

Realized Bond-Stock Correlation: Macroeconomic Announcement Effects*

Charlotte Christiansen[†]
Aarhus School of Business

Angelo Ranaldo[‡]
Swiss National Bank

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[†]Finance Research Group, Aarhus School of Business, Fuglesangs Alle 4, 8210 Aarhus V, Denmark. Phone: +45 8948 6691. Fax: +45 8948 6660. Email: mail@CharlotteChristiansen.dk.

[‡]Research Department, Swiss National Bank, Switzerland. Email: Angelo.Ranaldo@snb.ch.

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Abstract: We investigate the effects of macroeconomic announcements on the realized correlation between bond and stock returns. We find that it is not so much the surprise component of the announcement, but the mere fact that an announcement occurs that influences the realized bond-stock correlation. The impact of macroeconomic announcements varies across the business cycle. Announcement effects are highly dependent on the sign of the realized bond-stock correlation which has recently gone from positive to negative. Macroeconomic announcement effects on realized bond and stock volatilities are also investigated. Our results are robust across 8:30 and 10:00 announcements.

Keywords: Bond-stock correlation; Macroeconomic announcements; Realized correlation; Realized volatility

JEL Classifications: G12; G13; G14

1 Introduction

How do markets adjust to important news arrivals? How and to what extent are bond and stock markets linked to fundamentals? Do macroeconomic announcement effects vary across assets? Do the price discovery processes in different markets proceed independently or in tandem? Does the current economic business cycle characterize the market's price reactions to macroeconomic news? In this paper, we attempt to shed new light on these important issues.

This paper studies the news impact of US macroeconomic announcements on realized variance and realized correlation of bond and stock returns. While the previous literature focuses on the price and volatility impact of scheduled macroeconomic news, we investigate the effect on the realized correlation between bond and stock returns. The study of comovement across asset classes is relevant for many reasons. First, asset correlation is a key issue in asset allocation decisions. Portfolio optimization hinges on the concept of correlation. Second, correlation is a central issue in risk management and hedging. Third, correlation patterns across business cycles and in response to major macroeconomic announcements provide interesting information that help disentangle the factors that dominate the valuation mechanism of stocks and bonds. The evolution through time and across economic regimes of the sensitivity of asset values to inflation, real interest rates, and other asset-specific factors is informative for monetary policy decision makers and central bankers. Using trade-by-trade data, we analyze more than a decade of realized correlation between US government bonds and stocks. This long sample period allows us to address two essential features of bond-stock comovement: its time-varying nature and its state-dependent character. Furthermore, we investigate the macroeconomic news impact on realized correlation.

The analysis of market comovement of different assets surrounding the announcements illuminates the price discovery process. New information about fundamental asset values triggers the search for a new equilibrium value. This search process gets through the interactions of buyers and sellers as well as the operational characteristics of the marketplace. Market microstructure and trader behavior could determine the efficiency of the process in many aspects. Also, the arrival of important news items could cause a disruption in the price discovery process. Our study delivers insights into the synchronized process of price formation in different markets.

The intimate nature of the correlation between bond and stock returns is not well understood and is mainly confined to some stylized facts. First, bond-stock correlation may change sharply across time and economic conditions. For

instance, after a long period of relatively high positive correlation, the US bond-stock correlation has witnessed a strong negative reversal. Second, in accordance with the “flight-to-quality” pattern, when risk aversion increases, investors adjust their portfolios to include more safe assets and fewer risky assets. As a consequence, government bond prices go up and stock prices fall. In this research, we attempt to extend the understanding of these stylized facts. We provide further evidence on the time-varying comovement between bond and stock returns. By analyzing the state-dependence of the market reaction to macroeconomic news releases, we find that realized correlation strongly depends on general economic and market conditions and that different news items have different impacts. Our findings suggest that the dominating factors in the bond and stock pricing - and thereby in bond-stock comovements - vary across economic and market conditions.

Finally, this research adds to the literature on volatility and correlation measurement. First, we use the recent techniques based on the realized volatility and realized correlation. Second, we exploit the finest information contents provided by high-frequency data and real-time information releases. High-frequency data allow us to study price movements in nearly continuous time. Real-time macroeconomic information releases coupled with synchronized survey data on market participants’ expectations enable us to infer the actual market impact of news surprises. Matching trade-by-trade data with real-time information, we can observe the cross-market movements and interactions.

The discounted-value method suggests that there are roughly two main common drivers for equity and bond values, namely real interest rates and expected inflation. Innovations in the former are supposed to impact on bond and equity values in the same direction. Instead, innovations in inflation expectations should significantly dampen only bond prices. Equity-specific factors such as equity risk premia and dividends should essentially characterize only equity values. Thus, we expect that realized correlation strengthens only in response to news announcements in which the predominant information content is about the real interest rate. However, it is possible that interpretation of news contents varies across market conditions and economic regimes. Good news, say, on unemployment rates could be interpreted as a promising sign of recovery in recessions and a risk of an overheating economy in expansions. Moreover, “good” news is supposed to always represent “bad” news for bonds but not for equities. In recessions, only equities can specifically benefit from good news by improving risk premia and dividends (in nominal terms). So, we conjecture that news bulletins can impact differently across business cycles.

Finally, we examine both announcement and surprise effects. The former only accounts for the release time whereas the latter considers the unexpected component in the news bulletins. We hereafter refer to "announcement" and "news" effects, respectively. This methodological distinction has at least two main advantages. First, the news effect is specific for each news item whereas the announcement analysis allows considering the combined effect due to simultaneous releases. Second, this distinction permits us to perceive the nature of market volatility and correlation. Since the release time is pre-scheduled, uncertainty may only stem from the information content. If assets react to announcement rather than news effects, this suggests that the prominent part of realized volatility is due to "operational" reasons such as pent-up demand and portfolio rebalancing. Instead, if news effects best characterize the news impact, the price adjustment may be perturbed by a price discovery process. These different patterns should ultimately be discernible in realized volatility and correlation responses to news arrivals. Previous research has not investigated the difference between announcement and news effects of macroeconomic announcements.

Our empirical findings are in accordance with the hypotheses outlined above. A novel finding is that the realized bond-stock correlation reacts strongly to announcement effects (the occurrence) but only weakly (although statistically significantly) to news effects (the unexpected part). Another new result is that the effects of macroeconomic announcements on the realized bond-stock correlation vary across the business cycle. In expansions (recessions) news announcements typically increase (decrease) realized correlation. Finally, we are the first to document that the reaction to macroeconomic announcements depends upon the sign of the lagged realized bond-stock correlation. Our research also contributes to the analysis of realized volatility. The realized bond and stock volatility also reacts more strongly to announcement effects than to news effects which is not known previously. The reactions of the realized volatilities to macroeconomic announcements and news vary across the business cycle which is in accordance with previous findings. Our empirical findings are robust across 8:30 and 10:00 announcements, although these announcements occur at different times of the trading day and in different market structures (only floor data for 10:00 and mixed floor and electronic data for 8:30).

The paper proceeds as follows: The related literature is surveyed in the following section. The data are introduced in Section 3. The empirical results are divided into two parts; in Section 4 we cover the macroeconomic announcement effects on bond realized variance and stock realized variance. The

macroeconomic announcement effects on the realized bond-stock correlations are discussed in Section 5. Finally, Section 6 concludes.

2 Related Literature

In this section we describe the related literature. First we discuss the literature on macroeconomic announcement effects and then we briefly touch upon the realized variance literature. Finally, we survey the literature on the relation between bond and stock returns.

2.1 Macroeconomic Announcement Effects

The previous literature investigates the effect of macroeconomic announcements on the first and second moments of asset returns. Some papers rely on dummy variables to distinguish between announcement days and non-announcement days, whereas other papers use the unexpected part (surprise) of macroeconomic announcements as explanatory variables. In our empirical work (yet to be presented) we use both approaches; we denote them "announcement" effect (announcement occurrence) and "news" effect (announcement surprise) analysis, respectively.

Overall, the previous research shows that macroeconomic announcement effects are significant for asset returns. Fleming and Remolona (1997) document that over a year the largest intradaily price changes in the 5-year Treasury note stem from the occurrence of macroeconomic announcements. Balduzzi, Elton and Green (2001) use inter daily data and show that the price of the 10-year Treasury note reacts significantly to the surprise components of macroeconomic announcements. Ederington and Lee (1993) apply daily data and find that the futures prices of Treasury bonds react significantly to the occurrence of macroeconomic announcements. Flannery and Protopapadakis (2002) find that stock market returns are also significantly affected by the surprise components of macroeconomic announcements.

Some previous papers study the effect of macroeconomic announcements on the conditional volatility of asset returns, typically using the GARCH-volatility relying on daily data and indicator variables as explanatory variables. Jones, Lamont and Lumsdaine (1998) apply GARCH models to investigate government bond returns of varying maturity and find that the observed persistence in conditional volatility is not caused by macroeconomic releases. Christiansen (2000) uses a multivariate GARCH model to document that macroeconomic announcements induce common movement in the government bond market. Flannery and

Protopapadakis (2002) show that the GARCH variance of stock returns is also affected by macroeconomic announcement surprises. Arshanapalli, Switzer and Vezina (2003) use a bivariate GARCH model to analyze bond and stock returns. The GARCH conditional covariance is regressed on various explanatory variables including announcement day indicators. The bond-stock GARCH conditional covariance is not significantly influenced by macroeconomic announcement effects. In contrast, we find that the realized bond-stock correlation is significantly influenced by macroeconomic announcements and surprises.

Faust, Rogers, Wang and Wright (2003) and Andersen, Bollerslev, Diebold and Vega (2004b) are closely related to our paper. Faust et al. (2003) show that announcement surprises affect the returns of several exchange rates and interest rates in a window around the announcements. Their data cover a fairly long period, from 1987 to 2002. Andersen et al. (2004b) conduct similar analyses using several futures contracts for a shorter period, from 1994 to 2002. They investigate the effects of business cycles, although their data include only one fairly short recession period. In this paper we conduct similar regressions, but we use realized variances and realized correlations for windows surrounding macroeconomic announcements.

2.2 Realized Variances and Realized Correlations

In recent years, the availability of high-frequency data has made the usage of realized variances popular. The realized variance for a given period is calculated as the sum of the squared returns for that period. The daily realized variance is used instead of other volatility measures such as GARCH-volatility. The realized variance is introduced by Andersen, Bollerslev, Diebold and Labys (2003) who find that the realized volatility performs well compared to other volatility measures.

The daily realized correlation is calculated as the correlation between (say) the 5-minute returns during the day. The realized correlation has not been applied widely in the empirical literature.

2.3 Bond-Stock Relations

To the authors' knowledge, macroeconomic announcement effects on bond-stock realized correlation have not been studied in the previous literature. Yet, Arshanapalli et al. (2003) find no effects on the bond-stock GARCH covariance, cf. discussion above.

In the literature, the present value model represents a straightforward frame-

work for understanding how bond and stock prices are determined. Using annual data for the period 1948 to 1989, Shiller and Baltratti (1992) find that the present value model implies a small positive bond-stock return correlation. Campbell and Ammer (1993) use an econometric approach to recast the present value model and to break the excess returns of long-term bonds and stocks into unexpected components of future cash flows and future discount rates. They find that most of the stock variance is due to innovations in risk premia and dividends. For bonds, the relevance of inflation and risk premia varies across time. In the present value model, inflation (real interest rate) changes make bond and stock returns move in opposite (same) directions. Changes in risk premia and term premia typically affect bonds and stocks differently. Although the bond-stock return correlation is generally positive, the relation might be negative in periods of "flight to quality". Ilmanen (2003) shows that the bond-stock correlation has recently gone from positive to negative and that it is influenced by the inflation level and the state of the economy (the business cycle). Li (2002) shows that real interest rates drive the bond and stock comovements and that inflation shocks make bond and stock returns move in opposite directions. Other drivers that decrease the bond-stock correlation are dividends and risk premia. Moreover, Li (2002) finds that the bond-stock correlation mainly depends on inflation uncertainty.

Connolly, Stivers and Sun (2005) show that the comovement of bond and stock returns is influenced by stock market uncertainty. When the stock market uncertainty is high, it is more probable that the future bond-stock correlation is negative

Barberis, Schleifer and Wurgler (2002) provide evidence that comovements in stock markets are influenced by investors having fixed the proportions of investments in different asset classes. Another non-fundamental factor with some bearing on the correlation is the price discovery process, i.e. microstructure effects, cf. Andersen, Bollerslev, Diebold and Vega (2004a).

3 Data

3.1 High Frequency Bond and Stock Data

We analyze the futures contracts on the Standard & Poor's 500 Stock Price Index and 10-Year US Treasury Notes quoted on the Chicago Mercantile Exchange (CME) and Chicago Board of Trade (CBOT), respectively. The database has kindly been provided by the Swiss-Systematic Asset Management SA, Zurich. The data contain the time stamp to the nearest second and transaction price of

all trades that occurred from November 11, 1988 to May 31, 2003. Moreover, we have purchased additional GLOBEX data for the S&P500 futures contract.

The study of realized correlation between two assets using high-frequency data implies the observation of two synchronized price movements. This is possible only when both markets for these two assets are open. Since 1988, the trading day on the CBOT has taken place from 8:20 to 15:00 (all time indications are in Eastern Time) and the trading hours at the CME have been from 9:30 to 16:15. This means that it is possible to investigate the joint market impact of news bulletins released at 10:00 across all our sample period using the Swiss-Systematic Asset Management SA data base. However, these data do not allow us to investigate the joint impact of the 8:30 announcements which have been found to have a strong influence on the Treasury market.

In September 1993, the CME supplemented the 9:30-16:15 floor session for the S&P futures contracts with the GLOBEX electronic trading platform. The trading hours on the CME GLOBEX platform go from 6:00 to 9:15. Thus, this time extension enables us to analyze the market impact due to news bulletins announced at 8:30. Therefore, we examine news releases at both 8:30 and 10:00.¹ From a microstructure point of view, this means that we consider two different price discovery processes at the CME, namely the floor trading (for news releases at 10:00) and GLOBEX electronic system (for news releases at 8:30). Combining the electronic and floor trading sessions warns us about at least two caveats. First, trading sessions outside the regular floor trading were relatively illiquid in the first years after the GLOBEX inception. In this respect, we have checked the consistency of our results across sample sub-periods. Second, the market microstructure of the floor and electronic trading differs in many aspects. The GLOBEX is a highly transparent electronic matching system strictly governed by the price-time priority rule. Its order book shows information on the ten best bid and ask quotes and is continuously available, and trading information is disseminated in real-time to a large trading community. On the other hand, the trading floor is based on an open-outcry auction system. Trading in the pits implies the traders' physical presence. Traders cannot trade anonymously with each other. The information set formally available in the pit is much more limited (typically the best bid and ask) and heterogeneous (e.g. interpretation of incoming flow of orders). For those reasons, the comparison between 8:30 and 10:00 news releases need some caution. Throughout our study, we analyze and present the 8:30 and 10:00 results separately. Despite our caveats, the results appear to be consistent for the 8:30 and 10:00 announcement times.

¹The sample period for the 8:30 announcements is shorter than for the 10:00 announcements, because the former starts in 1993 whereas the latter starts in 1988.

We use the most actively traded nearest-to-maturity or cheapest-to-delivery futures contract, switching to the next-maturity contract five days before expiration, cf. Andersen et al. (2004b) for a similar approach. We then construct the exact matching between trading hours and official holidays between the CBOT and CME. If no trades occur in a given 5-minute interval, we copy down the last trading price in the previous time interval. After coupling the simultaneous price changes on the CBOT and CME, we are able to calculate realized volatilities and realized correlations of bond and stock returns.

Realized volatility is the sum of consecutive squared log price changes. Realized correlation is the correlation coefficient between synchronized 5-minute price returns. For news announcements scheduled at 10:00, we calculate realized volatility and realized correlation from 10 minutes before the announcement to 90 minutes afterwards, i.e. the same window as in Andersen et al. (2004b). For news announcements at 8:30, the time window goes from 8:20 to 9:15. We have to constraint the time window to 55 minutes because of the CME GLOBEX trading hours. Considering the price movements prior to the news arrival, we account for any premature price adjustment or information leakage.

Table 1 shows various descriptive statistics for the realized variances and realized correlations. In Table 1 (and the remaining tables) Panel A concerns the 8:30 announcements and Panel B concerns the 10:00 announcements. We show the summary statistics for the full sample and separately for announcement days and non-announcement days. Below we describe in more detail which announcements are included. The realized variances have been scaled by 100,000. As expected, the bond realized variances are much smaller than the stock realized variances; for the 10:00 window on average 0.31 compared to 2.67.²

Both the average bond and stock realized variances are larger on announcement days than on non-announcement days, and the same goes for their standard deviations. This is in line with the previous literature using returns or GARCH-variance, cf. e.g. Jones et al. (1998) and Faust et al. (2003). The realized variances show excess kurtosis and are strongly skewed. Thus, for all variables the null hypothesis of normal distribution is strongly rejected by the Jarque-Bera non-normality test (not tabulated).

Throughout our study, we use the logarithm of the realized variances instead

²Since these assets are highly liquid, the realized variance and realized correlation are only marginally affected by microstructure issues such as bid-ask bounces, difference of the bid-ask spread size between assets, and non-synchronized trading between assets. Moreover, the realized volatilities always concern the same time period of the day, so intraday patterns of bid-ask spreads are not important. Additional experiments to assess the possible biases due to bid-ask bounces on the realized volatility and realized correlation have been performed. Even after accounting for these microstructure biases the data remain qualitatively the same.

of the actual realized volatility. The log realized volatility is much closer to being Gaussian distributed. Moreover, in regression analysis, the log realized volatility assures a more linear pattern with explanatory variables and a lower exposure to outliers. The skewness of the 10:00 log bond realized variance equals 0.43 (compare to 6.45 for the realized variance itself) and the kurtosis equals 3.58 (compare to 79 for the realized variance itself). Equivalent for the 10:00 stock realized variance, using logarithm the skewness reduces from 8.74 to 0.23 and the kurtosis from 134 to 3.17. The Jarque-Bera test statistics have been reduced vastly, but still we reject normality.

Figure 1 shows the time series of the 10:00 realized bond-stock correlation. The realized bond-stock correlation has gone from being positive to negative in the last part of the sample period thereby confirming the findings of Ilmanen (2003) regarding rolling window bond-stock correlations based on low frequency data. There are at least three historical reasons explaining this pattern. First, the market uncertainty and risk were significantly lower in the first part of nineties than in the end and at the beginning of 2000s. The annualized historical equity market volatility measured by the return standard deviation of the S&P 500 index from 1997 to 2003 was essentially twice than that from 1988 to 1996 (from 11% up to 21%). In the meantime, if we exclude the recession at the beginning of 1990, the economic conditions in the latter period were worse. For instance, the US yield curve was generally less upward sloping. In this economic framework, the flight-to-quality effect suggests the phenomenon of fleeing from stock to bond markets. Second, from the late nineties inflation expectations steadily decreased. Concerns of disinflation were even perceptible. Holding other factors constant, this should increase bond prices and leave equity values substantially unaffected. A further element decreasing equity prices was accounting frauds such as Enron at the beginning of 2000. Besides the market pressure on equity prices, corporate accounting scandals had financial de-leveraging effects deviating companies from an optimal debt/equity structure. All these factors taken together may at least partially explain the divergent patterns between equity and bond prices depicted in Figure 1.

Below, we make use of the Fisher transform of the realized correlation; $F(x) = \frac{1}{2} \log\left(\frac{1+x}{1-x}\right)$. The Fisher transform has the advantage that it transforms the realized correlation to support the whole real line, whereas the realized correlation is restricted to the interval $[-1;1]$. The Fisher transform of the 10:00 realized correlation has skewness of -0.51 (compare to -0.42 for the realized correlation itself) and kurtosis of 2.93 (compare to 2.23). The Jarque-Bera test statistic is smaller, indicating that the Fisher transform of the realized correla-

tion is closer to being Gaussian than the realized correlation itself, although it is still significantly different from being normal.

We use 60-minute rolling windows to construct intraday patterns of the realized bond-stock correlation only using the floor data. For each trading day we obtain 56 hourly observations (ending from 10:25 to 15:00). Figure 2 shows the intraday pattern of the average 60-minute realized correlations for each year in the sample. Compared to how much the realized correlation changes across the period, there are no observable strong intradaily patterns.

3.2 Announcement Data

We obtain the announcement data from Informa Global Markets (Europe) Ltd.³ For each different macroeconomic announcement we obtain a time series of the realized values as well as market forecasts based on survey expectations. With some exceptions the data are available during the sample period for which we have access to the high frequency data, namely from May 1988 to May 2003. Table 2 shows the 15 and 8 different announcements for which we have data that occur at 8:30 and 10:00, respectively. Announcements that take place at 10:00 in the beginning of the sample period and later at 8:30 (e.g. Business Inventories) are treated as two different announcement types.

The announcement days are spread out almost evenly across the different days of the week, cf. Table 2.

In the empirical analysis we follow the previous literature, e.g. Balduzzi et al. (2001), and use the standardized news for announcement k :

$$S_{kt} = \frac{A_{kt} - E_{kt}}{\sigma_k} \quad (1)$$

where A_{kt} is the realized value for announcement k at time t , and E_{kt} is the corresponding expected value. σ_k is the standard deviation of the announcement surprise ($A_{kt} - E_{kt}$) across the entire sample. Hereby we are able to compare the size of various regression coefficients associated with different announcements.

3.3 Business Cycle Data

We construct a recession indicator variable which is equal to one when the economy is in recession as defined by the NBER business cycle data. The economy is in recession from July 1, 1990 to February 28, 1991 and again from March 1, 2001 to October 31, 2001. Thereby there are 334 recession days in the

³In previous studies this data source is denoted the International Money Market Service (MMS).

sample, which amounts to just above 9% of the sample. We denote the recession indicator by R_t .

4 Realized Variance

In this section we investigate how the realized variance of bonds and stocks react to macroeconomic announcements. Although the previous literature has investigated macroeconomic announcement effects upon volatility, the authors are not aware of any studies using realized volatility measured as the sum of squared returns. More importantly, the results for the realized volatility provide us with a convenient base of comparison for the subsequent analysis of the bond-stock realized correlation.

4.1 News Effects

In order to investigate the news impact of macroeconomic announcements, we regress the log realized variance ($\log(RV_t)$) (first for bonds then for stocks) on the absolute value of the standardized announcement shock, $|S_{kt}|$. The regression is repeated and is conducted separately for each announcement. The regression for announcement k is as follows

$$\log(RV_t) = \alpha_k + \beta_k |S_{kt}| + \varepsilon_t \quad (2)$$

where the realized variance applies in the window around the announcement on day t and ε_t is the NIID residual. The regression is similar to the regressions in Balduzzi et al. (2001), Andersen et al. (2004a), and Faust et al. (2003) who employ returns as dependent variable. In contrast to the previous studies, we use absolute announcement shocks (instead of raw announcement shocks) because we expect that large positive and negative surprises affect volatility identically.⁴ The regression only includes observations from days with announcements, i.e. the regressions are based on at most 62 and 172 observations for 8:30 and 10:00 announcements, respectively. All models are estimated using the Ordinary Least Squares technique and we use Newey and West (1987) standard errors.

In Table 3 (column one) we show the estimated slope coefficients and the centered R^2 s from the news regressions for bond realized volatility.⁵ It is noticed that for four 8:30 news bulletins (Consumer Price Index, Nonfarm Pay-

⁴In the news regression Balduzzi et al. (2001) correct for the fact that some announcements occur simultaneously. Here, this does not affect the results.

⁵We re-run the regression leaving out the 1% smallest and the 1% largest realized variances. This does not alter the conclusions. We confirm that all subsequent regression results are robust to outliers in a similar fashion.

roll Employment, Personal Consumption Expenditure, and Retail Sales) and for three announcements at 10:00 (Consumer Confidence, Institute for Supply Management index, and the New Home Sales), there are significant news effects on the bond realized volatility.⁶ The bond realized volatility is larger the greater the news contained in these reports. Moreover, the R^2 s are relatively low. So it appears that surprises from macroeconomic releases have only limited bearing on the realized bond variance. This is in contrast to the findings for bond returns: Balduzzi et al. (2001) find that 14 (including Consumer Price Index, Nonfarm Payroll Employment, Personal Consumption Expenditure, Retail Sales, Consumer Confidence, Institute of Supply Management index, and New Home Sales) out of 26 announcements have significant news coefficients for the 10-year Treasury note. Balduzzi et al. (2001) find that the news impact on bond returns are negative for these announcements and that the R^2 s are much higher (average around 0.27). The results for the 30-year Treasury bond returns reported in Andersen et al. (2004b) also contain 16 (including Consumer Price Index, Nonfarm Payroll Employment, Retail Sales, Consumer Confidence, Institute for Supply Management index, and New Home Sales) out of 25 significant slope coefficients for announcement surprises. Again the R^2 s are much larger than here (average of around 0.26). Thus, the news impact from macroeconomic announcements is much more pronounced for bond returns than for bond realized volatilities in the window around announcements. This is not surprising since price and volatility reactions to news announcements have completely different patterns, especially in terms of magnitude and persistence.

The results on stock realized volatility are in line with those on bond realized volatility. We find only weak evidence of news effects, cf. Table 3 (column three). For the 8:30 announcements, the news impact is significant for the Consumer Price Index, Personal Consumption Expenditure, Producer Price Index, Trade Balance, and GDP advance. Most are reoccurrences from the bond case. For the 10:00 announcements, only for the Personal Consumption Expenditures is the news impact significant. Moreover, the R^2 s are all relatively small. Similarly, Andersen et al. (2004b) find that only 6 announcement has significant news impact upon the return of the S&P500 futures index. It appears that the news impact on stock returns and realized volatility in the window around announcements are of about the same low level.

Confirming *a priori* expectations, the news impact is larger for bond realized volatility than for stock realized volatility, cf. the discussion in the Introduction. This expectation is based on the fact that stock markets have firm specific news

⁶The Institute for Supply Management was denoted the National Association of Purchasing Managers (NAPM) until August 2002.

items, whereas this is not the case for bond markets. Moreover, stronger bond reactions than stock reactions are consistent with the findings of Andersen et al. (2004b) regarding returns.

To investigate the impact of the state of the business cycle on news effects we include the recession dummy, R_t , in the intercept and the slope of the news regression:

$$\log(RV_t) = \alpha_k + \beta_k |S_{kt}| + \alpha_k^* R_t + \beta_k^* R_t |S_{kt}| + \varepsilon_t \quad (3)$$

Table 3 (column two) shows the estimates of β_k and β_k^* as well as the centered R^2 s from the news regression for bond realized volatility including recession effects. Only one of the slope coefficients is significantly different during expansions than during recessions (see GDP, final). This is in line with the bond return findings in Andersen et al. (2004b).

Table 3 (column four) shows the results from conducting the business cycle news regression for stock realized volatility. Six news effects are significantly different during recessions, namely the Consumer Price Index, Nonfarm Payroll Employment, Personal Consumption Expenditure, Producer Price Index, Trade Balance, Business Inventories, and Consumer Confidence. For all of the four significant 8:30 announcements, the announcements tend to reduce volatility during recessions i.e. $\beta_k^* < 0$. During expansions the announcement surprises tend to increase the realized bond volatility, i.e. the opposite sign as recessions. For the 10:00 announcements, the news impacts are stronger during recessions than during expansions ($\beta_k^* > 0$). Boyd, Hu and Jagannathan (2005) and Andersen et al. (2004b) find that some macroeconomic news items cause a stronger price reaction in recessions. Our equity results for the 10:00 announcements go in the same direction; there is stronger market reaction in terms of realized variance during recessions.

To summarize, we learn that it is highly desirable to distinguish between the news impacts during recessions and expansions. Moreover, it appears that the state of the business cycle is only important for stocks but not for bonds with respect to news effects upon realized volatilities. This is in line with the findings in Andersen et al. (2004b) where there are only business cycle effects at play for stock returns not for bond returns. The results appear robust across announcement time. Overall, there is only limited evidence of any news effects of macroeconomic announcements on the realized variances of bonds and stocks.

4.2 Announcement Effects

We also investigate whether the mere occurrence of an announcement has an effect on the realized variances of bonds and stocks. First for bonds then for stocks, we run a regression using all the days in the sample and regress the realized variance on announcement dummy variables for all announcement types.

$$\log(RV_t) = a + \sum_{k=1}^K b_k D_{kt} + e_t \quad (4)$$

We estimate the 8:30 and 10:00 regressions separately. D_{kt} is an indicator function which equals one on days when announcement k is released and zero otherwise and e_t is the NIID residual. After accounting for simultaneous news releases, there are $K = 12$ and $K = 7$ different announcements for 8:30 and 10:00 announcement time, respectively. Personal Consumptions Expenditures and Personal Income are always released simultaneously, so they are treated as one announcement. The same applies to the Nonfarm Payroll Employment and Civilian Unemployment Rate. The regression is similar to the absolute return regression on equivalent dummy variables in Ederington and Lee (1993).

In Table 4 (column one) we show the slope coefficient estimates and the R^2 from the announcement regression for the bond realized volatility. There are significant announcement effects from almost all announcements to the bond realized volatility. The exceptions are only Business Inventories, Personal Consumption Expenditures/Personal Income, and Construction Spending. Nonfarm Payroll Employment and Institute for Supply Management index exerts most influence (it has the largest b_k -estimate) within the 8:30 and 10:00 announcement times, respectively. The bond realized volatility is larger on macroeconomic announcement days (the coefficients are positive). The R^2 s of the regressions equal 0.34 and 0.06, respectively. Ederington and Lee (1993) conduct a similar regression although they use the absolute return instead of realized volatility as dependent variable. They find only one significant announcement effect for long-term Treasury bond futures, namely Construction Spending/Institute for Supply Management index (in the sample period (1988-1991) covered by Ederington and Lee (1993) the Construction Spending and Institute for Supply Management indexes are almost always released on the same day). Our findings suggest a much stronger link between bond volatility and news releases. This may be due to the availability of a much longer sample period and the use of a different volatility definition.

The results for the stock realized variance are shown in Table 4 (column

three). On announcement days, for 16 out of 23 news items the stock realized volatility is significantly different from the volatility on non-announcement days. Business Inventories and Personal Consumption Expenditures/Personal Income bulletins appear as exceptions since the realized variance induced by their release is smaller. Fewer announcements provide significant impacts on stock realized volatility than on bond realized volatility. This is in line with the firm-specific news story that we confirm by the news regressions above. Moreover, the R^2 s for the stock regressions are smaller than those for the bond regression.

Again, we investigate the effect of business cycles by including the recession dummy R_t both in the intercept and the slopes and run the following regression for the realized volatility of bonds and stocks:⁷

$$\log(RV_t) = a + \sum_{k=1}^K b_k D_{kt} + a^* R_t + \sum_{k=1}^K b_k^* R_t D_{kt} + e_t \quad (5)$$

Table 4 (column two) shows the results of conducting the business cycle announcement regression for the bond realized volatility. We test the null hypothesis that there are no recession announcement effects: $b_1^* = \dots = b_K^* = 0$ and find strong evidence that the announcement effects are different during recessions for both the 8:30 and the 10:00 announcements. In particular, the announcement effects of the Business Inventories and New Home Sales are significantly negative during recessions ($\widehat{b}_k + \widehat{b}_k^* < 0$), whereas they are significantly positive during expansions ($\widehat{b}_k > 0$). So, during recessions these announcements tend to reduce the bond realized volatility. We interpret this such that in recessions uncertainty is high and therefore any news item is welcomed in order to reduce uncertainty and thereby volatility. Another interpretation is that traders tend to trade more in expansions and less in contractions. More passive trading in contractions would imply less noise and more focus on primitive sources of values, i.e. macroeconomic fundamentals. If this idea holds, one would observe that trading volumes magnify news impacts in terms of volatility in expansions and straighter market adjustments in recessions. Our data set does not allow us to substantiate this proposition.

There are also business cycle announcement effects for stock realized volatility, cf. Table 4 (column four). The null hypothesis that $b_1^* = \dots = b_K^* = 0$ is rejected. However, the effect on realized stock volatility is more mixed. In two cases, news releases tend to reduce volatility (Business Inventory and Retail Sales). On the other hand, three other bulletins tend to strengthen volatility

⁷The Construction Spending and the Institute for Supply Management indexes are released simultaneous during recessions. Therefore, only the former is multiplied with the recession dummy and included in the regression.

(GDP preliminary Consumer Confidence, and Personal Consumption Expenditures). As for the bond volatility, Consumer Confidence announcements significantly exacerbate stock volatility in recessions.

Overall, we find that it is not so much the surprise of macroeconomic announcements that matters. Rather, it is the mere fact that an announcement occurs that has implications for the realized volatilities of bond and stock returns. Our results appear to be more significant than those found in the previous literature, even for some new bulletins that have rarely been found to impact on return volatility (e.g. Business Inventories). There are at least two explanations. First, our data set allows us to analyze a longer sample period. Therefore, we can investigate more precisely the news impact across recessions and expansions. Second, we use the realized volatility technique and ultra high-frequency data. Most of the previous literature gauges the news impact on the second moment by means of absolute price changes (e.g. Ederington and Lee (1993)) or the absolute value of the regression residual for the price change impact (e.g. Andersen et al. (2004b)). It is more than likely that realized measures of volatility enhance the measurement precision.

5 Bond-Stock Realized Correlation

5.1 News Effects

We investigate the news effects from the unexpected part of macroeconomic announcements onto the bond-stock realized correlation. Figure 3 provides a graphical indication of the news effect on realized correlation in the specific case of Factory Orders announcements. Using 30-minute time intervals, this picture shows the realized correlation reaction to large positive news surprises during announcement days.⁸ The intraday pattern suggests that realized correlation is normal before the news release and it increases significantly afterwards. After one hour of immediate impact, realized correlation tends to decrease in the middle of the trading session and then it rises again before closing.

To conduct a more comprehensive analysis in line with the approach above, we run similar regressions as in equation (2). The Fisher transform of the realized correlation is the dependent variable and the explanatory variable is the surprise effect of the macroeconomic announcement (not the absolute surprise as in the variance regressions).

The results are shown in Table 5 (column one). As for both bond and stock realized variances, there are only weak indications of news effects from macro-

⁸We define large positive surprises to be the 20% largest observations of the surprises.

economic announcements into the bond-stock realized correlation. Only in two instances (Producer Price Index and Consumer Confidence) are the news effects significant. When the surprise is larger than expected the realized correlation increases.

We also run a regression that includes recession dummies in the intercept and slope, similar to equation (3) above. Table 5 (column two) shows that there are clear indications that the news effects are different during recessions and expansions (nine out of 22 β_k^* s are significant). In recessions the news impacts from Institute for Supply Management index and New Home sales are significantly negative whereas they are positive (but insignificant) in expansions. On the other hand, seven other macroeconomic bulletins significantly increase realized correlation in recessions. Among them, Retail Sales announcements turn a significant negative impact into a positive one. In six other circumstances, a negative (but insignificant) coefficient turns into a significantly positive one. Overall, the state of the economy has bearing on how macroeconomic news affects the realized bond-stock correlation.

It has been discussed widely that the sign of the bond-stock correlation has changed from positive to negative during 1997, cf. Figure 1 and our discussion of it above as well as Imanen (2003). Here we accommodate for the fact that the sign of the correlation might have some bearing on the macroeconomic announcement effects by running the following news regression:

$$F(RC_t) = \alpha_k + \beta_k S_{kt} + \alpha_k^\# [F(RC_{t-1}) < 0] + \beta_k^\# [F(RC_{t-1}) < 0] S_{kt} + \varepsilon_t \quad (6)$$

In equation (6), both the intercept and the slope depend on the sign of the realized correlation yesterday, in that the indicator $[F(RC_{t-1}) < 0]$ equals 1 if the realized correlation yesterday is negative and 0 if it is positive.⁹ We use the lagged value of the realized correlation to determine the sign in order to keep the explanatory variables exogenous from the dependent variable.¹⁰

Table 5 (column three) shows the results. We observe five significant news impacts when the lagged realized correlation is negative. The news effect of the Factory Orders, New Home Sales, and Personal Consumption Expenditures (all 10:00 announcements) are negatively dependent on the sign of the lagged

⁹The sign of the realized correlation is identical to the sign of the Fisher transform of the realized correlation.

¹⁰The obtained results are similar to the results obtained if we instead of the sign indicator use a sub-period indicator which divides the sample into the period up to the middle of 1997 and the following period. Using the sign indicator we do not have to explicitly date the change in the bond-stock correlation which has been gradual.

realized correlation. In contrast, for Housing Starts and Nonfarm Payroll Employment (8:30 announcements) news items there is a positive dependence in recessions. It is noticeable that the R^2 s are much higher now; on average 0.23. So, accounting for the sign of the correlation is of immense importance as it has bearing on the news reactions. We conjecture that this is caused by the difference in causality between bond and stock markets when the correlation changes sign. Second, it is worth emphasizing that the recession-indicator method (Table 5, column two) and the sign-correlation method (Table 5, column 3) provide very consistent results. In particular, sign and size of estimated coefficients are comparable. This suggests that the sign-correlation method is an efficient alternative method to determine the economic frameworks.

5.2 Announcement Effects

The announcement effects on bond-stock realized correlation are investigated by running regressions similar to equation (4) where the explained variable is the Fisher transform of the realized correlation. The results are shown in Table 6 (column one). There are significant announcement effects on the realized bond-stock correlation. The most influential announcement is the Nonfarm Payroll Employment and Business Inventories, for 8:30 and 10:00 news announcements, respectively. From Table 6 (column one), a clear picture emerges: The bond-stock correlation tends to increase when macroeconomic announcements occur. This is in line with the findings in Christiansen (2000) who shows that the correlations between bonds of different maturities are strengthened on macroeconomic announcement days.

We also run a similar regression as in equation (5) where the intercept and the slopes are allowed to differ during recessions. Table 6 (column two) shows that the announcement effects are significantly different during recessions. The null hypothesis that all slope coefficients are insignificantly different during recessions is strongly rejected (p-values for the null that $b_1^* = \dots = b_K^* = 0$ are below 1%). The announcement effects are generally stronger during recessions than during expansions, $|\widehat{b}_k| < |\widehat{b}_k + \widehat{b}_k^*|$.

A natural question is why bond-stock comovement reacts differently across announcement types and why there are reversal effects during recessions for the majority of news items. As discussed above, the discount factors for bond and stock pricing have common factors (real interest rates and inflation) as well as stock-specific factors (equity risk premia and dividends). For news items that increase the realized correlation in both expansions and recessions (10:00 Business Inventory and Personal Consumption Expenditures/Personal Income), the

real interest rate appears to dominate. One explanation for the stronger positive correlation in downturns is that the inflation concern is less relevant; especially during the last recession in 2001 with a low inflation rate. On the other hand, stock-specific factors seem to dominate the price revision process driven by those macroeconomic news items with a negative impact on realized correlation in recessions. This is the case for Nonfarm Payroll Employment, Retail Sales, GDP preliminary, and Consumer Confidence. This interpretation is supported by other findings in the recent literature: Boyd et al. (2005) find that bonds and stocks have different news reactions in expansions and recessions. Bond and stock prices rise as a reaction to bad labor market news during expansions but only stock prices fall during contractions. Boyd et al. (2005) argue that unemployment news must convey more information about the real interest rates (risk premia and dividends) in expansions (recessions). In the same line of reasoning, Andersen et al. (2004b) interpret the opposite market reaction as a change in the dominating factors that determine asset values. More specifically, the discount rate tends to dominate the information content of some macroeconomic news items during expansions, whereas the cash flow effects stand out during contractions. Looking more closely at the results in Andersen et al. (2004b), we find a high correspondence between our and their results. In Andersen et al. (2004b) good news releases in Consumer Confidence, Nonfarm Payroll Employment, Retail Sales, GDP preliminary, as well as New Home Sales are always bad for bonds (both in recessions and expansions) whereas good news has a positive impact on stock prices in recessions and a negative impact in expansions. This implies a positive bond-stock correlation in expansions and a negative correlation in recessions. This exactly matches our results on news effects in Table 6, column two. Thus, our findings are in support of the proposition that the interpretation of macroeconomic news items depend on the economic situation. The influence of these factors varies over economic conditions and so do bond-stock comovements.

As above, we control for the changing sign of the realized correlation by allowing the slope and the intercepts to be different when yesterday's realized correlation is negative. Table 6 (column three) show the results from the following regression:

$$F(RC_t) = a + \sum_{k=1}^K b_k D_{kt} + a^\# [F(RC_{t-1}) < 0] + \sum_{k=1}^K b_k^\# [F(RC_{t-1}) < 0] D_{kt} + e_t \quad (7)$$

The p-values for the null hypotheses that $b_1^\# = \dots = b_K^\# = 0$ are below 1%.

So the announcement effects are strongly dependent on the sign of the realized correlation. Also, many of the $b_k^\#$ parameters are individually significant and the R^2 s are now as high as 0.20 and 0.36 for the 8:30 regression and the 10:00 regression, respectively, thus the regression has strong explanatory power. When the realized correlation is positive, the impacts from announcements are positive ($\widehat{b}_k > 0$). When the realized correlation is negative the impacts from announcements is typically stronger, i.e. ($|b_k| < |b_k + b_k^*|$). The release of Consumer Price Index, Nonfarm Payroll Employment, Trade Balance, Institute for Supply Management index, and New Home Sales in a negative correlation context implies a significant decrease of the realized bond-stock correlation. This pattern also holds for Consumer Confidence news although not significantly. On the other hand, Business Inventories (10:00), Construction Spending, Factory Orders, and Personal Consumption Expenditures bulletins in a negative correlation framework imply a stronger realized correlation. These results are largely consistent with those using the NBER business cycle indicator presented above.

Overall, we find strong evidence that the bond-stock realized correlation is significantly influenced by releases of macroeconomic announcements and that the sign of the bond-stock correlation plays a dominant role. The time-varying patterns of realized correlation can be explained by the dominating drivers of bond-stock comovements and how they vary across economic conditions.

6 Conclusion

By analyzing the synchronized market movements of US bond and stock futures, this study delivers some insights into the parallel price discovery processes of bonds and stocks resulting from US macroeconomic news releases. We investigate the highly informative contents of a long sample period of trade-by-trade data. We measure the separate market reactions by the realized variances and the joint market responses by means of realized correlation between bond and stock returns. Both announcement effects and surprise effects are examined.

We find that the surprise component of macroeconomic news releases has a small impact on realized volatility. The mere releases of scheduled news items have a stronger impact. This suggests that the main reaction to new public information is due to operational reasons such as pent-up demand and portfolio rebalancing rather than due to surprise effects. Thus, the simultaneous price discovery processes on the equity and bond markets appear to be connected and efficient. We also find that the volatility reaction varies across assets and economic conditions. Bonds respond more than stocks to these information

events. Confirming our propositions, bond values appear more connected to macroeconomic factors whereas equity values are more affected by firm-specific factors. Importantly, the market reaction is stronger during recessions than expansions.

Overall, macroeconomic announcements have a significant impact on realized bond-stock return correlation. This evidence holds especially in terms of scheduled announcement times. It is worth emphasizing, however, that different news items have very different impacts and that the market response radically depends on the business cycle. In expansions, a macroeconomic news release typically strengthens bond-stock comovements. This finding suggests that the real interest rate is the dominating factor in expansions. Concerns of interest rate increases seem to affect the market participants. On the other hand, the market reaction in recessions significantly depends on which macroeconomic announcement is released. Releases on Business Inventory and Personal Consumption Expenditures/Personal Income typically strengthen bond-stock return correlation. Instead, Consumer Confidence, Nonfarm Payroll Employment, and GDP preliminary announcements are associated with a weakened correlation. For these news items, stock-specific factors seem to dominate the price revision process for stocks, but not for bonds.

Adding to the debate regarding the changing sign in the bond-stock correlation, we find that macroeconomic announcement effects of the bond-stock realized correlation are highly dependent on the sign of the bond-stock correlation. Once we account for these sign differences, we find very strong announcement effects.

Our study raises further questions to be answered by future research. The time-varying nature of realized correlation calls for a better understanding of at least two main issues: First, the way the market participants process the information content of news items into prices. Second, the implications for asset pricing models and, in particular, for realized betas.

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Table 1: Summary Statistics
 Panel A: 8:30 Announcements

	Mean	Std. Dev.	Skewness	Kurtosis	Obs.
Bond RV*100,000					
Full Sample	0.38	0.93	10.22	144	2397
Ann. Days	0.64	1.39	7.04	67	935
Non-Ann. Days	0.21	0.32	11.67	228	1462
Stock RV*100,000					
Full Sample	0.88	3.54	16.16	380	
Ann. Days	1.38	4.58	13.95	280	
Non-Ann. Days	0.56	2.63	16.96	377	
Realized Correlation					
Full Sample	0.14	0.42	-0.10	2	
Ann. Days	0.21	0.44	-0.19	2	
Non-Ann. Days	0.11	0.40	-0.10	2	

Panel B: 10:00 Announcements

	Mean	Std. Dev.	Skewness	Kurtosis	Obs.
Bond RV*100,000					
Full Sample	0.31	0.40	6.45	79	3633
Ann. Days	0.44	0.57	5.98	64	782
Non-Ann. Days	0.28	0.33	5.51	49	2851
Stock RV*100,000					
Full Sample	2.67	4.39	8.74	134	
Ann. Days	2.89	5.52	9.01	112	
Non-Ann. Days	2.61	4.02	8.05	133	
Realized Correlation					
Full Sample	0.06	0.42	-0.42	2	
Ann. Days	0.12	0.43	-0.06	2	
Non-Ann. Days	0.05	0.42	-0.40	2	

The table shows the mean, standard deviation, skewness, and kurtosis of the bond realized variance, stock realized variance and bond-stock realized correlation applying in the intervals [8:20;9.15] and [9.50;11.30], respectively. The realized variances are multiplied by 100,000. The summary statistics are shown for the full sample, macroeconomic announcement days, and non-announcement days.

Table 2: Summary of Macroeconomic Announcements
Panel A: 8:30 Announcements

Announcement	Source	Period	Obs.	Day of the Week				
				Mon	Tue	Wed	Thu	Fri
Business Inventories	BC	Jan. 1997 - May 2003	76	14	7	19	12	24
Consumer Price Index	BLS	Sept. 1993 - May 2003	116	0	32	33	20	31
Housing Starts	BC	Sept. 1993 - May 2003	115	1	37	37	23	17
Index of Leading Indicators	CB	Sept. 1993 - May 2003	114	13	38	33	21	9
Nonfarm Payroll Employment	BLS	Sept. 1993 - May 2003	113	0	0	0	4	109
Personal Consumption Expenditures	BEA	Jan. 1994 - May 2003	108	43	7	5	17	36
Personal Income	BEA	Jan. 1994 - May 2003	107	43	7	5	16	36
Producer Price Index	BLS	Sept. 1993 - May 2003	115	0	11	14	34	56
Retail Sales	BC	Sept. 1993 - May 2003	115	0	31	16	36	32
Trade Balance	BEA	Sept. 1993 - May 2003	116	0	25	31	36	24
Unemployment Rate, Civilian	BLS	Sept. 1993 - May 2003	114	1	0	0	3	110
<i>Quarterly Announcements</i>								
GDP, Advance	BEA	Sept. 1993 - May 2003	39	0	0	6	11	22
GDP, Preliminary	BEA	Sept. 1993 - May 2003	35	0	2	10	10	13
GDP, Final	BEA	Sept. 1993 - May 2003	35	0	2	6	15	15

Panel B: 10:00 Announcements

Announcement	Source	Period	Obs.	Day of the Week				
				Mon	Tue	Wed	Thu	Fri
Business Inventories	BC	Nov. 1988 - Dec. 1996	98	21	5	28	14	30
Construction Spending	BC	Nov. 1988 - May 2003	172	66	29	30	23	24
Consumer Confidence	CB	Jul. 1991 - Jan. 2003	139	1	132	3	2	1
Factory Orders	BC	Nov. 1988 - Feb. 2003	170	2	24	46	57	41
Institute for Supply Management Index	ISM	Feb. 1990 - May 2003	160	62	30	21	26	21
New Home Sales	BC	Nov. 1988 - May 2003	172	23	49	40	32	28
Personal Consumption Expenditures	BEA	Nov. 1988 - Dec. 1993	62	13	1	12	17	19
Personal Income	BEA	Nov. 1988 - Dec. 1993	62	13	1	12	17	19

The table provides a summary of the macroeconomic announcements. BC: Bureau of the Census, BEA: Bureau of Economic Analysis, BLS: Bureau of Labor Statistics; CB: Conference Board, ISM: Institute for Supply Management (ISM was denoted the National Association of Purchasing Managers until August 2002). In January 1997 Business Inventories announcements were moved from 10:00 to 8:30. In December 1993 Personal Consumption Expenditures and Personal Income announcements were moved from 10:00 to 8:30. Missing forecast data for New Home Sales on February 2, 1989.

Table 3: Variance News Regressions
Panel A: 8:30 Announcements

Announcement	Bond RV		Bond RV - Recession			Stock RV		Stock RV - Recession		
	β_k	R^2	β_k	β_k^*	R^2	β_k	R^2	β_k	β_k^*	R^2
Business Inventories	0.236	0.022	0.231	-0.989	0.039	-0.138	0.004	-0.147	-6.476	0.180
Consumer Price Index	0.211*	0.028	0.303**	-0.334	0.083	0.389**	0.049	0.501***	-0.954***	0.077
Housing Starts	0.165	0.019	0.156	0.326	0.021	0.143	0.005	0.167	-0.041	0.035
Index of Leading Indicators	0.043	0.001	0.072	-0.653	0.011	0.213	0.019	0.240	-0.473	0.060
Nonfarm Payroll Employment	0.415**	0.079	0.422**	-0.088	0.079	0.315	0.021	0.259	0.748**	0.047
Personal Consumption Expenditures	0.186*	0.031	0.178*	-0.367	0.038	0.325*	0.033	0.375*	-1.950**	0.059
Personal Income	0.074	0.005	0.068	0.143	0.016	-0.121	0.004	-0.106	-0.450	0.014
Producer Price Index	-0.030	0.000	-0.007	-0.492	0.007	0.386***	0.047	0.439***	-1.057**	0.082
Retail Sales	0.168*	0.018	0.182	-0.169	0.020	0.191	0.014	0.149	0.466	0.026
Trade Balance	0.105	0.010	0.071	0.212	0.016	0.441***	0.063	0.503***	-0.491**	0.087
Unemployment Rate, Civilian	0.104	0.005	0.099	0.068	0.005	-0.040	0.000	-0.073	0.502	0.024
<i>Quarterly Announcements</i>										
GDP, Advance	0.318	0.043	0.258	0.713	0.059	0.573*	0.057	0.527	0.751	0.066
GDP, Preliminary	0.099	0.006	na			0.124	0.006	na		
GDP, Final	0.415	0.134	0.423	1.819***	0.170	0.140	0.005	0.161	0.593	0.011

Panel B: 10:00 Announcements

Announcement	Bond RV		Bond RV - Recession			Stock RV		Stock RV - Recession		
	β_k	R^2	β_k	β_k^*	R^2	β_k	R^2	β_k	β_k^*	R^2
Business Inventories	0.070	0.004	0.066	-0.560	0.023	-0.002	0.000	-0.004	1.613**	0.085
Construction Spending	-0.160	0.012	-0.122	-0.332	0.019	0.050	0.001	0.075	-0.068	0.032
Consumer Confidence	0.558***	0.174	0.538***	-0.014	0.184	0.135	0.006	0.040	0.453**	0.060
Factory Orders	0.002	0.000	0.032	-0.124	0.004	0.061	0.002	0.059	-0.129	0.021
Institute for Supply Management Index	0.517***	0.132	0.512***	0.063	0.132	0.139	0.007	0.151	0.006	0.027
New Home Sales	0.214*	0.023	0.195	-0.052	0.038	-0.084	0.003	-0.063	0.218	0.036
Personal Consumption Expenditures	0.126	0.011	0.154	-0.088	0.015	0.310*	0.054	0.237	-0.335	0.234
Personal Income	-0.015	0.000	-0.015	-0.117	0.002	-0.068	0.004	0.018	-0.102	0.208

Columns one and three in the table show the estimated β_k s and the centered R^2 s from the following regressions: $\log(RV_t) = \alpha_k + \beta_k |S_{kt}| + \varepsilon_t$. RV_t is the bond realized variance and stock realized variance, respectively, that applies in the relevant window around the announcement. The RV_t s are multiplied with 100,000. S_{kt} is the standardized news for announcement k .

Columns two and four in the table show the estimated β_k s and β_k^* s and the centered R^2 from the following regressions: $\log(RV_t) = \alpha_k + \beta_k |S_{kt}| + a_k^* R_t + \beta_k^* R_t |S_{kt}| + \varepsilon_t$. R_t is a recession indicator.

*, **, *** indicates that the parameter is significant at a 10%, 5%, and 1% level of significance based on the Newey and West (1987) standard errors.

Table 4: Variance Announcement Regressions
Panel A: 8:30 Announcements

Announcement	Bond RV	Bond RV - Recession		Stock RV	Stock RV	
	b_k	b_k	b_k^*	b_k	b_k	b_k^*
Constant	-13.471***	-13.458***	-0.195**	-1.670***	-1.745***	0.739***
Business Inventories	0.133	0.107	0.210	0.526***	0.682***	-1.979**
Consumer Price Index	0.721***	0.756***	-0.473**	0.816***	0.805***	-0.334
Housing Starts	0.300***	0.306***	0.075	0.228**	0.246**	-0.130
Index of Leading Indicators	-0.197**	-0.212**	0.177	-0.099	-0.123	0.338
Nonfarm Payroll Employment	2.269***	2.256***	0.201	2.200***	2.195***	0.053
Personal Consumption Expenditures	-0.030	-0.031	0.038	0.060	0.066	-0.153
Producer Price Index	0.937***	0.951***	-0.127	1.073***	1.054***	0.239
Retail Sales	0.826***	0.823***	-0.041	0.803***	0.847***	-0.689*
Trade Balance	0.191***	0.168***	0.298	0.094	0.101	-0.132
GDP, Advance	1.396***	1.394***	0.057	1.620***	1.660***	-0.629
GDP, Preliminary	0.764***	0.789***	-0.461	0.858***	0.812***	0.920*
GDP, Final	0.322***	0.296***	0.360	0.406**	0.430**	-0.441
R^2	0.339		0.342	0.196		0.214
Wald test for $b_1^* = \dots d_K^* = 0$ (p-value)			0.008			0.000

Panel B: 10:00 Announcements

Announcement	Bond RV	Bond RV - Recession		Stock RV	Stock RV	
	b_k	b_k	b_k^*	b_k	b_k	b_k^*
Constant	-1.619***	-1.617***	-0.017	0.428***	0.359***	0.742***
Business Inventories	0.204***	0.233***	-0.353**	-0.417***	-0.405***	-0.037
Construction Spending	-0.089	-0.089	-0.035	-0.102	-0.076	-0.276
Consumer Confidence	0.373***	0.331***	0.674**	0.043	0.047	0.345**
Factory Orders	0.230***	0.236***	-0.070	0.102	0.122	-0.236
Institute for Supply Management Index	0.910***	0.914***		0.422***	0.425***	
New Home Sales	0.293***	0.332***	-0.425***	0.077	0.098	-0.168
Personal Consumption Expenditures	-0.029	-0.044	0.076	-0.517***	-0.601***	0.419*
R^2	0.061		0.063	0.014		0.059
Wald test for $b_1^* = \dots d_K^* = 0$ (p-value)			0.003			0.045

Columns one and three in the table show the estimated b_k s and the centered R^2 from the following regressions: $\log(RV_t) = a + \sum_{k=1}^K b_k D_{kt} + e_t$. RV_t is the bond realized variance

and stock realized variance, respectively, that applies in the relevant window around the announcement. The RV_t s are multiplied with 100,000. D_{kt} is the indicator function for announcement type k occurring at time t .

Columns two and four in the table show the estimated parameters and the centered R^2 from the following regressions: $\log(RV_t) = a + \sum_{k=1}^K b_k D_{kt} + a^* R_t + \sum_{k=1}^K b_k^* R_t D_{kt} + e_t$. R_t is a recession indicator.

*, **, *** indicates that the parameter is significant at a 10%, 5%, and 1% level of significance based on the Newey and West (1987) standard errors.

Table 5: Correlation News Regressions
Panel A: 8:30 Announcements

Announcement	(i)		(ii)			(iii)		
	β_k	R^2	β_k	β_k^*	R^2	β_k	$\beta_k^\#$	R^2
Business Inventories	-0.007	0.000	0.003	-0.385	0.050	0.126	-0.187	0.267
Consumer Price Index	-0.057	0.007	-0.079	0.125	0.054	0.036	-0.188	0.210
Housing Starts	-0.011	0.000	-0.035	0.440***	0.066	-0.092*	0.215**	0.120
Index of Leading Indicators	0.011	0.001	-0.007	0.272**	0.047	-0.004	0.029	0.100
Nonfarm Payroll Employment	0.109	0.022	0.091	0.027	0.050	0.054	0.245**	0.253
Personal Consumption Expenditures	-0.014	0.001	-0.011	-0.194	0.011	-0.048	0.185	0.126
Personal Income	-0.002	0.000	-0.003	0.016	0.008	0.008	-0.093	0.137
Producer Price Index	0.166**	0.064	-0.178**	0.112	0.113	-0.137	0.008	0.177
Retail Sales	-0.059	0.009	-0.087**	0.160***	0.066	-0.133**	0.224	0.124
Trade Balance	0.024	0.002	0.046	-0.025	0.065	-0.016	0.034	0.304
Unemployment Rate, Civilian	0.013	0.000	0.030	-0.159	0.039	0.042	-0.145	0.187
<i>Quarterly Announcements</i>								
GDP, Advance	-0.204	0.093	-0.228	0.619***	0.138	0.037	-0.606	0.367
GDP, Preliminary	-0.133	0.038	-0.119	0.153	0.103	-0.265**	0.229	0.322
GDP, Final	0.034	0.004	0.027	0.764***	0.135	-0.023	0.189	0.141

Panel B: 10:00 Announcements

Announcement	(i)		(ii)			(iii)		
	β_k	R^2	β_k	β_k^*	R^2	β_k	$\beta_k^\#$	R^2
Business Inventories	0.022	0.005	0.025	-0.098	0.018	0.022	-0.017	0.009
Construction Spending	-0.022	0.002	-0.036	0.197*	0.024	-0.033	0.060	0.304
Consumer Confidence	0.1200***	0.071	0.112**	0.007	0.131	0.071*	-0.015	0.427
Factory Orders	0.026	0.004	0.035	-0.049	0.016	0.061**	-0.151**	0.280
Institute for Supply Management Index	0.051	0.012	0.070	-0.232***	0.041	0.077	-0.039	0.384
New Home Sales	0.017	0.001	0.031	-0.279**	0.053	0.041	-0.106*	0.488
Personal Consumption Expenditures	0.025	0.009	0.010	0.062	0.027	0.030	-0.099*	0.190
Personal Income	-0.001	0.000	-0.009	0.194*	0.037	-0.015	0.084	0.177

(i) shows the estimated β_k s and the centered R^2 s from the following regressions: $F(RC_t) = \alpha_k + \beta_k S_{kt} + \varepsilon_t$. RC_t is the realized bond-stock correlation that applies in the relevant window around the announcement. S_{kt} is the standardized news for announcement k . F is the Fisher transform: $F(x) = \frac{1}{2} \log\left(\frac{1+x}{1-x}\right)$.

(ii) shows the estimated β_k s and β_k^* s and the centered R^2 from the following regressions: $F(RC_t) = \alpha_k + \beta_k S_{kt} + \alpha_k^* R_t + \beta_k^* R_t S_{kt} + \varepsilon_t$. R_t is a recession indicator.

(iii) shows the estimated β_k s and $\beta_k^\#$ s from the following regressions $F(RC_t) = \alpha_k + \beta_k S_{kt} + \alpha_k^\# [F(RC_{t-1}) < 0] + \beta_k^\# [F(RC_{t-1}) < 0] S_{kt} + \varepsilon_t$

*, **, *** indicates that the parameter is significant at a 10%, 5%, and 1% level of significance based on the Newey and West (1987) standard errors.

Table 6: Correlation Announcement Regressions
Panel A: 8:30 Announcements

Announcement	(i)	(ii)		(iii)	
	b_k	b_k	b_k^*	b_k	$b_k^\#$
Constant	0.136***	0.152***	-0.234**	0.278***	-0.378***
Business Inventories	-0.069	-0.063	-0.089	0.047	-0.181
Consumer Price Index	0.260***	0.273***	-0.212	0.294***	-0.213*
Housing Starts	0.063	0.080*	-0.159	0.034	0.118
Index of Leading Indicators	-0.021	-0.017	-0.040	-0.039	0.073
Nonfarm Payroll Employment	0.379***	0.340***	-0.289**	0.495***	-0.258**
Personal Consumption Expenditures	-0.004	-0.011	0.096	-0.039	0.036
Producer Price Index	0.287***	0.303***	-0.176	0.321***	-0.158
Retail Sales	0.103*	0.119*	-0.283**	0.094	0.102
Trade Balance	0.064	0.077*	-0.180	0.122***	-0.176**
GDP, Advance	0.313***	0.319***	-0.076	0.349***	-0.154
GDP, Preliminary	0.242**	0.269**	-0.540***	0.389***	-0.260
GDP, Final	-0.010	0.013	-0.264	-0.022	0.051
R^2	0.053	0.079		0.202	

Panel B: 10:00 Announcements

Announcement	(i)	(ii)		(iii)	
	b_k	b_k	b_k^*	b_k	$b_k^\#$
Constant	0.039*	0.059***	-0.206***	0.285***	-0.608***
Business Inventories	0.301***	0.273***	0.316***	0.067*	0.533***
Construction Spending	0.015	0.011	0.045	-0.038	0.270*
Consumer Confidence	-0.027	-0.014	-0.364***	0.014	-0.069
Factory Orders	0.043	0.038	0.031	-0.008	0.121*
Institute for Supply Management Index	0.091	0.093		0.145**	-0.360**
New Home Sales	0.070*	0.080**	-0.092	0.127***	-0.144**
Personal Consumption Expenditures	0.243***	0.207***	0.323***	0.054	0.338***
R^2	0.016	0.031		0.356	

(i) shows the estimated b_k s and the centered R^2 from the following regression: $F(RC_t) = a + \sum_{k=1}^K b_k D_{kt} + e_t$. RC_t is the bond-stock realized correlation that applies in the relevant

window around the announcement. D_{kt} is the indicator function for announcement type k occurring at time t . F is the Fisher transform: $F(x) = \frac{1}{2} \log\left(\frac{1+x}{1-x}\right)$.

(ii) shows the estimated parameters and the centered R^2 from the following regression:

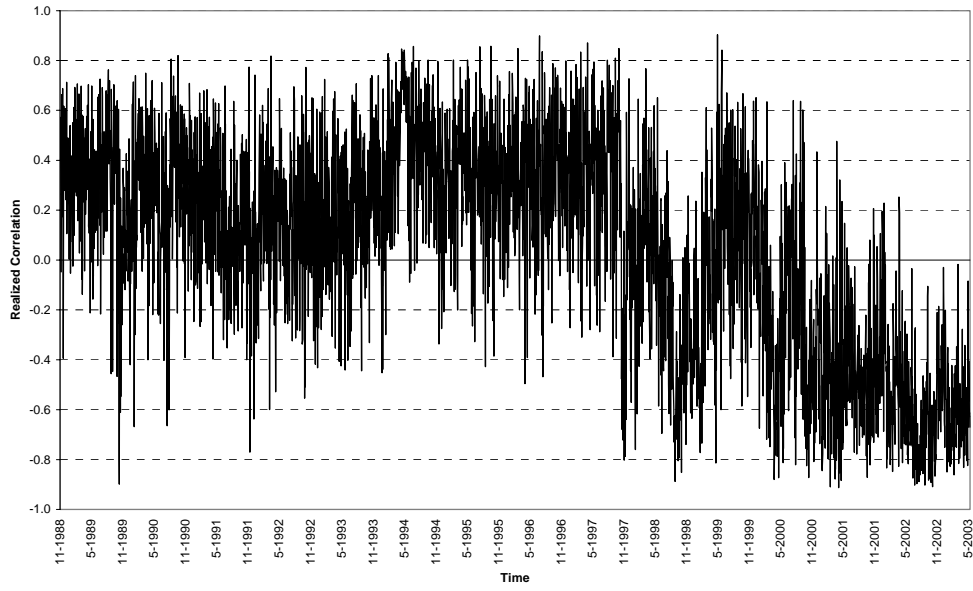
$$F(RC_t) = a + \sum_{k=1}^K b_k D_{kt} + a^* R_t + \sum_{k=1}^K b_k^* R_t D_{kt} + e_t. R_t \text{ is a recession indicator.}$$

(iii) shows the estimated parameters and the centered R^2 from the following regression:

$$F(RC_t) = a + \sum_{k=1}^K b_k D_{kt} + a^\# [F(RC_{t-1}) < 0] + \sum_{k=1}^K b_k^\# [F(RC_{t-1}) < 0] D_{kt} + e_t$$

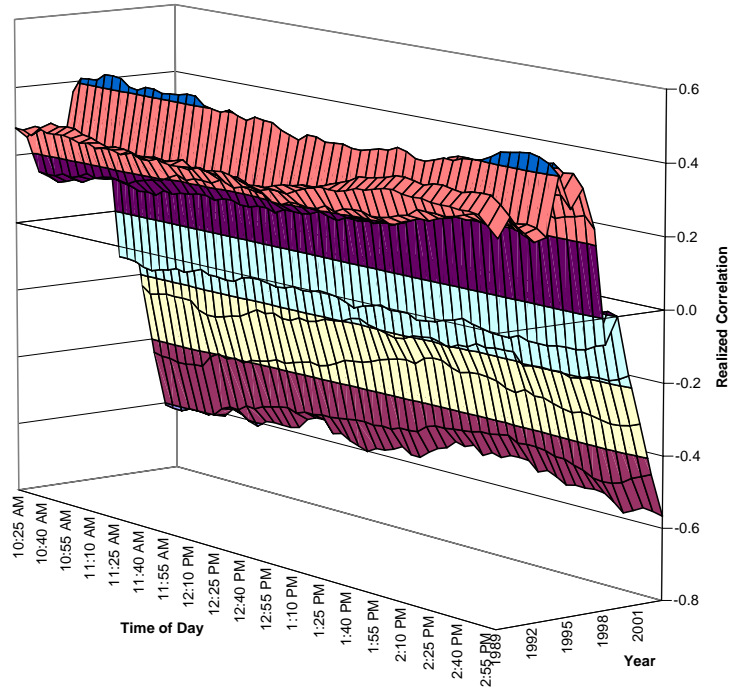
*, **, *** indicates that the parameter is significant at a 10%, 5%, and 1% level of significance based on the Newey and West (1987) standard errors.

Figure 1: Time Series of Realized Correlations



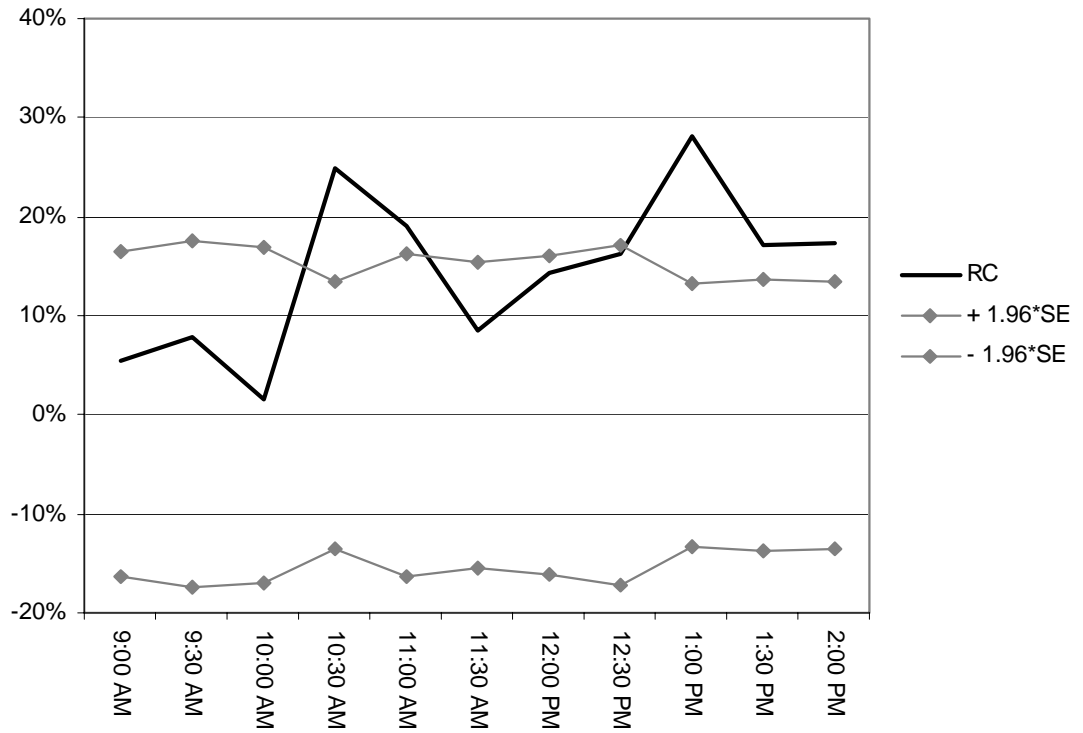
The figure shows the time series of the bond-stock realized correlation applying in the interval [9:50;11:30] each day.

Figure 2: Intraday Pattern of Average Bond-Stock Realized Correlation for Each Year



The figure shows the intraday pattern of the average hourly bond-stock realized correlation for each year.

Figure 3: Effects on Realized Correlation due to Large Positive Surprises from Factory Orders Announcements



The black line shows the average size of realized correlation during the day of Factory Orders announcements released at 10:00. The grey lines show the standard errors times 1.96 defining the 95% confidence interval. We define large positive surprises by taking the fifth quintile of the standardized surprise component of the news (34 observations).