The Low Frequency Effects of Macroeconomic News on Government Bond Yields[1]

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Abstract

This study analyzes the reaction of the U.S. Treasury bond market to innovations in macroeconomic fundamentals. We identify these innovations with macroeconomic news, defined as differences between the actual releases and their market expectations. We show that macroeconomic news explain about one-third of the low frequency (quarterly) fluctuations of long-term bond yields. When focusing on the high frequency (daily) movements this share decreases to one-tenth. This result is due to the fact that macro news have a persistent effect on bond yields. Non-fundamental factors, instead, substantially influence the day-to-day movements of bond yields but their effects are shorter-lived.

Keywords: Macroeconomic announcements, news, treasury bond yields

JEL classification: E43; E44; E47; G14.

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We analyze the reaction of the U.S. Treasury bond market to innovations in macroeconomic fundamentals. We identify innovations in macroeconomic fundamentals with macroeconomic news, defined as the differences between the actual macroeconomic releases and the median of the market participant predictions for those releases. Although macroeconomic news explain only a small amount of the daily changes in bond yields, we show that this percentage rises considerably when moving to longer-horizon changes: innovations in macroeconomic fundamentals have a persistent effect on bond yields. These results suggest that, although non fundamental factors substantially influence the day-to-day movements of bond yields, their effects are short-lived. In other words, this paper explores the conjecture that the importance of macroeconomic factors is hidden by high-frequency noise that dominates the high-frequency fluctuations of bond yields.

Our analysis starts with regressions of the daily changes in bond yields on macroeconomic news: macroeconomic news are the fundamental part, while the regression errors are the nonfundamental part. Although we find that several macroeconomic news are economically important, having a statistically significant impact on daily bond yield changes, the R^2 of these regressions is only 8%. Summing over a month (quarter) the elements of these regressions, we obtain on the left-hand side monthly (quarterly) changes in bond yields, while on the right-hand side we obtain the sum of all the news over that month (quarter) weighted by their impact. The R^2s of these "low-frequency regressions" are 25% for the monthly aggregation and 35% for the quarterly aggregation. The non-fundamental factors tend to become less important when moving from daily to quarterly changes: their effect is not persistent and tends to average out when the horizon is longer than one day. On the contrary, the fundamental part becomes more important: macroeconomic news have a persistent effect on the portfolio strategies of fixed-income market participants and, consequently, on bond yields.

Identifying innovations to macroeconomic fundamentals with macroeconomic news is a natural strategy: in most industrialized countries, a range of macroeconomic indicators is released

by national statistical agencies and specialized private firms almost every calendar day. Policy makers, private agents and media commentators constantly and somewhat obsessively assess whether the newly available information has economic value. Real time monitoring of macroeconomic activity allows market participants to update their models and conjectures about the economic outlook when new data is released. For almost every macroeconomic release, market participants also form a prediction: macroeconomic news are defined as the difference between the release and the median of the market participants' predictions. The evidence that bond yields tend to move whenever releases are different from predictions suggests that macroeconomic news are the unpredictable innovations that update the information set of market participants about the state of the economy.

In this study, we consider all U.S. macroeconomic news available from at least January 1, 2000, for a total of 41 variables. We consider such a large dataset of macroeconomic news for two reasons: first, macro variables are imperfectly measured and it is unlikely that they correspond to the precise economic concepts provided by theoretical models. For example, in macro literature several series are used to capture the price concept of theoretical models including the consumer price index, the producer price index and the GDP deflator. Including all of these variables in our analysis allows us to not omit any information about prices.[1] Second, macro variables are released in a non-synchronous manner: the GDP deflator is released at quarterly frequency, usually one month after the reference quarter, and the consumer price index is released, on average, four days later than the producer price index. Including all of them in our analysis allows us to capture the most recent developments on the price side.

Although we are considering a large set of news, we are most likely underestimating the importance of macroeconomic fundamentals for bond yields for several reasons: there are fundamental events that can have an immediate effect on bond yields, but that cannot be

[1] In order to overcome this problem, Ang and Piazzesi (2003) include the first principal component of several price series, as price factor, in an affine term structure model.

immediately captured by macroeconomic data, such as natural disasters or political decisions. In addition, in order to have a sufficiently large sample, we consider macroeconomic news that are available from at least January 2000. Since then, more news of macro variables have become available. Finally, we consider only U.S. macroeconomic news, but macroeconomic news of other countries can reveal innovations in fundamentals that are also important for U.S. bond yields. Therefore, we can argue that we are underestimating the effect of macro fundamentals on bond yields and that most likely fundamentals explain more than the 35% of the bond yields' quarterly fluctuations. For simplicity, here we define nonfundamental the part of the bond yields not explained by macro news; however, we have to keep in mind that within that part there are fundamental innovations that we cannot extract.

Interestingly, when analyzing the robustness of our findings over different subsamples, we find that the interaction between macro news and yields did not break apart after the zero lower bound (ZLB) became binding at the end of 2008. At daily frequencies we do not find any change for the medium-long maturity bonds like in Swanson and Williams (2013). Our evidence suggests that the non-standard monetary policies adopted by the U.S. Federal Reserve, forward guidance and large-scale asset purchases, have been successful in keeping the bond yields anchored to macro news, thus limiting nonfundamental fluctuation in a period of high economic uncertainty.

The persistency of the effect of macroeconomic news on bond yields reconciles some contrasting findings in previous studies. Gurkaynak and Wright (2013) and Swanson and Williams (2013) document that bond yields react to macroeconomic releases when the releases are different from market participants' predictions, but macro news can account only for a small portion of the daily variation in bond yields. However, several other studies show that, when estimating models at monthly or quarterly frequencies, a significant fraction of the bond yield fluctuations is driven by macroeconomic variables (see Ang and Piazzesi, 2003, Diebold et al., 2006, Coroneo et al., 2013). These apparently contrasting results can be now reconciled:

informative macroeconomic releases cause changes in bond prices. These changes do not dominate the day-to-day movements of bond yields but are nevertheless persistent over at least a quarter and cause a strong correlation between bond yields and macroeconomic variables at monthly and quarterly frequencies.

Apart from being relevant in their own right, monthly and quarterly fluctuations of yields have an additional economic interpretation: excess bond returns with a holding period of a month (quarter) are a linear function of monthly (quarterly) bond yield changes and, therefore, of their fundamental and nonfundamental parts. An important implication of our results is that macroeconomic news considerably influence the dynamics of excess bond returns when the holding period goes beyond a single day.

We also analyze the impact of macroeconomic fundamentals on other assets, in particular on stock prices (S&P 500) returns and the trade-weighted U.S. dollar index (major currencies). For the former, we find that the variance explained by macroeconomic fundamentals is larger for lower frequencies but the increase is not as strong as for bond yields. For the latter, the fraction of variance explained by macroeconomic fundamentals is the same for high and low frequencies.

The rest of the paper is organized as follows: section 1 describes the macroeconomic news and their effects on bond yields at different frequencies. We discuss how our findings affect excess bond returns for investors with different investment horizons. In section 2 shows the effect of macroeconomic news on stock price returns and exchange rates at different frequencies. Section 3 analyzes the impact of the macroeconomic news before and during the ZLB period. Section 4 concludes.

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

In this study we use the zero-coupon yields constructed by Gurkaynak, Sack and Wright (2007) from one- to ten-year horizons.[2] This dataset also includes the estimated parameters of the model of Svensson (1994) used to smooth the yields data. In principle, with these parameters, one can retrieve any desired maturity. In section 1.3, in order to compute the 3-month holding period excess returns we use data generated with these parameters for maturities that are not available in Gurkaynak, Sack and Wright (2007) plus the three-month Treasury bill.[3]

In order to mimic the macroeconomic information 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 prediction formed by a panel of market participants on the same value. ECO survey forecasts normally start one to two weeks before each release and are updated in real time until the macroeconomic variable is officially released. The survey value used in the empirical analysis is the median (consensus) forecast. Having both the official releases and the corresponding forecast for each macroeconomic variable allows us to reconstruct the size and direction of all news that have hit the market at each point in time.

The first column of Table 1 provides an overview of the macroeconomic variables used in this analysis. We use the overall set of variables whose releases are available in Bloomberg, with the corresponding market predictions from at least January 1, 2000. For some of the listed variables, Bloomberg collects more than one release. This is the case for GDP Annualized QoQ and GDP Price Index, for which we have an advanced (A), second (S) and third (T) release,

[2]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/.

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

and for Nonfarm Productivity, Unit Labor Costs and University of Michigan Confidence, for which we have a preliminary (P) and final (F) release. We treat these releases as separate variables. The second column of Table 1 reports the relevance index. The value of this index corresponds to the percentage of Bloomberg users that have set an alert for the particular event. For example, more than 98% of the users have set an alert to be notified before the scheduled release of the Change in Nonfarm Payrolls variable. This index gives us an idea of which releases 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 within which each variable is released with respect to the end of the period to which it refers. For example, the Change in Nonfarm Payrolls data are released 4 days after the end of the reference month. A negative entry, like in the case of University of Michigan Confidence, means that the variable is released before the end of the reference period.

1.1 Empirical analysis at daily frequency

The starting point of our analysis is to study the daily reaction of bond yields to macroeconomic news. For this purpose, we regress the daily change of a bond yield Δy_t^τ at maturity τ in day t on a constant and on the news released in day t, consistent with Equation (1). If variable i is not released at time t, we set $news_{i,t} = 0$. The dataset spans from January 1, 2000 to January 28, 2014.

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

Table 1 reports the values of the estimated βs from the regression described in Equation (1)

for the bond yields with 1-, 5- and 10-year maturities. We use boldface to denote coefficients that are significantly different from zero at the 5% confidence level. There are three groups of variables that are particularly important in explaining the daily changes of yields through 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 macro variables (e.g., GDP Annualized QoQ advanced and Advanced Retail Sales). Surveys are important for their timeliness: they are the first available information regarding the economic situation of the current month. Jobless Claims are released on a weekly basis. Similar to surveys, jobless claims are very timely and are therefore relevant for market participants in order to understand the employment situation. GDP, Nonfarm Payrolls and sales are important indicators of the state of the economy and are among the indicators the Federal Reserve monitors in order to determine its stance on monetary policy. These indicators are therefore also relevant to market participants. The last row of Table 1 shows the R^2s for the regression described in Equation (1). Even though some of the regression parameters are statistically significant, macroeconomic news explain only a small fraction of the daily variation in bond yields, around 8%.

INSERT TABLE 1 HERE

1.2 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). In order to analyze the persistence of the macroeconomic news on the yields' changes, we aggregate both yields and news indices over different time spans. Specifically, we aggregate the daily changes of bond yields in order 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:

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

The effect of these aggregations on the yields is to "clean" the series from high-frequency fluctuations and 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. The fitted value of Equation (4), $\widehat{\Delta^h y_t^\tau}$, represents the part of $h-$days changes of bond yields due to macroeconomic fundamentals. Since on average there are 22 trading days per month, $\Delta^{22} y_t^\tau$ and $\widehat{\Delta^{22} y_t^\tau}$ approximately corresponds to the actual and fitted monthly change of bond yields at maturity τ. $\Delta^{66} y_t^\tau$ and $\widehat{\Delta^{66} y_t^\tau}$ instead refer to quarterly changes. The residual, $\Delta^h y_t^\tau - \widehat{\Delta^h y_t^\tau}$, defines the component driven by nonfundamental factors. In what follows, we will refer to $\widehat{\Delta^h y_t^\tau}$ and $\Delta^h y_t^\tau - \widehat{\Delta^h y_t^\tau}$ as the the fundamental and nonfundamental components of the $h-$days changes of bond yields with maturity τ.

For simplicity, here we define the part of the bond yields not explained by macro news as the nonfundamental part; however, we have to keep in mind that within that part there are fundamental innovations that we cannot extract. The macroeconomic news considered in this paper are only a sub-sample of the innovations in macroeconomic fundamentals that

may affect the U.S. Treasury yields. There are many reasons: 1) Bloomberg does not collect market expectations for all the variables released; 2) we consider only the variables for which Bloomberg collects market predictions from January 2000; 3) we are considering only U.S. variables, whereas international variables could play an important role as well; 4) there are events (like natural disasters or political decisions) that cannot be immediately embedded in macroeconomic releases but that can immediately affect bond markets; and 5) we do not consider the surprises related to the announcements of the standard and non-standard monetary policy interventions.

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

INSERT FIGURES 1 HERE

INSERT FIGURE 2 HERE

Looking only at the actual values, the realized changes in bond yields, we can better explain the effect of filtering. The more we filter, i.e. aggregate daily changes to monthly and quarterly, the more we "clean" our series from high-frequency fluctuations, thus giving more prominence to the low-frequency ones. In other terms, filtering reveals long-run patterns, or low-frequency fluctuations, of our variables. Looking at the fitted values obtained from Equation (1), the fit is quite poor in the case of daily changes. As also reported in Table 1, we can only explain up to 8% of the daily variation. Aggregation to monthly and quarterly measures isolates the lower-frequency variation of yields, which appear to be more closely related to news indices.

Once we remove the high-frequency fluctuations, the fitted values are able to capture a larger fraction of the variation in bond yield changes.

In order to better understand what drives the increase in the R^2 with the horizon, it is useful to introduce a measure of persistence. Following Cochrane (1988) and Cochrane and Sbordone (1988), persistency of a series, say x_t, can be assessed by looking at $1/h$ times the variance of h-period change, i.e. $1/h$ var$(x_t - x_{t-h})$, as a function of h. If all shocks to x_t are immediately and permanently incorporated then the series is a white noise and $1/h$ var$(x_t - x_{t-h})$ is constant with respect to h. If instead the effect of shocks to x_t is partially reversed after some time, the reversion will be reflected in a decline of $1/h$ var$(x_t - x_{t-h})$ from the a given horizon onward. On the other hand, 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 longer horizons changes of government bond yields can be explained by the relative persistence of the fundamental and the nonfundamental components.

Figure 3 reports $1/h$ times the variance of the bond yields, their fundamental and their nonfundamental components, at different maturities, for daily ($h = 1$), monthly ($h = 22$) and quarterly ($h = 66$) changes. It is evident that $1/h$ times the variance of h-period change decreases for the nonfundamental part when moving from daily to monthly and from monthly to quarterly horizons. The decrease is particularly evident for medium and long maturities. On the other hand, $1/h$ times the variance of h-period changes does not decline for the fundamental part. We can therefore conclude that the increase in the R^2 is driven by the

fact that shocks to the fundamental components tend to be immediately incorporated with long-lasting effects while shocks to the nonfundamental components tend to be reverted with time.

INSERT FIGURE 3 HERE

Summing up, the results above indicate that once the high-frequency fluctuation of yields is filtered out through aggregation, macroeconomic news have a strong explanatory power, up to 25% for the monthly aggregation and 35% for the quarterly aggregation. The reason is that while the effect of macroeconomic news on yields is persistent, the high-frequency fluctuations due to non-fundamental factors tend to be short-lived and, as a consequence, they are aggregated out within the month (or quarter). As the impact of macroeconomic news tends to be long-lasting, these news are better suited to explain the low-frequency fluctuations of the 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, a significant fraction of bond yield fluctuations is driven by macroeconomic variables that measure real activity and prices. Our findings explain why this correlation exists at low frequencies: macroeconomic news persistently affect portfolio strategies of fixed-income market participants.

1.3 Implications for Excess Returns

Apart from being relevant in their own right, the low-frequency fluctuations of yields have an additional economic interpretation. There is a straightforward relation between these

components and excess bond returns. To see this relation, define $rx_t^{\tau,k}$ as the k-day holding period excess bond return

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

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 had maturity τ; y_t^k is the interest paid for borrowing money for the k period. In turn, 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 $k = 66$, equivalent to a quarter, 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 τ= 12-, 24-, 36-, 48-, 60-, 72-, 84-, 96-, 108- and 120-month, we need to generate yields with maturity $\tau - k$. These yields can be generated using the parameters of the model proposed by Svensson (1994), included in the dataset of Gürkaynak, Sack and Wright (2007).

Figure 4 shows the average 3-month holding period excess returns across maturities $\bar{rx}_t^{66} = \frac{1}{10}\sum_{\tau=[12,24,...,120]} rx_t^{\tau,66}$. The figure also shows the average fitted values obtained from the regression described in Equation (7), $\bar{\hat{rx}}_t^{66} = \frac{1}{10}\sum_{\tau=[12,24,...,120]} \hat{rx}_t^{\tau,66}$. As we can see, macroeconomic fundamentals track well the 3-month holding period excess bond return, explaining 35% of its fluctuations.

INSERT FIGURES 4 HERE

There is an open debate on the predictability of excess bond returns. Cochrane and Piazzesi (2005) show that the yield curve itself has forecasting power for excess bond returns. However, Ludvigson and Ng (2009) show that macro variables forecast excess bond returns beyond the predictability of the yield curve. Our contribution to this debate is to highlight what can be predicted by the yield curve itself.

In what follows, we show that the predictability of returns is due to non-fundamental fluctuations since the component of bonds returns driven by macroeconomic news is unpredictable. We build a factor similar to that in Cochrane and Piazzesi (2005) but for a 3-month holding period (from now on we refer to it as the CP factor), and show that it can predict only the nonfundamental part of the excess bond returns. We construct the CP factor from the available yields with maturities 12- to 120-month, and from the generated yields with maturities 9-, 21-, 33-, 45-, 57-, 69-, 81-, 93-, 105- and 117-month. We first 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 $t+\tau$ is:

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

We collect an intercept, the three-month Treasury bill and these forwards in 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:

$$\bar{rx}_t^{66} = \rho' * \boldsymbol{g_{t-66}} + \bar{\epsilon}_t,$$

defining $CP_t = \hat{\rho}' * \boldsymbol{g_t}$. In order to understand which part of the excess bond returns can be predicted by the yield curve itself, we run the following predictive regression:

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

where x_t is in turn $r\bar{x}_t^{66}$, the observed 66-day holding period excess bond return, $f_t^{66} \equiv -\frac{1}{10}\sum_{\tau=[12,24,...,120]}(\tau-66)\gamma^{q,\tau-66}nix_{t+66}^{q,\tau-66}$, the fundamental part of the 66-day holding period excess bond return; and $nf_t^{66} = r\bar{x}_t^{66} - f_t^{66}$, the nonfundamental part. Table 2 shows the coefficients and the relative R^2s of these regressions for the three dependent variables. As we can see, the CP factor predicts a large portion (20%) of excess bond returns. Not surprisingly, this portion is mainly relative to the non-macro news related part, nf_t (18%), while the CP factor does not explain almost anything of the news-related part. This result is not surprising if we consider the nature of the elements we are analyzing: forward prices are determined by market participants at time $t-66$ given the information available at that time. Macroeconomic news, by definition, are surprises to market participants (i.e. innovations to their information set) happening between time $t-65$ and t and therefore cannot be predicted by forward rates that are based on the information available to market participants at time $t-66$. Consequently, this result tells us that the predictable part of the 3-month holding period excess bond returns is the nonfundamental and short-lived part.

INSERT TABLE 2 HERE

2 Macroeconomic News, Stock Prices and Exchange Rates

The impact of macroeconomic news has not only been studied for the bond market. Other assets - in particular stock prices and exchange rates (see, among others, Andersen et al. 2003b and 2007, and Faust et al. 2007) - have been the objects of event studies. The common finding of these papers is that these assets are sensitive to macroeconomic news as well. In this section, we analyze the impact of macroeconomic news on the longer horizon changes of the trade-weighted U.S. dollar index (major currencies) and the $S\&P$ 500 stock price index, in order 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 and that therefore our analysis is incomplete. Nevertheless, it cannot be argued that U.S. economy fundamentals, among all, should play a predominant role in determining these asset prices.

Table 3 reports the coefficients from the regression of the daily returns of these assets on the macroeconomic news, equivalent to Equation (1). The fit of the returns due to macroeconomics at different horizons is reported in Figure (5)

INSERT TABLE 3 HERE

INSERT FIGURES 5 HERE

For the trade-weighted U.S. dollar index, six news have a statistically significant impact: change 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 displayed in Table 3, the R^2 for the daily changes, Equation (1), is equal to 2%, and the more we filter our dependent variable, the lower are the R^2s: the monthly and quarterly R^2s, from Equations (4), are equal to zero.

In our analysis of $S\&P$ 500 returns, we find that there only four macroeconomic news have coefficients statistically different from zero: capacity utilization, ISM manufacturing and non-manufacturing and retail sales. However, contrary to the results for the exchange rate, the effect of the U.S. macroeconomic news on the $S\&P$ 500 stock price index, like for bond yields, tend to increase with the horizon: the R^2 is equal to 2% for daily changes, 5% for monthly changes and 15% for quarterly changes. Even if the increase of the explanatory power of macroeconomic news for longer horizon is qualitatively similar to the one observed for bond yields, the effect of the macroeconomic news on $S\&P$ 500 returns is quantitatively smaller. It is likely that international macroeconomic news are more important for stock returns than for bond yields, but this is a topic for future research.

3 Government Bonds and Macroeconomic News at the Times of the Zero Lower Bound

The normal conduct of monetary policy provides a link between macro news and Treasury bond yields: the central bank reacts to macro news by changing the Federal Funds Rate and consequently all bond yields are affected. At the zero lower bound this mechanism would not work: the interaction between macro news and yields could break apart, and therefore low frequency effect of the macroeconomic news could disappear. In this section we want to understand the consequences of the ZLB on our finding. We start estimating Equation (1)

augmented by interacting each news with a ZLB dummy:

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

where zlb_t is a an indicator variable taking value 1 when the ZLB has been binding (from December 16, 2008 to January 28, 2014), and 0 before (from January 1, 2000 to December 15, 2008). The coefficient δ_i^τ measures how the impact of each news to the change in bond yields have changed when the policy rate reached the ZLB.

Estimation results are reported in table 4 for the maturities $\tau = 1, 5, 10$ years . It is evident, that if some of these coefficients are quantitatively changed over the two subsamples, their differences are rarely statistically significant, especially for long maturities. The unchanged responsiveness of bond yields at long maturities has been recently interpreted by Swanson and Williams (2013) as evidence that unconventional policy actions seem to have helped offset the effects of the zero bound on medium- and longer-term rates. However, the relevance of this finding is limited since macroeconomic news explain less than 10% of bond yields fluctuations in both samples.

INSERT TABLE 4 HERE

INSERT FIGURES 6 HERE

Figure 6 shows the R^2s computed during the pre-ZLB period and during the ZLB period. The three panels in the figure report R^2s for daily changes, as in Equation (1); monthly changes and quarterly changes, as in Equation (4). Interestingly, the interaction between macro news

and yields did not break apart. These results provide evidence that the measures adopted by the Federal Reserve at the ZLB, forward guidance and large-scale asset purchases, did not weaken the relation between macro news and bond yields at low frequencies. This is not surprising since monetary policy authorities have made explicit a clear macroeconomic target in their communication.[4] As a consequence market participants have continued to pay attention to macro news in order to understand the state of the economy in general and to eventually anticipate decisions of the Federal Reserve about the future conduct of monetary policy.[5]

4 Conclusions

In this study, we have analyzed the reaction of the U.S. Treasury bond market to innovation to macroeconomic fundamentals, identified as the surprise component of macroeconomic releases. We show that macroeconomic fundamentals explain about 35% of the quarterly fluctuations in long-term bond yields. At the daily frequency, however, the economic impact of these these surprise components - although statistically significant - is explaining only about 10% of the fluctuations in bond yields. This result shows that macroeconomic news have a persistent effect on bond yields that does not disappear immediately after the announcement. Interestingly, macroeconomic news continue to have a persistent effect on government bond yields even at the zero lower bound. Our evidence might suggest that the non-standard monetary policies taken by the Federal Reserve have been successful in keeping the bond yields anchored to macro news in a period of high volatility. An important implication of our results is that

[4]For example, the FOMC Statement of August 2011 said 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 zeros would remain appropriate at least as long as the unemployment rate remains above 6-1/2 per cent and inflation expectations continue to be well anchored.

[5]These results are robust and not due to overfitting. Indeed, using the parameters estimated in the pre-ZLB period for the ZLB period we obtain the same fit.

macroeconomic news considerably influences the dynamics of excess bond returns when the holding period goes beyond a single day. We show that the nonfundamental part of the excess bond returns is mean-reverting and short-lived, and therefore predictable with a factor similar to that proposed by Cochrane and Piazzesi (2005). On the contrary, the part of excess bond returns related to the macroeconomic news is unpredictable: forward rates, determined by market participants, cannot predict events that are innovations to the information set of the same market participants. We also show that these results do not pertain to exchange rate returns, while results for stock price returns are qualitatively similar, but quantitatively less important than for bond yields.

Although we are considering a large set of news, we are most likely underestimating the importance of macroeconomic fundamentals for bond yields for several reasons: there are fundamental events that can have an immediate effect on bond yields, but that cannot be immediately captured by macroeconomic data, such as natural disasters or political decisions. Also, in order to have a sufficiently large sample, we consider only macroeconomic news that are available from at least January 2000. Since then, more news of macro variables have become available. Finally, our sample is restricted to only U.S. macroeconomic news, but macroeconomic news of other countries can reveal innovations in fundamentals that are also important for U.S. bond yields. Therefore, we can argue that we are underestimating the effect of macro fundamentals on bond yields and that most likely fundamentals explain more than the 35% of the bond yields' quarterly fluctuations. Including news of other countries and of more recent collection will be material for future research.

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Figures

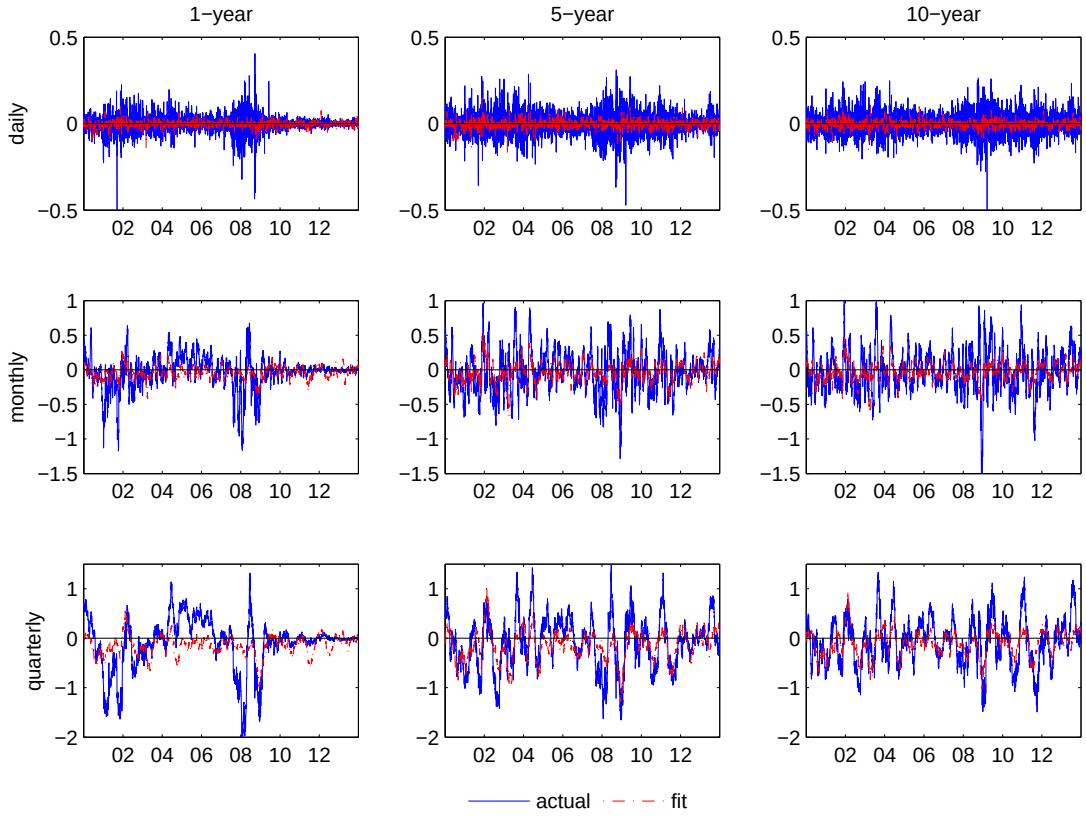

Figure 1: Daily, monthly and quarterly bond yield changes

Notes: The figure reports the daily, monthly and quarterly yield changes for 1-, 5- and 10-year maturities with their fit obtained as in Equations (1) and (4) estimated on the entire sample, from January 1, 2000 to January 28, 2014.

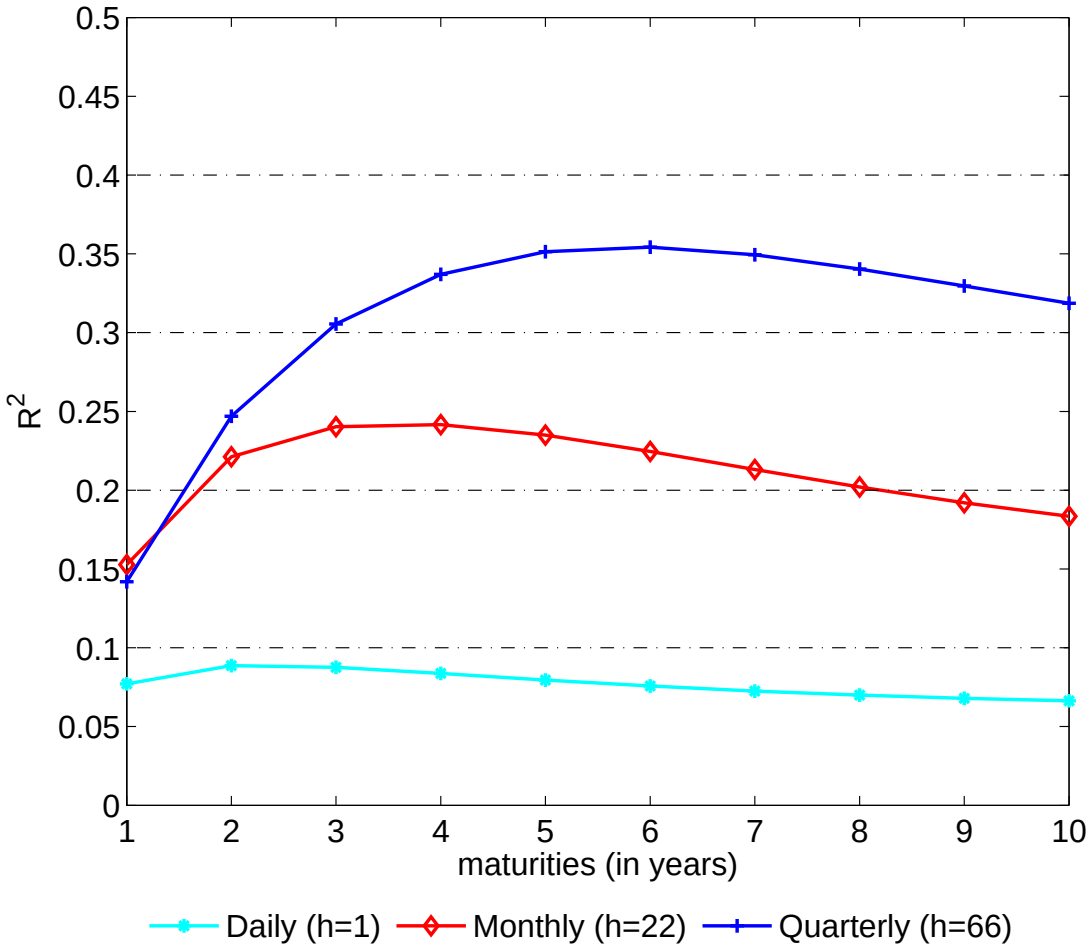

Figure 2: R^2 for the daily, monthly and quarterly bond yields changes

Notes: The figure reports the R^2 from the regression of the daily, monthly and quarterly change of yields at different maturities on the daily, monthly and quarterly news indexes, as in Equations (1) and (4).

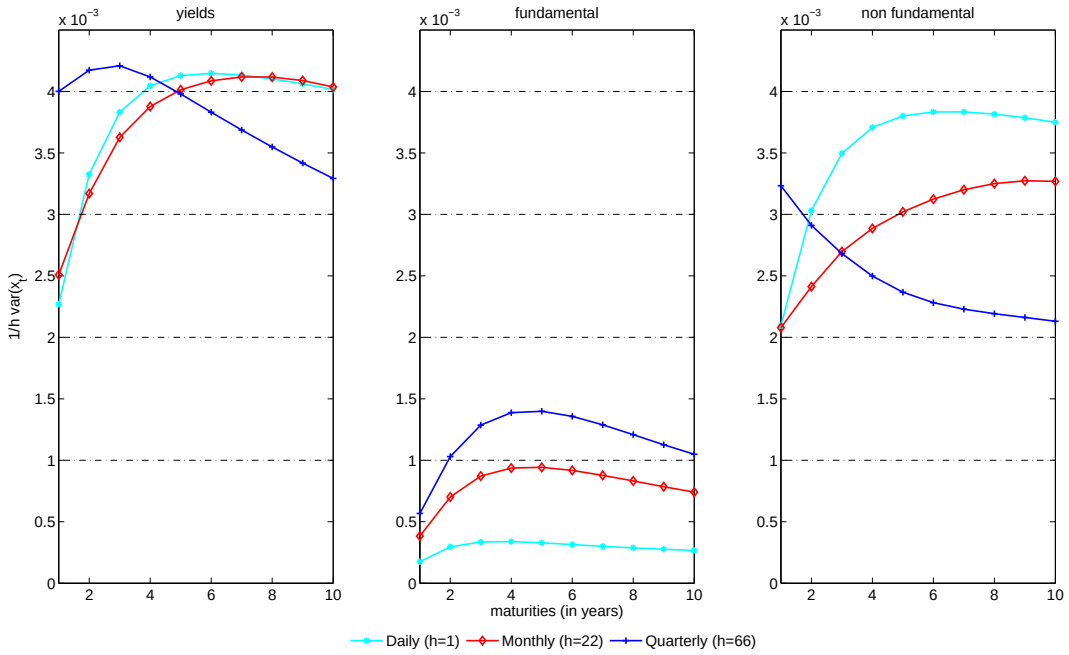

Figure 3: $1/h$ times variance of the h difference of bond yield, its fit and the residuals.

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

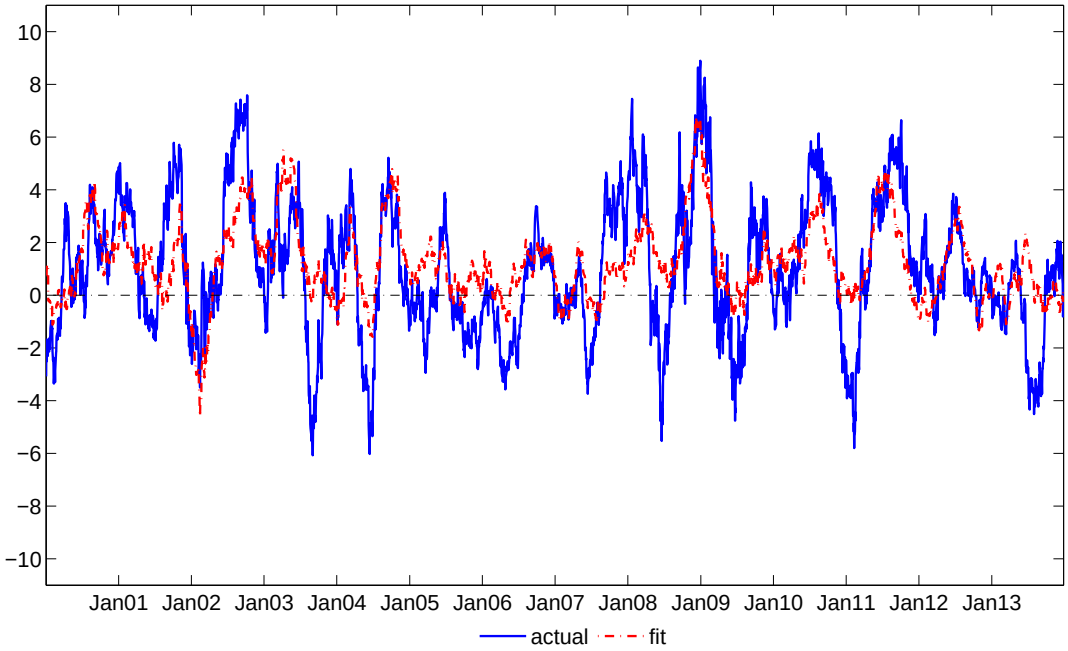

Figure 4: 3-month holding period excess bond returns

Notes: The figure reports the 3-month holding period excess bond returns average across maturities and the fit obtained with the macroeconomic news, through Equation (7).

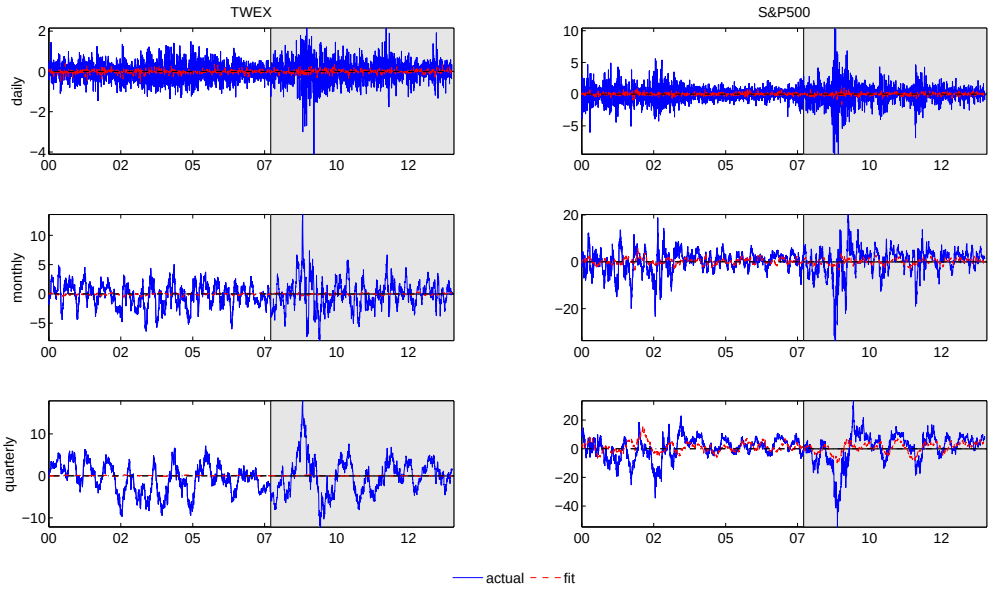

Figure 5: Other assets

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

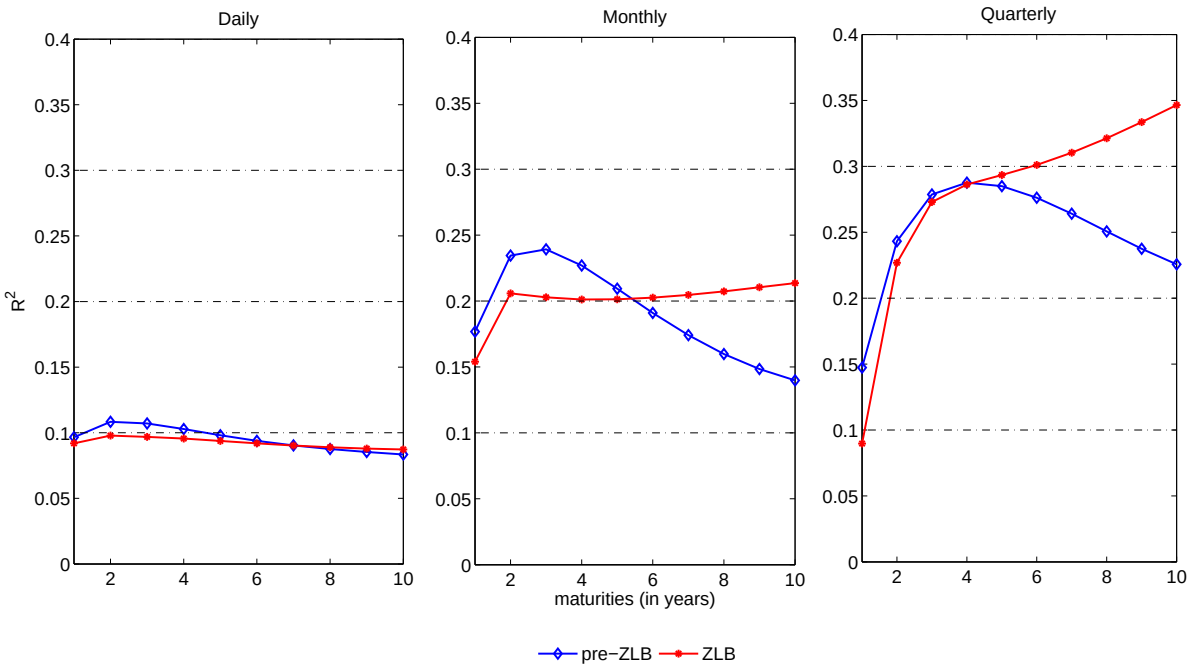

Figure 6: R^2 on the pre-ZLB and ZLB

Notes: The figure reports the R^2 from the regression of the daily (left-hand side panel), monthly (center panel) and quarterly (right-hand side panel) change of yields on the daily, monthly and quarterly news indexes on the pre-ZLB and the ZLB subsamples.

Tables

Table 1: Macroeconomic News and Their Effects of 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 reports the macroeconomic releases for which we compute the news. For each, we report the relevance index, i.e., the percentage of users that have set an alert for the particular event, the frequency, the average publication delay, expressed in days, and the values of the estimated coefficients from Equation (1) for the yields of bonds with maturity 1-, 5- and 10-year. Values in bold are statistically different from zero at a 5% confidence level (t-stat based on HAC standard errors). The last three rows report the R^2 obtained from: Equations (1) , daily; and Equation (4), monthly ($h = 22$) and quarterly ($h = 66$).

Table 2: Predictive regressions

	$r\bar{x}_t^{66}$	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 reports the coefficients and the R^2s for equation (8), when x_t is in turn defined as $r\bar{x}_t^{66}$, the 66-day holding period excess bond returns average through different maturities, f_t^{66}, its fundamental obtained from the macro news, and nf_t^{66}, the residual part.

Table 3: The effects of Macroeconomic News on Stock Prices and 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 reports the macroeconomic releases that we use to compute the news and the estimated coefficients from Equation (1) for the trade-weighted U.S. dollar index (TWEX) and the SP 500 log differences. Values in bold are statistically different from zero at a 5% confidence level (t-stat based on HAC standard errors). The last three rows report the R^2 obtained from: Equations (1) , daily; and Equation (4) , monthly ($h = 22$) and quarterly ($h = 66$)

Table 4: The Effect of Macroeconomic News on Bond Yields at the ZLB

	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 reports estimated coefficients from Equation (1) for the yields of bonds with maturity 1-, 5- and 10-year on the pre-ZLB and ZLB subsamples, with their differences. Values in bold are statistically different from zero at a 5% confidence level (t-stat based on HAC standard errors). The last three rows report the R^2 computed on the entire sample and obtained from: Equations (1) , daily; and Equation (4), monthly ($h = 22$) and quarterly ($h = 66$).