	M	3	**0.90**	0.30	-0.06
Durable Goods Orders	91	M	21	0.49	0.78	0.71
Employment Cost Index	71	M	31	0.18	0.36	0.29
Factory Orders	82	M	34	0.17	0.23	0.27
Housing Starts	88	M	19	0.23	0.32	0.03
Import Price Index (MoM)	78	M	11	0.05	0.00	-0.15
Industrial Production	87	M	16	-0.02	-0.26	-0.80
Initial Jobless Claims	99	W	5	**-1.12**	**-1.57**	**-1.42**
ISM Manufacturing	94	M	2	**1.73**	**2.78**	**2.66**
ISM Non-Manf. Composite	70	M	2	**1.67**	**2.19**	**2.01**
Leading Indicators	84	M	24	0.25	0.72	0.91
New Home Sales	90	M	25	0.40	0.59	0.74
Personal Income	83	M	21	-0.37	-0.39	-0.31
Personal Spending	83	M	21	0.31	0.16	0.13
Philadelphia Fed.	75	M	-14	**1.11**	**1.96**	**1.73**
PPI Ex Food & Energy (MoM)	68	M	14	0.27	1.06	1.39
Producer Price Index (MoM)	85	M	14	0.04	-0.26	-0.11
Retail Sales Less Autos	62	M	15	0.71	0.96	1.25
Trade Balance	81	M	41	0.21	0.87	**1.19**
Unemployment Rate	88	M	4	**-0.92**	-0.66	-0.42
Wholesale Inventories	79	M	40	0.10	0.10	0.07
GDP Annualized QoQ A	96	Q	26	**2.46**	**2.68**	**2.28**
GDP Annualized QoQ S	96	Q	59	-0.44	0.05	0.08
GDP Annualized QoQ T	96	Q	80	0.03	-0.91	-1.09
GDP Price Index A	77	Q	26	0.38	0.43	0.21
GDP Price Index S	77	Q	59	0.81	1.87	1.78
GDP Price Index T	77	Q	80	0.43	-1.09	-0.82
Nonfarm Productivity P	35	Q	31	**-1.43**	**-1.95**	-1.78
Nonfarm Productivity F	35	Q	65	-1.00	-0.95	-0.70
Unit Labor Costs P	27	Q	31	0.13	0.48	0.51
Unit Labor Costs F	27	Q	65	-0.10	0.22	0.34
U. of Michigan Confidence P	93	M	-23	**1.00**	**1.65**	**1.42**
U. of Michigan Confidence F	93	M	-9	0.02	-0.13	0.09
R^2						
daily				0.08	0.08	0.07
monthly				0.15	0.23	0.18
quarterly				0.14	0.35	0.32

Notes: The table shows the macroeconomic releases used to compute the news indices. In each case, we show the relevance index, i.e., the percentage of users who set an alert for a particular event, the frequency, the average publication delay expressed in days, and the values of the coefficients estimated from Equation (1) for the yields of bonds with maturities at 1, 5, and 10 years. The values in bold are different significantly from zero at the 5% confidence level (t-stat based on HAC standard errors). The final three rows show the R^2 values obtained from: Equations (1), daily; and Equation (4), monthly ($h = 22$) and quarterly ($h = 66$).

Table 2: Predictive regressions

	$\bar{rx}_t^{66}$	f_t^{66}	nf_t^{66}
const	0	0.41	-0.35
CP	1	0.27	0.74
R^2	20	4	18

Notes: The table shows the coefficients and the R^2 values for equation (8), where x_t is in turn defined as $\bar{rx}_t^{66}$, the 66-day holding period excess bond returns average through different maturities; f_t^{66} is its fundamental obtained from the macroeconomic news; and nf_t^{66} is the residual part.

Table 3: Effects of Macroeconomic News on Stock Prices and the Exchange Rate

Releases	TWEX	S&P 500
Advance Retail Sales	1.6	0.1
Business Inventories	-2.5	0.7
Capacity Utilization	0.0	**24.5**
Change in Nonfarm Payrolls	**13.9**	7.2
Consumer Confidence	3.7	-6.0
Consumer Credit	-1.1	5.3
Consumer Price Index (MoM)	-2.1	1.2
CPI Ex Food & Energy (MoM)	1.9	-14.8
Domestic Vehicle Sales	1.7	8.5
Durable Goods Orders	1.1	9.2
Employment Cost Index	-5.2	-2.8
Factory Orders	4.7	-18.0
Housing Starts	0.5	7.6
Import Price Index (MoM)	3.9	-15.4
Industrial Production	0.7	-27.4
Initial Jobless Claims	1.1	-8.0
ISM Manufacturing	**10.0**	**18.7**
ISM Non-Manf. Composite	-1.5	**21.6**
Leading Indicators	3.2	1.8
New Home Sales	-2.6	-6.2
Personal Income	-2.9	-4.8
Personal Spending	1.8	15.9
Philadelphia Fed.	-1.6	19.8
PPI Ex Food & Energy (MoM)	**-9.5**	-0.9
Producer Price Index (MoM)	3.5	-4.1
Retail Sales Less Autos	5.7	**37.4**
Trade Balance	6.5	18.1
Unemployment Rate	**-8.4**	-0.3
Wholesale Inventories	0.8	-5.3
GDP Annualized QoQ A	**18.9**	-19.1
GDP Annualized QoQ S	10.9	-12.7
GDP Annualized QoQ T	-11.7	-3.5
GDP Price Index A	5.5	7.7
GDP Price Index S	-0.7	6.5
GDP Price Index T	-4.7	-24.3
Nonfarm Productivity P	-11.4	-5.7
Nonfarm Productivity F	**15.0**	-18.8
Unit Labor Costs P	-10.2	-15.5
Unit Labor Costs F	6.7	-8.7
U. of Michigan Confidence P	3.0	-0.7
U. of Michigan Confidence F	-1.4	-9.8
R^2		
daily	0.02	0.02
monthly	0.00	0.05
quarterly	0.00	0.15

Notes: The table shows the macroeconomic releases used to compute the news indices and the coefficients estimated from Equation (1) for the trade-weighted U.S. dollar index (TWEX) and the SP 500 log differences. The values in bold are significantly different from zero at the 5% confidence level (t-stat based on HAC standard errors). The final three rows show the R^2 values obtained from: Equations (1), daily; and Equation (4) , monthly ($h = 22$) and quarterly ($h = 66$)

Table 4: Effects of Macroeconomic News on Bond Yields at the Zero Lower Bound

	1-year		5-year		10-year	
Releases	β	δ	β	δ	β	δ
Advance Retail Sales	**1.35**	-0.65	**1.73**	-0.08	1.11	0.83
Business Inventories	-0.39	0.27	-0.35	0.23	-0.24	0.33
Capacity Utilization	**1.76**	-1.10	**2.13**	-1.15	**2.02**	-1.37
Change in Nonfarm Payrolls	**3.63**	-0.45	**3.87**	**1.20**	**2.84**	**1.60**
Consumer Confidence	**1.34**	-0.78	1.09	-0.28	0.71	0.28
Consumer Credit	-0.02	-0.09	-0.12	-0.17	-0.43	0.20
Consumer Price Index (MoM)	0.32	-0.09	0.12	0.24	-0.26	0.25
CPI Ex Food & Energy (MoM)	0.74	-0.57	1.32	-1.60	1.35	-1.74
Domestic Vehicle Sales	**1.18**	-0.66	0.45	-0.27	-0.14	0.33
Durable Goods Orders	0.66	-0.35	0.78	-0.06	0.67	0.01
Employment Cost Index	0.18	0.06	0.87	-1.05	0.96	-1.32
Factory Orders	0.49	-0.61	0.79	-0.95	0.98	-1.17
Housing Starts	0.28	0.13	0.06	0.96	-0.27	1.04
Import Price Index (MoM)	-0.08	0.14	-0.04	0.01	-0.04	-0.25
Industrial Production	-0.19	0.18	-0.11	-0.53	-0.76	-0.30
Initial Jobless Claims	**-1.60**	**0.75**	**-1.83**	0.40	**-1.50**	0.10
ISM Manufacturing	**2.58**	**-1.43**	**3.60**	**-1.34**	**3.07**	-0.63
ISM Non-Manf. Composite	**1.86**	-0.66	**2.18**	-0.44	**1.94**	-0.33
Leading Indicators	0.22	-0.03	-0.13	1.14	0.24	0.93
New Home Sales	0.45	-0.16	0.62	-0.07	0.79	-0.09
Personal Income	-0.77	0.45	-1.04	0.84	-1.07	1.04
Personal Spending	0.42	-0.31	0.23	-0.17	0.16	0.04
Philadelphia Fed.	**1.91**	**-1.22**	**2.79**	**-1.28**	**2.08**	-0.55
PPI Ex Food & Energy (MoM)	0.23	0.14	0.89	0.52	1.10	0.80
Producer Price Index (MoM)	-0.06	0.23	-0.50	0.58	-0.47	0.76
Retail Sales Less Autos	**1.27**	-0.42	1.19	-0.24	1.27	-0.48
Trade Balance	0.18	0.05	0.85	0.07	1.11	0.13
Unemployment Rate	**-1.81**	**1.38**	**-1.37**	1.04	-0.78	0.55
Wholesale Inventories	0.24	-0.21	-0.09	0.28	-0.23	0.46
GDP Annualized QoQ A	**2.95**	-1.10	**3.64**	-2.16	**3.36**	-2.33
GDP Annualized QoQ S	-0.76	0.48	-1.07	1.55	-1.15	1.66
GDP Annualized QoQ T	0.40	-0.49	-0.92	0.03	-0.68	-0.55
GDP Price Index A	0.11	0.14	0.41	-0.74	0.07	-0.61
GDP Price Index S	0.50	0.35	1.17	0.69	1.01	0.76
GDP Price Index T	0.49	-0.19	-0.49	-1.23	-0.09	-1.43
Nonfarm Productivity P	**-2.37**	1.14	**-3.05**	1.07	**-2.95**	1.06
Nonfarm Productivity F	-1.72	1.54	**-2.68**	**2.93**	-2.16	2.46
Unit Labor Costs P	-0.55	0.80	-1.45	2.48	-1.84	**3.03**
Unit Labor Costs F	0.06	-0.18	-0.69	0.99	-0.81	1.25
U. of Michigan Confidence P	**1.32**	-0.66	**1.47**	0.03	**1.12**	0.21
U. of Michigan Confidence F	0.14	-0.12	0.33	-0.73	0.75	-1.11
R^2						
daily	0.10		0.10		0.09	
monthly	0.19		0.23		0.20	
quarterly	0.19		0.34		0.32	

Notes: The table shows the coefficients estimated from Equation (1) for the yields of bonds with maturities of 1, 5, and 10 years based on the pre-zero lower bound and zero lower bound subsamples, as well as their differences. The values in bold are significantly different from zero at the 5% confidence level (t-stat based on HAC standard errors). The final three rows show the R^2 values computed from the entire sample, which were obtained from: Equations (1), daily; and Equation (4), monthly ($h = 22$) and quarterly ($h = 66$).