The Cross-Market Information Content of Stock and Bond Order Flow

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In this paper I find strong evidence that aggregate order flow in the U.S. equity and Treasury markets can help to explain returns in the other market, even after controlling for own-market order flow. The direction and magnitude of the cross-market order flow-return relation varies through time, and is related to a measure of equity market uncertainty. The results indicate that trading activity in one market can aggregate information about economy-wide factors that is relevant for valuing securities in another market.

Key words: Cross-market; Order flow, Market microstructure
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"It's stocks, stocks, stocks" said Chris Rupkey, senior financial economist at Bank of Tokyo/Mitsubishi. "No matter what economic data come out, people just have all eyes on the stock market. It will be another frustrating week to trade because to guess at the direction of fixed-income, you have to know where stocks are going to trade."

- Reuters News, October 11, 2002

1. Introduction

Within a single market, it is well known that order flow may convey information about the value of a specific asset. For example, a buy order in a specific stock may lead market participants to revise upward their beliefs concerning the value of the stock. The same holds true in the Treasury market, although possibly for different reasons. Little attention has been paid, however, to the information content of order flow *across* markets. The linkages between the stock and bond markets are very strong, since many investors follow strategies in which they adjust their allocations to bonds and stocks through time. In addition, as the quote above makes clear, institutional traders in one market often closely watch trading activity in the other market. These links point to one question that has not been addressed to this point in the stock-bond literature: does order flow in one market convey information about asset values in the other market? In this paper I investigate whether equity market order flow conveys information about bond market returns, as well as whether bond market order flow conveys information about equity market returns.

There is a large body of theoretical and empirical literature proving that the information in stock trades leads to price changes in the equity market.[1] The existence in the

[1] See Bagehot (1971), Kraus and Stoll (1972), Kyle (1985), Easley and O'Hara (1987), Hasbrouck (1991), etc.

market of private information about future cash flows leads to the informativeness of trades in individual stocks. In the Treasury market, however, it is clear that no individual or institution has better information concerning the (nominal) payoff of a riskless bond. Yet Brandt and Kavajecz (2004), Green (2004), and Fleming (2001) all show that, as in the equity market, order flow does explain returns in the Treasury market at various intervals.

Why should order flow be informative about the value of a security when it contains no information about the terminal payoff of the security? The key is in expanding one's definition of private information beyond simply knowledge of future cash flows to include any information that is not known by all participants in the market. For example, information about an investor's attributes and beliefs is revealed through his trading strategy. As this information is not publicly known prior to his trade, it falls within this expanded definition of private information. When trading is aggregated across all market participants, this trading activity reveals important information concerning the investor population in general. Evans and Lyons (2002a) show in a simultaneous trade model of interdealer foreign exchange trading that shifts in market-wide demand for currencies due to changing risk preferences or endowments can lead to changes in exchange rates; thus, order flow in the currency market can explain returns even though there is no asymmetric information concerning the "payoffs" of individual currencies.[2] Lyons (2001) provides a simple example that gives intuition for why this is the case. Consider a two period trading model, in which trading takes place at time 0 and time 1, and the liquidation value of the security is realized at time two. The prices at which trading occurs are P_0 and P_1, and the liquidation value is V.

[2] Saar (2001) also builds a sequential trade model that produces similar implications in terms of the information content of order flow.

Thus the value at time 1 is $P_1 = E(V)/(1+d)$, where d is the 1 period discount rate. The normal view of private information concerns information about V, which is clearly relevant for the prices P_0 and P_1 since it affects the E(V) term. However, there may also be information that does not concern V, but that is still relevant in determining P_0 and P_1. For example, order flow may reveal information about the aggregate risk preferences and endowments of traders in the economy. Since these are important in determining discount rates, they are also useful in determining the interim prices P_0 and P_1.

Once one expands the concept of private information in order flow to include that described in the paragraph above, there is reason to believe that order flow in one market may convey important information about economy-wide factors that is relevant for valuing securities in another market. For example, Evans and Lyons (2002b) expand their single currency model to include multiple currencies and show that order flow in one currency may help to explain returns in another currency. The vector of price changes in their model from one period to the next is given by $\Delta P_t = \Delta R_t + \Lambda X_t$, where ΔR_t represents the flow of publicly available macroeconomic information that occurs in the period, X_t is the vector of interdealer order flows in the period, and the matrix Λ is a multivariate version of the price impact variable λ from Kyle's (1985) model. Evans and Lyons show that as long as customer order flow across currencies is correlated, Λ is non-diagonal and order flow has cross-market return implications. In order to accommodate economy-wide shifts in demand for certain currencies, dealers must take into account trade in other currencies as well in setting prices. The authors find strong empirical evidence that order flows in some currencies, especially the German mark and Japanese yen, have very significant cross-market effects. For example, in regressions of daily Swiss Franc returns on Swiss Franc order flow, the coefficient estimate for order flow is positive and statistically significant, but the adjusted R^2 is actually negative. When order flows from eight other currencies are added to the regression, the adjusted R^2 increases to 70%.[3]

In this paper I test for a similar relation between the stock and bond markets. Here again, shifts in demand in one market may signal marketwide changes in risk aversion, wealth levels, or general beliefs that will affect the interim values of assets in the other market. Alternatively, these shifts in demand may not necessarily signal *changes* in these characteristics; rather, the shifts may simply be important because traders are *uncertain* about these characteristics. Regardless of where the uncertainty lies, the decision by investors to move funds in and out of markets is an important signal that should help resolve the uncertainty.

The results show that cross-market order flow is indeed informative about intraday stock and bond returns in some periods. I first examine three one-month periods with distinctly different levels of equity market uncertainty, as indicated by the CBOE's Volatility index (VIX). Common factors of order flow in both the equity and Treasury market are significantly related to returns of individual securities in the other market, even after controlling for order flow in those securities. The strength and direction of this relation varies across the three periods; the low and medium volatility periods are associated with a positive cross-market relation, while the high volatility period is associated with a negative cross-market relation. When futures returns and common factors of own-market order flow are added to the specification, it appears that equity order flow plays a relatively larger cross-

[3] Danielsson, Payne, and Luo (2002) also find similar empirical evidence in the foreign exchange market regarding the importance of order flow across markets.

market role than does bond order flow. I then provide results showing that the one-month subperiod results hold in general across the entire sample period.

Several recent papers that examine the stock-bond relation are closely related to mine. Connolly, Stivers, and Sun (2003) show that the correlation between daily returns on stocks and bonds varies substantially over the 1986-2000 period.[4] They also find that this variation is related to the general level of uncertainty in the equity market; days of low uncertainty are associated with a positive stock-bond return correlation over the following month, while days of high uncertainty are more likely to be associated with a negative correlation. Fleming, Kirby, and Ostdiek (1998) document informational linkages between the stock, bond, and money markets using daily futures returns. And Chordia, Sarkar, and Subrahmanyam (2003) show that innovations to bid-ask spreads in the stock and bond markets are correlated during the 1990's. They link this variation in “micro” liquidity to variation in “macro” liquidity through monetary policy and mutual fund flows. I contribute to this literature by examining the importance of order flow in this relation across markets. I show that order flow has time-varying cross-market impacts, and that this time variation seems to be related to “macro” level uncertainty in the economy. The results indicate that increased market-wide uncertainty may lead to greater relevance for order flow in a cross-market framework. The results also provide empirical evidence that “cross-market hedging”, as discussed by Connolly, Stivers and Sun (2003) and Fleming, Kirby, and Ostdiek (1998), is present in certain periods.

This paper is also related to recent work by Anderson, Bollerslev, Diebold, and Vega (2004) and Boyd, Jagganathan, and Hu (2004), both of which document a stock market

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[4] See also Li (2002) for more on the time-varying correlation of stock and bond returns.

reaction to news that differs depending on the state of the economy. They interpret this as a result of the competing cash flow and discount rate effects in valuing equities. My results have similar interpretations, in that the behavior of traders in the financial markets has different implications depending on marketwide uncertainty about economic strength.

Finally, this paper builds on the work of Hasbrouck and Seppi (2001) regarding common factors in order flow. Hasbrouck and Seppi show that the first principal component of order flow in the Dow 30 stocks has incremental power in helping to explain returns of individual stocks. In this paper I show that the information contained in aggregate equity order flow is not only relevant within the stock market, but in the fixed income market as well.

The remainder of the paper is as follows: Section 2 describes the equity and Treasury market data used in the study. Section 3 formalizes the econometric approach used. The results are shown in Section 4, and Section 5 contains concluding remarks.

2. Data

2.1. Stock Data

For the equity market analysis I include the components of the Dow Jones Industrial Average from January 1, 1993 to August 31, 2000. The starting date is chosen to be January 1993 due to the starting date of the NYSE TAQ database. I end the sample in August 2000 due to an interruption in my version of the GovPX dataset at that point in time. I focus on the 30 Dow stocks because they are very actively traded and are less likely to be affected by traders with firm-specific private information than are smaller firms. Trading in these stocks is likely to reflect general shifts in investors' portfolios in aggregate. Such shifts are likely to be most relevant in a cross-market framework such as the one I examine. The companies making up the Dow Jones Index have an average market capitalization of $104.8 Billion and in sum represent approximately 25% of the total market capitalization of U.S. stocks.[5] As such, their trading activity serves well to approximate aggregate stock market activity. I perform the estimation on a month-by-month basis, and for each month I include all 30 Dow Jones components. There were several changes to the index during the 1990's, and companies are eliminated from the sample for a given month if they were added to or deleted from the index in that month. The 38 total companies used in the study are listed in the Appendix, along with the dates in which they are included in the study. For each individual stock in the sample, all trades and quotes from the NYSE TAQ database are collected for the entire period. Once the data is collected, I initially perform a series of checks to remove any erroneous data from the sample.

1. If either the bid or ask price for a given quote is equal to zero, that observation is removed from the sample.
2. If the quote or trade occurs before 9:30 am or after 4:00 pm, the observation is removed.
3. If the absolute spread for a given observation is greater than $5 per share, the observation is removed.
4. For the trade data, all observations are removed in which the trade price is more (less) than 1.5 (0.5) times the last trade price.

For each stock, I then divide each trading day into one minute intervals. The return over an interval is calculated using the midpoint of the last quote in each one minute period.

[5] Dow Jones Industrials Average factsheet, 2004.

Next, the net order flow is computed for each interval. To calculate net order flow, trades are first signed as buyer or seller initiated using the Lee and Ready (1991) algorithm. I then calculate net order flow in dollar terms by subtracting net sell volume (in dollars) from net buy volume. Net order flow is also calculated using the net number of trades. The net trade results, however, are qualitatively similar to the net dollar volume results, and as such are omitted from the paper.

For robustness in determining the cross market informational effects of bond market order flow, I also make use of the return on the nearby Standard & Poor's 500 futures contract from the Chicago Mercantile Exchange. Huang and Stoll (1994), Hasbrouck (1996), and Hasbrouck (2003) all show that the S&P futures serve as an important source of price discovery for the equity market. Thus the return on the contract serves as a useful benchmark in helping to determine the importance of cross-market order flow effects from the bond market.[6]

2.2. Bond Data

The data for the U.S. Treasury market is obtained from the GovPX dataset. GovPX maintains tick-by-tick trading data for all interdealer activity involving five of the top six interdealer brokers. From GovPX I retain all trading data for on-the-run Treasury securities for the entire sample. "On-the-run" indicates that a security is newly auctioned and is the most recently issued security in a given maturity class. On-the-run Treasuries are very actively traded and the market is extremely liquid. This choice of securities will be useful in looking for order flow effects related to market-wide factors, since they are less likely to be

[6] I thank Ray Fair for providing the S&P futures data on his website, http://fairmodel.econ.yale.edu.

affected by noisy trading than more seasoned Treasuries. Securities used in the sample are the three month, six month, and one year bills; two, three, five, and ten year notes; and the 30 year bond.[7] Although GovPX reports a small and decreasing fraction of trading in the 30 year bond, it is included here for the sake of completeness.[8]

For each on-the-run Treasury security, I collect the same information as was collected for equities: the return over the one minute interval, and the net order flow as measured by the net dollar volume. Of note here is the fact that trades do not have to be signed for bonds as was done with equities. The GovPX dataset clearly indicates whether each trade is a "hit" (sell) or a "take" (buy).

Before calculating the return and net order flow measures, the data is checked for erroneous observations by performing a series of screens:

1. If either a quoted bid price or ask price is equal to zero, the observation is removed from the sample.
2. If a trade price is greater than 125, the trade observation is removed from the sample.
3. If the quoted depth is greater than 1000 units (equal to $1 billion), the observation is removed. Such large depth figures are likely to be unreliable.
4. Finally, all trades and quotes recorded prior to 9:30 a.m. or after 4:00 p.m. are removed from the sample.

[7] The three year note is included through July 1998. The last quarterly auction of the three year note during the 1993-2000 period occurred in May 1998, thus it ceased being a normal on-the-run note during August of that year.

[8] Cantor Fitzgerald, the only major interdealer broker which does not participate in GovPX, is dominant in the long end of the yield curve.

The last data screen mentioned is worthy of further discussion in that there are no set trading hours for U.S. Treasury securities. However, Fleming (1997) reports that 95% of trading volume in the U.S. Treasury market occurs during the hours of 7:30 a.m. and 5:00 p.m. Given my goal of examining the relation between intraday bond and stock market activity, I choose to limit the study to activity occurring between 9:30 a.m. and 4:00 p.m, the hours of trading on the NYSE. To eliminate observations spanning the overnight period and avoid complications relating to the opening of trading on the NYSE, I drop the first 15 minutes of trading (9:30-9:45) from the analysis. Finally, all observations are eliminated which occur when the bond market is closed but the stock market is open. Such instances occur on certain holidays (such as Columbus Day), as well as after 2:00 p.m. on the day before holidays. The final sample gives a time series of return and order flow measures for the Dow Jones Industrial Average stocks and the on-the-run Treasuries for January 1993 through August 2000.

To check the robustness of any conclusions made concerning the cross-market informational effects of stock order flow on bond returns, I also make use of the return on the relevant Treasury futures contract which is traded on the Chicago Board of Trade. Since the futures pits are an important source of price discovery, including these returns in the analysis will help us make stronger statements regarding any cross-market effects that flow from stocks to bonds.[9]

3. Methodology

[9] For analysis involving the bond futures data all trading after 3:00 p.m. is dropped from the sample.

I follow the methodology of Hasbrouck (1991), as expanded by Chan, Chung, and Fong (2002) and Tookes (2003), in modeling the relation between stock and bond trades and quote revisions. Hasbrouck (1991) proposes a bivariate vector autoregression (VAR) of trades and quotes for individual stocks to measure the information content trading:

$$\begin{aligned} r_t &= \sum_{i=1}^{p} a_{1,i} r_{t-i} + \sum_{i=0}^{p} b_{1,i} x_{t-i} + \varepsilon_{1,t} \\ x_t &= \sum_{i=1}^{p} a_{2,i} r_{t-i} + \sum_{i=1}^{p} b_{2,i} x_{t-i} + \varepsilon_{2,t} \end{aligned} \tag{1}$$

Where r_t is the quote-midpoint return over the interval since the last transaction and x_t is the signed volume of the trade occurring at t. Note that this setup varies slightly from a traditional VAR in that the contemporaneous order flow is allowed to enter the return equation. This is based on the assumption that contemporaneous causality runs from trades to quotes, and is well grounded in theoretical models such as Kyle (1985).

Chan, Chung, and Fong (2002) and Tookes (2003) expand this setup to analyze the relation among multiple securities. For example, Chan, Chung, and Fong (2002) use this framework to gauge the information content of stock and option trading with a system of equations including both returns and order flows for calls, puts, and the underlying stock. I use a similar setup including returns and order flows for a single security, and common factors of returns and order flows from the other market. For example, the system below will be used to test for the relevance of a common factor of equity order flow in explaining returns in the five year Treasury note.

$$
\begin{aligned}
r_{5y,t} &= \sum_{i=1}^{p} a_{1,i} r_{5y,t-i} + \sum_{i=0}^{p} b_{1,i} of_{5y,t-i} + \sum_{i=1}^{p} c_{1,i} r_{equity,t-i} + \sum_{i=0}^{p} d_{1,i} of_{equity,t-i} + \varepsilon_{1,t} \\
of_{5y,t} &= \sum_{i=1}^{p} a_{2,i} r_{5y,t-i} + \sum_{i=1}^{p} b_{2,i} of_{5y,t-i} + \sum_{i=1}^{p} c_{2,i} r_{equity,t-i} + \sum_{i=1}^{p} d_{2,i} of_{equity,t-i} + \varepsilon_{2,t} \\
r_{equity,t} &= \sum_{i=1}^{p} a_{3,i} r_{5y,t-i} + \sum_{i=0}^{p} b_{3,i} of_{5y,t-i} + \sum_{i=1}^{p} c_{3,i} r_{equity,t-i} + \sum_{i=0}^{p} d_{3,i} of_{equity,t-i} + \varepsilon_{3,t} \\
of_{equity,t} &= \sum_{i=1}^{p} a_{4,i} r_{5y,t-i} + \sum_{i=1}^{p} b_{4,i} of_{5y,t-i} + \sum_{i=1}^{p} c_{4,i} r_{equity,t-i} + \sum_{i=1}^{p} d_{4,i} of_{equity,t-i} + \varepsilon_{4,t}
\end{aligned} \qquad (2)
$$

Here r_{5y} is the return on the five year Treasury note, of_{5y} is the order flow in the five year note, r_{equity} is the first principal component of returns for the 30 Dow stocks, and of_{equity} is the first principal component of order flow for the 30 Dow stocks. As in Chan, Chung, and Fong (2002), I use a calendar time approach rather than the transaction time approach of Hasbrouck (1991). Using clock intervals rather than transaction time facilitates the comparison of returns and order flows across markets.

One area of possible concern in the setup is the assumed interaction of order flows and returns, in which order flows contemporaneously affect returns but returns are not allowed to affect order flow in the same manner. Hasbrouck (1991) finds evidence of feedback trading in equities, where order flow appears to respond to past returns. In order to alleviate the concern that returns could be driving order flows within a period of time, I choose one minute intervals for the VAR analysis. While there is still the possibility that traders use price-dependent strategies at such frequencies, the likelihood is small. The choice of a one-minute interval gives sufficient levels of trading activity while keeping the potential issues associated with feedback trading to a minimum. In each equation I include the contemporaneous value (for order flows only) and the first five lags of all explanatory variables.[10]

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[10] The results are insensitive to adding additional lags.

Of course, the possibility remains that any cross-market informational effect found may simply capture some omitted variable which is related to trading within the asset's market. To help control for this possibility, for each period I also estimate each VAR specification with additional "benchmark" variables. In testing the cross-market importance of equity order flow, for example, returns on the relevant Treasury futures contracts are included in the VAR along with the already mentioned variables. In addition, I include along with the bond's own order flow the first principal component of bond market order flow.

A similar robustness check is used in evaluating the cross-market informational content of bond market order flows for stock returns. Here I use returns on the nearby Standard and Poor's 500 Index futures contracts. As with the bond futures, the S&P futures are an important source of price discovery and are useful in testing for the true cross-market importance of bond market order flows. I also include the first principal component of equity order flow along with the own-security order flow as in the example above. Hasbrouck and Seppi (2001) show that the first principal component of order flow is useful in helping to explain intraday returns on Dow stocks.

4. Results

Previous literature (see Connolly, Stivers, and Sun (2003)) tells us that the relation between daily stock and bond returns varies through time.[11] In periods of relatively high stock market uncertainty (the authors use the CBOE VIX index as a proxy), the correlation between stocks and bonds is more likely to be negative. In periods of lower uncertainty, the correlation between stock and bond returns is much more likely to be positive. I first confirm

[11] See also Li (2002).

that the results these authors find on a daily level hold when returns are examined on a minute-by-minute basis. Monthly correlations between the first principal components of stock and bond returns are estimated for the entire period of January 1993 to August 2000. Fig. 1 shows the time series of these monthly correlations. The plot confirms that the correlation between intraday returns across markets does vary significantly over time, with the correlation predominantly positive in the first half of the sample and mostly negative in the latter part of the sample. This is in line with the regimes found by Connolly, Stivers, and Sun. I now estimate the VAR models from the previous section on a month-by-month basis for the entire 1993-2000 sample period. For brevity, I only present in-depth estimation results for three one month periods; the overall month-by-month results will be discussed following the subperiod results.

The choice of subperiods for in depth analysis is based on the general level of uncertainty in the stock market. Given the Connolly, Stivers, and Sun results, I choose three one-month periods based on the average level of the VIX index during the month. Fig. 2 shows the time series of monthly observations for the VIX index from January 1993 through August 2000. Implied volatility was clearly much lower in the first half of the sample before increasing in later years. The large spikes in late 1997 and 1998 coincide with the Asian crisis and the Russian debt crisis. The first one-month period I choose is December 1993, during which the average VIX level reached its minimum of about 11%. The second period chosen is August 1998, when the maximum VIX of 39% occurred. I also choose November 1996 as a month in which VIX was around 19%, or approximately the average across all the months in the sample. This gives an opportunity to observe the dynamics of the stock-bond order flow-return relation in three periods with distinctly different levels of general uncertainty.

I begin by showing summary statistics concerning returns, order flows, and average trading activity in the stock and bond markets during the three subperiods. Table 1 shows means and standard deviations of returns, net order flows, number of trades, and number of quote updates for each individual Treasury and the average across all stocks in the sample. A couple of interesting patterns emerge in the data. For the equities, there is a general upward trend in trading activity across the three subperiods. Trading activity per one-minute interval, both in terms of the number of trades and the number of quote updates, more than doubled between December 1993 and August 1998. The pattern is less clear for Treasuries, although it is clear that the two, five, and ten year notes are the most active securities in terms of trading and quoting frequency. In general, all of the securities are actively traded, with every security having at least 1.88 quote updates per minute.

In order to concisely present results, I will focus on the importance of cross-market order flow for one stock and one Treasury security. Results are quantitatively similar for most other securities, with the exception of some Treasuries. The securities chosen are General Electric and the five year Treasury note. These are the two most frequently traded securities in each market sample and provide a representative picture of the nature of the cross-market relation.

4.1. Subperiod Results

4.1.1. December 1993

As mentioned earlier, I choose December 1993 as a "low volatility" subperiod. The results here will show a period in which investors in aggregate have relatively low levels of uncertainty, at least as measured by the VIX index. Table 2 shows results from the VAR which tests for the cross-market importance of equity order flow.[12] This VAR includes the return (in basis points) on the five-year Treasury note, order flow (in millions of dollars) in the five year note, the first principal component of returns in the 30 Dow stocks, and the first principal component of net order flow in the Dow stocks. Estimation is done using equation-by-equation ordinary least squares. Some general features of the results are readily apparent. First, returns on the five-year Treasury exhibit strong negative autocorrelation. Also, as one would expect, current order flow in the five-year is strongly positively related to returns on that security. The significance of the first lag of order flow may indicate a lagged price adjustment to the information in order flow. Also, order flow in both the five-year Treasury and the equity common factor display a fair amount of persistence. The results of most interest in this study are contained in the last rows of the first column, which is the column representing the equation for five year note returns. Lagged equity returns clearly show no relation with the Treasury return, but the concurrent equity order flow shows up with a positive and significant relation.

In Table 3, the direction of interest is reversed. Now I ask the question of whether aggregate bond market order flow helps to explain the returns on individual stocks. As mentioned earlier, I will focus on General Electric as a representative stock. This VAR includes the return (in basis points) on GE stock, order flow (in thousands of dollars) in GE stock, the first principal component of returns in on-the-run Treasuries, and the first principal component of net order flow in the on-the-run Treasuries. The general results are similar to

[12] In this and the following tables, parameter estimates are only displayed up to the third lag in order to conserve space.

those in Table 2, except that the when we consider the aggregate bond market return (as opposed to the return on the five-year note), it is now positively related to its lagged value. Of most interest here is the lack of a role for cross-market order flow. Aggregate bond market order flow shows no significant relation to the return on General Electric stock. Thus the results for this period of low uncertainty are mixed; equity order flow is significantly related to bond returns, while bond order flow does not appear to be related to the return of GE stock.

4.1.2. November 1996

November 1996 is chosen as a representative month due to its "average" level of uncertainty. As mentioned earlier, the average closing level of the VIX index during the month was just over 19%. This is approximately equal to the mean and median of the monthly VIX averages over the sample period. Table 4 shows the estimation results from the baseline VAR for five-year note returns for the month of November 1996. The results are similar to those from December 1993, with a few notable exceptions. First, aggregate equity returns are now highly persistent. Most importantly, though, there now seems to be a much stronger role for cross-market informational effects. There is a significant positive relation between five-year note returns and lagged equity returns. There is also a significant positive relation between contemporaneous equity order flow and five-year note returns.

The results for General Electric in Table 5 are similar in nature. GE returns are positively related to lagged bond market returns, and are also positively related to concurrent bond market order flow. There is also some evidence of a negative relation between lagged bond flows and GE returns, although the size of the coefficient is small relative to that for the contemporaneous order flow.

Thus far the results for the two subperiods indicate that the strength of the cross-market relation varies across time periods. In a period of low volatility or uncertainty such as December 1993, there is some evidence of order flow in the equity market having power to explain returns in the bond market. In a more "average" period such as November 1996, however, there is greater evidence of an informational role for order flow in a cross-market sense. I now turn to a period of great economic uncertainty to determine if the relation is even stronger in such a time.

4.1.3. August 1998

August 1998 witnessed the Russian debt default and a great deal of general turmoil in world financial markets. The month was one of great uncertainty as reflected by the highest monthly VIX average in the sample at over 39%. As such, it provides a natural environment for testing whether the cross-market importance of order flows increases in periods of greater uncertainty concerning economic fundamentals. Table 6 begins by showing the VAR parameter estimates for five-year Treasury note returns. The most interesting results here lie in the importance of the cross-market order terms. First, lagged returns on the equity common factor are significantly related to five-year note returns. In addition, contemporaneous equity order flow is strongly related to Treasury returns. The direction of these relations is quite different from the earlier subperiods. While the direction was positive in 1993 and 1996, it is now decidedly negative.

The results in Table 7 for General Electric stock are similar in nature. GE returns are negatively related to lagged bond returns. There is also the same negative relation between bond order flows and GE returns, although the coefficient on the first lag is now significantly positive. Taken together, these results point to a significant role for cross-market order flow in terms of its ability to explain returns.

4.2. Robustness

The subperiod results observed thus far indicate that order flow across the stock and bond markets does help to explain individual security returns. However, the possibility remains that the information contained in cross-market order flow is already captured by variables more closely related to trading in the security of interest. To examine this, I expand the VAR system used earlier to include common factors of *own-market* order flow as well as the relevant futures returns. For example, the system in equation (2) now becomes

$$\begin{aligned}
r_{5y,t} &= \sum_{i=1}^{5} a_{1,i} r_{5y,t-i} + \sum_{i=0}^{5} b_{1,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{1,i} r_{equity,t-i} + \sum_{i=0}^{5} d_{1,i} of_{equity,t-i} + \sum_{i=1}^{5} e_{1,i} r_{futures,t-i} + \sum_{i=0}^{5} f_{1,i} of_{bond,t-i} + \varepsilon_{1,t} \\
of_{5y,t} &= \sum_{i=1}^{5} a_{2,i} r_{5y,t-i} + \sum_{i=1}^{5} b_{2,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{2,i} r_{equity,t-i} + \sum_{i=1}^{5} d_{2,i} of_{equity,t-i} + \sum_{i=1}^{5} e_{2,i} r_{futures,t-i} + \sum_{i=1}^{5} f_{2,i} of_{bond,t-i} + \varepsilon_{2,t} \\
r_{equity,t} &= \sum_{i=1}^{5} a_{3,i} r_{5y,t-i} + \sum_{i=0}^{5} b_{3,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{3,i} r_{equity,t-i} + \sum_{i=0}^{5} d_{3,i} of_{equity,t-i} + \sum_{i=1}^{5} e_{3,i} r_{futures,t-i} + \sum_{i=0}^{5} f_{3,i} of_{bond,t-i} + \varepsilon_{3,t} \\
of_{equity,t} &= \sum_{i=1}^{5} a_{4,i} r_{5y,t-i} + \sum_{i=1}^{5} b_{4,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{4,i} r_{equity,t-i} + \sum_{i=1}^{5} d_{4,i} of_{equity,t-i} + \sum_{i=1}^{5} e_{4,i} r_{futures,t-i} + \sum_{i=1}^{5} f_{4,i} of_{bond,t-i} + \varepsilon_{4,t} \\
r_{futures,t} &= \sum_{i=1}^{5} a_{5,i} r_{5y,t-i} + \sum_{i=1}^{5} b_{5,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{5,i} r_{equity,t-i} + \sum_{i=1}^{5} d_{5,i} of_{equity,t-i} + \sum_{i=1}^{5} e_{5,i} r_{futures,t-i} + \sum_{i=0}^{5} f_{5,i} of_{bond,t-i} + \varepsilon_{5,t} \\
of_{bond,t} &= \sum_{i=1}^{5} a_{6,i} r_{5y,t-i} + \sum_{i=1}^{5} b_{6,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{6,i} r_{equity,t-i} + \sum_{i=1}^{5} d_{6,i} of_{equity,t-i} + \sum_{i=1}^{5} e_{6,i} r_{futures,t-i} + \sum_{i=1}^{5} f_{6,i} of_{bond,t-i} + \varepsilon_{6,t}
\end{aligned} \tag{3}$$

Where $r_{futures}$ represents the return on the five-year futures contract from the CBOT and of_{bond} represents the first principal component of bond market order flow.[13]

The results of the expanded analysis are shown in Table 8. Coefficient estimates are only shown for the cross-market order flow term. Panel A shows results for General Electric stock. The coefficient for contemporaneous bond market order flow in December 1993 is

[13] The system used for General Electric stock is similar, except that S&P futures returns and a common factor of equity order flow are used.

once again insignificant, as in Table 3. There is now only marginal significance for the same coefficient estimate in November 1996, with a t-statistic of 1.93 compared to 3.47 in the baseline system. And while the estimate for August 1998 continues to be marginally significant and negative, it is interesting to note the strong *positive* significance of the estimates for lagged bond order flow. Panel B shows results for the five year note. In the 1993 and 1996 subperiods, the contemporaneous equity order flow remains significant at the 5% level. And in August 1998, the contemporaneous equity order flow is still significant at the one percent level. Taken together, the results indicate that the cross-market role of equity order flow is more robust to the inclusion of futures returns and common factors of order flow. Aggregate order flow in the 30 Dow stocks continues to play a significant role in explaining returns on the five-year Treasury note.

4.3. Discussion of Results

The results for the three subperiods presented provide a snapshot of the importance of order flow in a cross-market sense. The major results are:

1. Order flow in the stock and bond markets does serve to aggregate information about market-wide factors that affects the valuation of individual securities.
2. In general, equity order flow is more informative about individual bond returns than bond order flow is about individual stock returns, at least in terms of statistical significance of the VAR parameter estimates. This result is especially true after the inclusion of futures returns and common factors of own-market order flow.
3. The importance of the cross-market order flow term varies through time, and this variation is related to general levels of uncertainty in the equity market as measured by VIX. Moreover, the direction of the cross-market relation also varies across

periods, with a positive relation holding in more "calm" periods and a negative relation holding in more "volatile" periods.

With regard to the result #1, some clarification is in order. My results do not necessarily imply that traders in a given market are actually observing order flow in the other market on a minute-by-minute basis and updating their beliefs based on this. It is highly unlikely that a Treasury trader is actually observing the trades that occur in the Dow stocks intraday. However, he may have access to information which is indicative of order flow in the other market. For example, communication with his firm's equity trading desk may give him an indication of what the firm's order book looks like for stocks. So while the cross-market order flow may not be informative in the sense of a typical microstructure model where market makers directly observe order flow, it is informative in that market participants may observe some proxy for it.

The second result pertains to the cross-market importance of equity order flow vs. bond order flow. I find that in all three periods presented equity order flow plays a significant role in explaining five-year note returns. This is robust to the inclusion of bond futures returns and the bond order flow common factor. However, evidence that Treasury order flow helps in explaining returns for General Electric stock is weakened in the presence of S&P futures returns and the equity order flow common factor. Several factors are likely at work here. First, the returns on individual stocks are much more likely to be affected by idiosyncratic factors than are bonds. The results of a monthly principal components analysis for one minute bond and stock returns (not shown) indicate that the first principal component of stock returns explains, on average, about five to ten percent of the variation in Dow stock returns. The first principal component of bond returns, however, typically explains about

30% of the variation in returns. This implies that a variable containing aggregated information is much more likely to be relevant in valuing a Treasury security than an individual stock. If this is the case, then an *aggregate* return measure for the stock market should be more closely related to bond market order flow than the return on an individual stock. In addition, when futures returns are added to the specifications, it is more likely that the S&P futures are quickly incorporating the information that is in bond order flow. Bond futures, on the other hand, are possibly affected by idiosyncratic factors such as cheapest-to-deliver issues and so may leave more room for equity order flow to have strong explanatory power.

As mentioned above, it may be the case that individual equities are less related to the cross-market order flow because their returns are more idiosyncratic. To examine this possibility, Table 9 shows VAR results where the individual security variables are removed and replaced with common factors. That is, the five variables in the VAR are now the first principal components of equity returns, equity order flow, bond returns, bond order flow, and the given futures returns. The results indicate that bond market order flow is much more informative for aggregate equity returns, at least in the last two subperiods, than it is in the GE return regressions. In both cases the coefficient on contemporaneous order flow is significant at the one percent level. Thus the results do indicate that bond market order flow has greater cross-market information content for a stock portfolio than for individual stocks.

I now turn to the third result concerning the variation through time in the importance of the cross-market order flow terms. I find that in periods of greater "uncertainty" (as measured by the level of the CBOE VIX index), order flow has greater information content across markets, at least in terms of significance of the VAR coefficient estimates. From a theoretical standpoint, this is in line with the predictions of models such as Kyle (1985). In Kyle's model, λ is increasing in the uncertainty concerning the terminal value of the asset. In the present scenario, the importance of aggregate cross-market order flow is increasing in the uncertainty surrounding the macro-level factors such as risk preferences and endowments.

While the three subperiods suggest that the results follow this general pattern, I now provide evidence that the same pattern holds throughout the entire 1993-2000 sample and across securities. Table 10 presents the time series correlation between the VIX level for a given month and the sum of the VAR coefficients which measure the importance of cross-market order flow in explaining security returns. This sum is given by $\sum_{i=0}^{5} d_{1,i}$ from the VAR system given in (2). In most cases, there is a strong and statistically significant negative correlation between the average VIX level and the sum of the coefficient estimates for cross-market order flow. That is, as the level of uncertainty in the equity market rises, cross-market order flow is more negatively related to individual security returns. For bonds, the result only holds for the two, five, and ten year notes. For equities, however, the result holds for all of the stocks, with all but two exhibiting a correlation which is significant at the 1% level. The difference across Treasuries is an interesting one. As mentioned earlier, the two, five, and ten year notes are the most frequently quoted and traded Treasuries. The increased sensitivity to equity market uncertainty may be related to their higher volume, and possibly their being dominated by a different group of traders than other Treasuries. Another related explanation is that these Treasury securities share a special link with the equity market. Given that the average duration of the Lehman Brothers aggregate bond index is between four and five years, it is likely that money flowing into and out of the bond market will have the strongest effect on this area of the yield curve (the strongest negative correlations are for the two and five year notes).

Why does the direction of the relation between cross-market order flow and returns change through time? One likely explanation is that in relatively calm periods (characterized by low to moderate VIX levels) money flowing into (out of) one market indicates increased levels of money flowing into (out of) markets in general. At the same time, there is little uncertainty about aggregate risk aversion, so order flow transmits relatively little information about this characteristic. Consider, however, a period of much higher aggregate uncertainty such as August 1998 and subsequent months. Here order flow in the equity market may contain much more information about the level of risk investors are willing to take on, or about their assessment of the riskiness of stocks. Money flowing out of the equity market indicates investors are leaving risky assets, presumably to place these funds in safe Treasury securities. Note that this argument does not necessarily rely on investors making minute-to-minute portfolio rebalancing decisions. It only depends on the assumption that investors in general are making these types of decisions on a regular basis. In aggregate, this behavior will then show up in intraday trading activity.

5. Conclusions

My results give strong evidence that intraday order flow in a securities market can contain information that is valuable in terms of explaining returns in another market. Using a multivariate VAR with order flows and returns from the stock and bond markets, I find that aggregate order flow in the equity market plays a significant role in explaining individual Treasury returns. Moreover, this result is robust to the inclusion of futures market returns in the VAR specification. In addition, I find evidence that in some periods Treasury order flow does provide information that helps to explain individual stock returns. However, when the return on the nearby S&P futures contract is added to the VAR system, it appears that most of the cross-market order flow information is captured by the futures return series.

These findings have important implications in terms of our understanding of the information in trading activity. Recent research such as Hasbrouck and Seppi (2001) has found that aggregate equity order flow is informative about the returns on individual stocks. My paper shows that this information in aggregate flows may be relevant *across* securities markets. Clearly, the cross-market order flow in the stock-bond setting should not be informative in terms of the nominal payoff of an individual asset. However, it may contain valuable information about the interest rate that is used to discount the future cash flows of an asset. Although it adds a level of complexity to theoretical and empirical models, to ignore the importance of trading in another market is to ignore a valuable piece of information concerning this discount rate.

Appendix A.: Dow Jones Industrials Components used in sample

Symbol	Name	Begin Date	End Date
AA	Alcoa	1/1/1993	8/31/2000
ALD	Allied Signal	1/1/1993	11/30/1999
AXP	American Express	1/1/1993	8/31/2000
BA	Boeing	1/1/1993	8/31/2000
CAT	Caterpillar	1/1/1993	8/31/2000
DD	Dupont	1/1/1993	8/31/2000
DIS	Disney	1/1/1993	8/31/2000
EK	Eastman Kodak	1/1/1993	8/31/2000
GE	General Electric	1/1/1993	8/31/2000
GM	General Motors	1/1/1993	8/31/2000
IBM	International Business Machines	1/1/1993	8/31/2000
IP	International Paper	1/1/1993	8/31/2000
JPM	JP Morgan	1/1/1993	8/31/2000
KO	Coca-Cola	1/1/1993	8/31/2000
MCD	McDonald's	1/1/1993	8/31/2000
MMM	Minnesota Mining and Manufacturing	1/1/1993	8/31/2000
MO	Philip Morris	1/1/1993	8/31/2000
MRK	Merck	1/1/1993	8/31/2000
PG	Procter and Gamble	1/1/1993	8/31/2000
T	AT&T	1/1/1993	8/31/2000
UTX	United Technologies	1/1/1993	8/31/2000
GT	Goodyear	1/1/1993	10/31/1999
S	Sears	1/1/1993	10/31/1999
CHV	Chevron	1/1/1993	10/31/1999
UK	Union Carbide	1/1/1993	10/31/1999
XON	Exxon	1/1/1993	11/30/1999
Z	Woolworth's	1/1/1993	2/28/1997
WX	Westinghouse	1/1/1993	2/28/1997
BS	Bethlehem Steel	1/1/1993	2/28/1997
TX	Texaco	1/1/1993	2/28/1997
TRV	Travelers	4/1/1997	9/30/1998
HWP	Hewlett Packard	4/1/1997	8/31/2000
JNJ	Johnson & Johnson	4/1/1997	8/31/2000
WMT	Wal-Mart	4/1/1997	8/31/2000
CCI	Citigroup	11/1/1998	11/30/1998
C	Citicorp	12/1/1998	8/31/2000
XOM	Exxon Mobil	12/1/1999	8/31/2000
HON	Honeywell	12/1/1999	8/31/2000

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Table 1: Summary Statistics

This table presents means and standard deviations (in italics) for returns, net order flow, the number of trades, and the number of quote revisions for one minute intervals in the three subperiods of December 1993, November 1996, and August 1998. Returns are in basis points, and net order flow is in thousands of dollars.

	Returns (Basis points)			Net Order Flow ($1,000's)			Number of Trades			Number of Quote Revisions		
	12/93	11/96	8/98	12/93	11/96	8/98	12/93	11/96	8/98	12/93	11/96	8/98
3 month	0.0045	0.0005	-0.0020	1041	1626	1132	0.42	0.38	0.3	1.91	2.63	2.28
	0.09	*0.05*	*0.07*	*30381*	*31882*	*16925*	*0.65*	*0.68*	*0.59*	*1.42*	*2.35*	*2.08*
6 month	0.0077	0.0006	-0.0018	1705	355.9	-191	0.4	0.34	0.22	1.88	2.46	1.97
	0.14	*0.13*	*0.12*	*29308*	*23053*	*21871*	*0.62*	*0.64*	*0.52*	*1.37*	*2.17*	*1.59*
1 year	0.0063	0.0001	-0.0011	398.5	-352	-0.87	0.4	0.46	0.38	1.96	2.96	2.87
	0.19	*0.13*	*0.24*	*20111*	*20830*	*19901*	*0.65*	*0.74*	*0.69*	*1.43*	*2.41*	*2.46*
2 year	0.0079	-0.0001	0.0093	1584	672.5	1211	0.64	0.8	0.9	3.42	5.36	6.21
	0.32	*0.30*	*0.43*	*69650*	*23949*	*37834*	*0.87*	*1.16*	*1.23*	*3.44*	*4.27*	*4.81*
3 year	0.0120	0.0036	-	198.8	324	-	0.52	0.66	-	3	4.48	-
	0.51	*0.41*	-	*14108*	*12673*	-	*0.75*	*0.93*	-	*2.92*	*3.47*	-
5 year	0.0100	0.0012	0.0180	144.8	528.2	500.1	0.9	1.45	1.36	4.41	8.32	8.46
	0.71	*0.72*	*0.86*	*16090*	*18713*	*21951*	*1.08*	*1.5*	*1.4*	*3.75*	*5.79*	*5.84*
10 year	0.0140	-0.0074	0.0270	251.4	364.2	395	0.99	1.36	1.12	4.46	7.34	7.13
	1.20	*1.30*	*1.30*	*10128*	*13963*	*16458*	*1.09*	*1.34*	*1.19*	*3.27*	*4.55*	*4.54*
30 year	0.0680	0.0610	0.0036	215.2	144.3	34.46	0.34	0.7	0.55	2.32	3.58	3.81
	2.60	*2.50*	*2.00*	*5082*	*4764*	*5787*	*0.59*	*1.01*	*0.9*	*1.83*	*2.6*	*2.87*
Avg.	0.0039	0.0575	-0.1895	0.2873	0.6020	0.2547	2.2563	2.9343	5.1153	3.3087	4.2467	8.6280
Stock	*14.77*	*13.38*	*12.87*	*8.505*	*11.574*	*12.034*	*1.61*	*2.25*	*3.98*	*2.69*	*3.65*	*5.58*

Table 2. This table presents OLS parameter estimates of the following VAR specification which is estimated for the month of December 1993:

$$r_{5y,t} = \sum_{i=1}^{5} a_{1,i} r_{5y,t-i} + \sum_{i=0}^{5} b_{1,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{1,i} r_{equity,t-i} + \sum_{i=0}^{5} d_{1,i} of_{equity,t-i} + \varepsilon_{1,t}$$

$$of_{5y,t} = \sum_{i=1}^{5} a_{2,i} r_{5y,t-i} + \sum_{i=1}^{5} b_{2,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{2,i} r_{equity,t-i} + \sum_{i=1}^{5} d_{2,i} of_{equity,t-i} + \varepsilon_{2,t}$$

$$r_{equity,t} = \sum_{i=1}^{5} a_{3,i} r_{5y,t-i} + \sum_{i=0}^{5} b_{3,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{3,i} r_{equity,t-i} + \sum_{i=0}^{5} d_{3,i} of_{equity,t-i} + \varepsilon_{3,t}$$

$$of_{equity,t} = \sum_{i=1}^{5} a_{4,i} r_{5y,t-i} + \sum_{i=1}^{5} b_{4,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{4,i} r_{equity,t-i} + \sum_{i=1}^{5} d_{4,i} of_{equity,t-i} + \varepsilon_{4,t}$$

r_{5y} is the log quote midpoint return for the 5-year Treasury note over the last minute, of_{5y} is the net order flow (in millions of dollars) in the 5-year note, r_{equity} is the first principal component of returns for the 30 Dow stocks, and of_{equity} is the first principal component of net order flow for the 30 Dow stocks. To conserve space, estimates for lags 4 and 5 are not shown. *(**)[***] indicates statistical significance at the 10% (5%)[1%] level.

Explanatory Variables	Dependent Variables			
	$r_{5y,t}$	$of_{5y,t}$	$r_{equity,t}$	$of_{equity,t}$
$r_{5y,t-1}$	-0.050*** *-4.491*	0.002*** *6.319*	0.030 *1.459*	-0.009 *-0.426*
$r_{5y,t-2}$	-0.041*** *-3.708*	0.000 *1.607*	0.046** *2.203*	-0.026 *-1.204*
$r_{5y,t-3}$	-0.025** *-2.229*	-0.001** *-2.449*	0.048** *2.317*	-0.036* *-1.693*
$of_{5y,t}$	0.015*** *35.345*		-0.00004 *-0.0554*	
$of_{5y,t-1}$	0.002*** *4.847*	0.078*** *6.489*	0.0008 *0.948*	-0.0013 *-1.413*
$of_{5y,t-2}$	-0.0005 *-1.082*	0.018 *1.499*	0.0016* *1.815*	0.0007 *0.811*
$of_{5y,t-3}$	-0.0001 *-0.214*	0.045*** *3.829*	0.0010 *1.121*	0.0012 *1.322*
$r_{equity,t-1}$	-0.003 *-0.564*	0.000 *-1.518*	-0.156*** *-14.162*	0.010 *0.897*
$r_{equity,t-2}$	-0.001 *-0.230*	0.000 *-0.616*	0.018 *1.592*	0.002 *0.191*
$r_{equity,t-3}$	0.004 *0.611*	0.000 *0.453*	0.072*** *6.486*	0.009 *0.759*
$of_{equity,t}$	0.012** *2.029*		0.006 *0.580*	
$of_{equity,t-1}$	0.001 *0.109*	0.000 *-0.471*	-0.012 *-1.108*	0.051*** *4.582*
$of_{equity,t-2}$	-0.005 *-0.818*	0.000 *-0.093*	-0.003 *-0.301*	0.007 *0.642*
$of_{equity,t-3}$	0.005 *0.825*	0.000 *-0.197*	0.016 *1.500*	0.021* *1.898*
Adjusted R^2	0.138	0.018	0.032	0.003

Table 3. This table presents OLS parameter estimates of the following VAR specification which is estimated for the month of December 1993:

$$r_{GE,t} = \sum_{i=1}^{5} a_{1,i} r_{GE,t-i} + \sum_{i=0}^{5} b_{1,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{1,i} r_{bond,t-i} + \sum_{i=0}^{5} d_{1,i} of_{bond,t-i} + \varepsilon_{1,t}$$

$$of_{GE,t} = \sum_{i=1}^{5} a_{2,i} r_{GE,t-i} + \sum_{i=1}^{5} b_{2,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{2,i} r_{bond,t-i} + \sum_{i=1}^{5} d_{2,i} of_{bond,t-i} + \varepsilon_{2,t}$$

$$r_{bond,t} = \sum_{i=1}^{5} a_{3,i} r_{GE,t-i} + \sum_{i=0}^{5} b_{3,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{3,i} r_{bond,t-i} + \sum_{i=0}^{5} d_{3,i} of_{bond,t-i} + \varepsilon_{3,t}$$

$$of_{bond,t} = \sum_{i=1}^{5} a_{4,i} r_{GE,t-i} + \sum_{i=1}^{5} b_{4,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{4,i} r_{bond,t-i} + \sum_{i=1}^{5} d_{4,i} of_{bond,t-i} + \varepsilon_{4,t}$$

r_{GE} is the log quote midpoint return for General Electric stock over the last minute, of_{GE} is the net order flow (in thousands of dollars) in GE stock, r_{bond} is the first principal component of returns for the on-the-run Treasuries, and of_{bond} is the first principal component of net order flow for the on-the-run Treasuries. To conserve space, estimates for lags 4 and 5 are not shown. *(**)[***] indicates statistical significance at the 10% (5%)[1%] level.

Explanatory Variables	Dependent Variables			
	$r_{GE,t}$	$of_{GE,t}$	$r_{bond,t}$	$of_{bond,t}$
$r_{GE,t-1}$	-0.348*** *-31.549*	0.010 *1.175*	0.0003 *-0.228*	0.002 *0.992*
$r_{GE,t-2}$	-0.096*** *-8.214*	0.007 *0.748*	-0.0004 *-0.311*	-0.001 *-0.838*
$r_{GE,t-3}$	0.008 *0.704*	0.017* *1.862*	-0.0004 *-0.279*	-0.001 *-0.629*
$of_{GE,t}$	0.087*** *6.274*		-0.0003 *-0.018*	
$of_{GE,t-1}$	0.036*** *2.607*	0.003 *0.241*	0.002 *1.028*	0.001 *0.298*
$of_{GE,t-2}$	0.020 *1.454*	0.019* *1.704*	-0.001 *-0.660*	-0.0002 *-0.107*
$of_{GE,t-3}$	0.010 *0.747*	0.015 *1.378*	0.001 *0.540*	-0.00002 *-0.010*
$r_{bond,t-1}$	-0.029 *-0.353*	0.024 *0.380*	0.078*** *6.950*	0.185*** *15.423*
$r_{bond,t-2}$	-0.021 *-0.251*	0.061 *0.936*	-0.021* *-1.855*	0.036*** *2.923*
$r_{bond,t-3}$	0.154* *1.878*	0.072 *1.114*	0.004 *0.344*	-0.033*** *-2.710*
$of_{bond,t}$	0.119 *1.608*		0.450*** *44.362*	
$of_{bond,t-1}$	0.073 *0.876*	0.016 *0.244*	0.029*** *2.579*	0.136*** *11.110*
$of_{bond,t-2}$	-0.099 *-1.191*	0.015 *0.225*	-0.023** *-1.997*	0.042*** *3.411*
$of_{bond,t-3}$	-0.014 *-0.166*	-0.038 *-0.573*	-0.033*** *-2.906*	0.007 *0.561*
Adjusted R^2	0.114	0.0006	0.23	0.089

Table 4. This table presents OLS parameter estimates of the following VAR specification which is estimated for the month of November 1996:

$$r_{5y,t} = \sum_{i=1}^{5} a_{1,i} r_{5y,t-i} + \sum_{i=0}^{5} b_{1,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{1,i} r_{equity,t-i} + \sum_{i=0}^{5} d_{1,i} of_{equity,t-i} + \varepsilon_{1,t}$$

$$of_{5y,t} = \sum_{i=1}^{5} a_{2,i} r_{5y,t-i} + \sum_{i=1}^{5} b_{2,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{2,i} r_{equity,t-i} + \sum_{i=1}^{5} d_{2,i} of_{equity,t-i} + \varepsilon_{2,t}$$

$$r_{equity,t} = \sum_{i=1}^{5} a_{3,i} r_{5y,t-i} + \sum_{i=0}^{5} b_{3,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{3,i} r_{equity,t-i} + \sum_{i=0}^{5} d_{3,i} of_{equity,t-i} + \varepsilon_{3,t}$$

$$of_{equity,t} = \sum_{i=1}^{5} a_{4,i} r_{5y,t-i} + \sum_{i=1}^{5} b_{4,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{4,i} r_{equity,t-i} + \sum_{i=1}^{5} d_{4,i} of_{equity,t-i} + \varepsilon_{4,t}$$

r_{5y} is the log quote midpoint return for the 5-year Treasury note over the last minute, of_{5y} is the net order flow (in millions of dollars) in the 5-year note, r_{equity} is the first principal component of returns for the 30 Dow stocks, and of_{equity} is the first principal component of net order flow for the 30 Dow stocks. To conserve space, estimates for lags 4 and 5 are not shown. *(**)[***] indicates statistical significance at the 10% (5%)[1%] level.

Explanatory Variables	Dependent Variables			
	$r_{5y,t}$	$of_{5y,t}$	$r_{equity,t}$	$of_{equity,t}$
$r_{5y,t-1}$	-0.163*** -13.273	1.45*** 4.126	0.086*** 4.786	0.073*** 3.868
$r_{5y,t-2}$	-0.072*** *-5.740*	0.072 *0.203*	0.021 *1.152*	0.028 *1.478*
$r_{5y,t-3}$	-0.021* *-1.704*	0.538 *1.503*	0.009 *0.489*	0.027 *1.420*
$of_{5y,t}$	0.016*** *37.357*		0.0059*** *9.433*	
$of_{5y,t-1}$	0.003*** *6.185*	0.11*** *7.885*	0.0005 *0.679*	0.0007 *0.937*
$of_{5y,t-2}$	0.00003 *0.061*	0.036*** *2.681*	-0.0009 *-1.283*	0.0002 *0.312*
$of_{5y,t-3}$	0.0003 *0.681*	0.016 *1.163*	0.0003 *0.468*	0.0002 *0.327*
$r_{equity,t-1}$	0.036*** *4.262*	1.16*** *4.838*	0.096*** *7.733*	0.154*** *11.946*
$r_{equity,t-2}$	-0.004 *-0.527*	0.291 *1.201*	0.124*** *9.987*	0.063*** *4.793*
$r_{equity,t-3}$	-0.009 *-1.047*	-0.265 *-1.081*	0.015 *1.216*	0.031** *2.383*
$of_{equity,t}$	0.027*** *3.471*		0.254*** *22.031*	
$of_{equity,t-1}$	0.010 *1.266*	0.348 *1.496*	0.105*** *8.810*	0.072*** *5.760*
$of_{equity,t-2}$	0.003 *0.425*	0.003 *0.013*	-0.029** *-2.395*	0.048*** *3.762*
$of_{equity,t-3}$	0.015* *1.891*	0.373 *1.593*	-0.006 *-0.510*	0.045*** *3.585*
Adjusted R^2	0.196	0.038	0.176	0.086

Table 5. This table presents OLS parameter estimates of the following VAR specification which is estimated for the month of November 1996:

$$r_{GE,t} = \sum_{i=1}^{5} a_{1,i} r_{GE,t-i} + \sum_{i=0}^{5} b_{1,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{1,i} r_{bond,t-i} + \sum_{i=0}^{5} d_{1,i} of_{bond,t-i} + \varepsilon_{1,t}$$

$$of_{GE,t} = \sum_{i=1}^{5} a_{2,i} r_{GE,t-i} + \sum_{i=1}^{5} b_{2,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{2,i} r_{bond,t-i} + \sum_{i=1}^{5} d_{2,i} of_{bond,t-i} + \varepsilon_{2,t}$$

$$r_{bond,t} = \sum_{i=1}^{5} a_{3,i} r_{GE,t-i} + \sum_{i=0}^{5} b_{3,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{3,i} r_{bond,t-i} + \sum_{i=0}^{5} d_{3,i} of_{bond,t-i} + \varepsilon_{3,t}$$

$$of_{bond,t} = \sum_{i=1}^{5} a_{4,i} r_{GE,t-i} + \sum_{i=1}^{5} b_{4,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{4,i} r_{bond,t-i} + \sum_{i=1}^{5} d_{4,i} of_{bond,t-i} + \varepsilon_{4,t}$$

r_{GE} is the log quote midpoint return for General Electric stock over the last minute, of_{GE} is the net order flow (in thousands of dollars) in GE stock, r_{bond} is the first principal component of returns for the on-the-run Treasuries, and of_{bond} is the first principal component of net order flow for the on-the-run Treasuries. To conserve space, estimates for lags 4 and 5 are not shown. *(**)[***] indicates statistical significance at the 10% (5%)[1%] level.

Explanatory Variables	Dependent Variables			
	$r_{GE,t}$	$of_{GE,t}$	$r_{bond,t}$	$of_{bond,t}$
$r_{GE,t-1}$	-0.105*** *-8.639*	0.032 *0.726*	0.004** *2.448*	0.007*** *3.565*
$r_{GE,t-2}$	0.017 *1.382*	0.035 *0.774*	-0.00005 *-0.031*	0.004** *2.318*
$r_{GE,t-3}$	0.028** *2.257*	-0.008 *-0.172*	0.003** *2.054*	0.001 *0.327*
$of_{GE,t}$	0.025*** *7.407*		0.001 *1.353*	
$of_{GE,t-1}$	0.015*** *4.594*	0.007 *0.539*	0.00004 *0.087*	-0.0003 *-0.596*
$of_{GE,t-2}$	0.003 *0.943*	0.003 *0.271*	0.00002 *0.034*	-0.0001 *-0.198*
$of_{GE,t-3}$	0.001 *0.263*	0.012 *0.963*	0.0001 *0.260*	-0.0001 *-0.211*
$r_{bond,t-1}$	0.440*** *4.813*	0.052 *0.160*	0.002 *0.190*	0.215*** *15.363*
$r_{bond,t-2}$	-0.005 *-0.054*	0.078 *0.235*	-0.015 *-1.183*	-0.023 *-1.627*
$r_{bond,t-3}$	-0.029 *-0.318*	0.267 *0.799*	-0.005 *-0.364*	0.019 *1.355*
$of_{bond,t}$	0.481*** *6.165*		0.589*** *55.573*	
$of_{bond,t-1}$	-0.199** *-2.095*	0.158 *0.462*	-0.013 *-0.978*	0.169*** *11.538*
$of_{bond,t-2}$	0.080 *0.840*	-0.006 *-0.019*	-0.026** *-1.990*	0.025* *1.682*
$of_{bond,t-3}$	-0.067 *-0.707*	-0.056 *-0.161*	0.014 *1.059*	0.016 *1.064*
Adjusted R^2	0.03	0.0001	0.341	0.133

Table 6. This table presents OLS parameter estimates of the following VAR specification which is estimated for the month of August 1998:

$$r_{5y,t} = \sum_{i=1}^{5} a_{1,i} r_{5y,t-i} + \sum_{i=0}^{5} b_{1,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{1,i} r_{equity,t-i} + \sum_{i=0}^{5} d_{1,i} of_{equity,t-i} + \varepsilon_{1,t}$$

$$of_{5y,t} = \sum_{i=1}^{5} a_{2,i} r_{5y,t-i} + \sum_{i=1}^{5} b_{2,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{2,i} r_{equity,t-i} + \sum_{i=1}^{5} d_{2,i} of_{equity,t-i} + \varepsilon_{2,t}$$

$$r_{equity,t} = \sum_{i=1}^{5} a_{3,i} r_{5y,t-i} + \sum_{i=0}^{5} b_{3,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{3,i} r_{equity,t-i} + \sum_{i=0}^{5} d_{3,i} of_{equity,t-i} + \varepsilon_{3,t}$$

$$of_{equity,t} = \sum_{i=1}^{5} a_{4,i} r_{5y,t-i} + \sum_{i=1}^{5} b_{4,i} of_{5y,t-i} + \sum_{i=1}^{5} c_{4,i} r_{equity,t-i} + \sum_{i=1}^{5} d_{4,i} of_{equity,t-i} + \varepsilon_{4,t}$$

r_{5y} is the log quote midpoint return for the 5-year Treasury note over the last minute, of_{5y} is the net order flow (in millions of dollars) in the 5-year note, r_{equity} is the first principal component of returns for the 30 Dow stocks, and of_{equity} is the first principal component of net order flow for the 30 Dow stocks. To conserve space, estimates for lags 4 and 5 are not shown. *(**)[***] indicates statistical significance at the 10% (5%)[1%] level.

Explanatory Variables	Dependent Variables			
	$r_{5y,t}$	$of_{5y,t}$	$r_{equity,t}$	$of_{equity,t}$
$r_{5y,t-1}$	-0.025** *-2.215*	0.626* *1.937*	-0.059*** *-5.076*	-0.072*** *-5.308*
$r_{5y,t-2}$	0.017 *1.510*	0.339 *1.047*	0.003 *0.264*	-0.026* *-1.899*
$r_{5y,t-3}$	-0.009 *-0.752*	-0.213 *-0.657*	-0.005 *-0.418*	-0.011 *-0.780*
$of_{5y,t}$	0.013*** *31.828*		-0.0026*** *-6.352*	
$of_{5y,t-1}$	-0.0009** *-2.090*	0.072*** *6.016*	0.0007* *1.656*	0.0002 *0.366*
$of_{5y,t-2}$	-0.001** *-2.532*	-0.005 *-0.447*	0.0003 *0.701*	-0.0003 *-0.669*
$of_{5y,t-3}$	-0.0001 *-0.316*	0.012 *0.965*	0.0001 *0.219*	-0.00004 *-0.071*
$r_{equity,t-1}$	-0.118*** *-10.064*	-2.92*** *-9.232*	0.186*** *15.611*	0.329*** *24.721*
$r_{equity,t-2}$	-0.021* *-1.792*	-0.39 *-1.160*	0.060*** *4.954*	0.052*** *3.668*
$r_{equity,t-3}$	-0.035*** *-2.957*	-0.25 *-0.729*	-0.020* *-1.654*	-0.006 *-0.398*
$of_{equity,t}$	-0.091*** *-9.560*		0.530*** *54.732*	
$of_{equity,t-1}$	0.004 *0.340*	-0.371 *-1.177*	0.023** *2.009*	0.112*** *8.433*
$of_{equity,t-2}$	-0.006 *-0.495*	-0.234 *-0.748*	-0.029** *-2.508*	0.036*** *2.741*
$of_{equity,t-3}$	0.011 *1.020*	-0.190 *-0.603*	-0.034*** *-2.950*	0.028** *2.138*
Adjusted R^2	0.195	0.047	0.452	0.253

Table 7. This table presents OLS parameter estimates of the following VAR specification which is estimated for the month of August 1998:

$$r_{GE,t} = \sum_{i=1}^{5} a_{1,i} r_{GE,t-i} + \sum_{i=0}^{5} b_{1,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{1,i} r_{bond,t-i} + \sum_{i=0}^{5} d_{1,i} of_{bond,t-i} + \varepsilon_{1,t}$$

$$of_{GE,t} = \sum_{i=1}^{5} a_{2,i} r_{GE,t-i} + \sum_{i=1}^{5} b_{2,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{2,i} r_{bond,t-i} + \sum_{i=1}^{5} d_{2,i} of_{bond,t-i} + \varepsilon_{2,t}$$

$$r_{bond,t} = \sum_{i=1}^{5} a_{3,i} r_{GE,t-i} + \sum_{i=0}^{5} b_{3,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{3,i} r_{bond,t-i} + \sum_{i=0}^{5} d_{3,i} of_{bond,t-i} + \varepsilon_{3,t}$$

$$of_{bond,t} = \sum_{i=1}^{5} a_{4,i} r_{GE,t-i} + \sum_{i=1}^{5} b_{4,i} of_{GE,t-i} + \sum_{i=1}^{5} c_{4,i} r_{bond,t-i} + \sum_{i=1}^{5} d_{4,i} of_{bond,t-i} + \varepsilon_{4,t}$$

r_{GE} is the log quote midpoint return for General Electric stock over the last minute, of_{GE} is the net order flow (in thousands of dollars) in GE stock, r_{bond} is the first principal component of returns for the on-the-run Treasuries, and of_{bond} is the first principal component of net order flow for the on-the-run Treasuries. To conserve space, estimates for lags 4 and 5 are not shown. *(**)[***] indicates statistical significance at the 10% (5%)[1%] level.

Explanatory Variables	Dependent Variables			
	$r_{GE,t}$	$of_{GE,t}$	$r_{bond,t}$	$of_{bond,t}$
$r_{GE,t-1}$	-0.090***	0.091***	-0.009***	-0.008***
	-7.881	*6.963*	*-8.676*	*-7.375*
$r_{GE,t-2}$	0.013	0.051***	-0.005***	-0.006***
	1.150	*3.807*	*-4.815*	*-5.488*
$r_{GE,t-3}$	-0.014	0.031**	-0.002*	-0.003**
	-1.195	*2.310*	*-1.748*	*-2.453*
$of_{GE,t}$	0.362***		-0.007***	
	36.882		*-8.201*	
$of_{GE,t-1}$	0.088***	0.116***	-0.003***	-0.0004
	8.255	*9.509*	*-2.826*	*-0.402*
$of_{GE,t-2}$	-0.0003	-0.009	-0.001	-0.001
	-0.024	*-0.762*	*-1.068*	*-0.482*
$of_{GE,t-3}$	-0.015	0.032***	0.001	-0.001
	-1.429	*2.614*	*0.657*	*-0.759*
$r_{bond,t-1}$	-0.952***	-0.916***	0.108***	0.166***
	-7.176	*-6.064*	*9.383*	*13.004*
$r_{bond,t-2}$	-0.258*	-0.218	0.058***	0.011
	-1.932	*-1.416*	*5.001*	*0.825*
$r_{bond,t-3}$	0.083	-0.142	0.022*	-0.005
	0.623	*-0.921*	*1.927*	*-0.390*
$of_{bond,t}$	-0.855***		0.438***	
	-7.394		*43.539*	
$of_{bond,t-1}$	0.532***	0.149	-0.044***	0.117***
	4.107	*1.002*	*-3.886*	*9.292*
$of_{bond,t-2}$	0.228*	-0.137	-0.053***	0.027**
	1.756	*-0.917*	*-4.666*	*2.160*
$of_{bond,t-3}$	0.123	-0.015	-0.012	0.022*
	0.946	*-0.102*	*-1.068*	*1.729*
Adjusted R^2	0.186	0.06	0.295	0.11

Table 8. This table presents OLS parameter estimates of the following VAR specification which is estimated for December 1993, November 1996, and August 1998:

$$r_{is,t} = \sum_{i=1}^{5} a_{1,i} r_{is,t-i} + \sum_{i=0}^{5} b_{1,i} of_{is,t-i} + \sum_{i=1}^{5} c_{1,i} r_{cm,t-i} + \sum_{i=0}^{5} d_{1,i} of_{cm,t-i} + \sum_{i=1}^{5} e_{1,i} r_{futures,t-i} + \varepsilon_{1,t}$$

$$of_{is,t} = \sum_{i=1}^{5} a_{2,i} r_{is,t-i} + \sum_{i=1}^{5} b_{2,i} of_{is,t-i} + \sum_{i=1}^{5} c_{2,i} r_{cm,t-i} + \sum_{i=1}^{5} d_{2,i} of_{cm,t-i} + \sum_{i=1}^{5} e_{2,i} r_{futures,t-i} + \varepsilon_{2,t}$$

$$r_{cm,t} = \sum_{i=1}^{5} a_{3,i} r_{is,t-i} + \sum_{i=0}^{5} b_{3,i} of_{is,t-i} + \sum_{i=1}^{5} c_{3,i} r_{cm,t-i} + \sum_{i=0}^{5} d_{3,i} of_{cm,t-i} + \sum_{i=1}^{5} e_{3,i} r_{futures,t-i} + \varepsilon_{3,t}$$

$$of_{cm,t} = \sum_{i=1}^{5} a_{4,i} r_{is,t-i} + \sum_{i=1}^{5} b_{4,i} of_{is,t-i} + \sum_{i=1}^{5} c_{4,i} r_{cm,t-i} + \sum_{i=1}^{5} d_{4,i} of_{cm,t-i} + \sum_{i=1}^{5} e_{4,i} r_{futures,t-i} + \varepsilon_{4,t}$$

$$r_{futures,t} = \sum_{i=1}^{5} a_{5,i} r_{is,t-i} + \sum_{i=1}^{5} b_{5,i} of_{is,t-i} + \sum_{i=1}^{5} c_{5,i} r_{cm,t-i} + \sum_{i=1}^{5} d_{5,i} of_{cm,t-i} + \sum_{i=1}^{5} e_{5,i} r_{futures,t-i} + \varepsilon_{5,t}$$

where r_{is} is the log quote midpoint return for an individual security (either the five year note or General Electric stock) over the last minute, of_{is} is the net order flow in that security, r_{cm} is the first principal component of returns from the other market, of_{cm} is the first principal component of net order flow from the other market, and $r_{futures}$ is the return on the relevant futures contract for the given market. To conserve space, estimates for lags 4 and 5 are not shown, and only estimates for the cross-market order flow terms are presented. *(**)[***] indicates statistical significance at the 10% (5%)[1%] level.

Explanatory Variable	December 1993	November 1996	August 1998
Panel A: General Electric returns			
$of_{bond,t}$	0.107	0.147*	-0.206*
	1.44	*1.93*	*-1.91*
$of_{bond,t-1}$	0.057	-0.174*	0.432***
	0.69	*-1.91*	*3.62*
$of_{bond,t-2}$	-0.111	0.087	0.282**
	-1.34	*0.96*	*2.36*
$of_{bond,t-3}$	-0.020	-0.023	0.138
	-0.24	*-0.26*	*1.15*
Panel B: Five year note returns			
$of_{equity,t}$	0.011**	0.015**	-0.082***
	2.04	*2.14*	*-8.74*
$of_{equity,t-1}$	0.0008	0.007	0.007
	0.15	*0.97*	*0.65*
$of_{equity,t-2}$	-0.005	-0.0002	-0.003
	-0.91	*-0.03*	*-0.27*
$of_{equity,t-3}$	0.004	0.014*	0.012
	0.63	*1.84*	*1.11*

Table 9. This table presents OLS parameter estimates of the following VAR specification which is estimated for December 1993, November 1996, and August 1998:

$$r_{equity,t} = \sum_{i=1}^{5} a_{1,i} r_{equity,t-i} + \sum_{i=0}^{5} b_{1,i} of_{equity,t-i} + \sum_{i=1}^{5} c_{1,i} r_{bond,t-i} + \sum_{i=0}^{5} d_{1,i} of_{bond,t-i} + \varepsilon_{1,t}$$

$$of_{equity,t} = \sum_{i=1}^{5} a_{2,i} r_{equity,t-i} + \sum_{i=1}^{5} b_{2,i} of_{equity,t-i} + \sum_{i=1}^{5} c_{2,i} r_{bond,t-i} + \sum_{i=1}^{5} d_{2,i} of_{bond,t-i} + \varepsilon_{2,t}$$

$$r_{bond,t} = \sum_{i=1}^{5} a_{3,i} r_{equity,t-i} + \sum_{i=0}^{5} b_{3,i} of_{equity,t-i} + \sum_{i=1}^{5} c_{3,i} r_{bond,t-i} + \sum_{i=0}^{5} d_{3,i} of_{bond,t-i} + \varepsilon_{3,t}$$

$$of_{bond,t} = \sum_{i=1}^{5} a_{4,i} r_{equity,t-i} + \sum_{i=1}^{5} b_{4,i} of_{equity,t-i} + \sum_{i=1}^{5} c_{4,i} r_{bond,t-i} + \sum_{i=1}^{5} d_{4,i} of_{bond,t-i} + \varepsilon_{4,t}$$

r_{equity} is the first principal component of returns for the 30 Dow stocks, of_{equity} is the first principal component of net order flow for the 30 Dow stocks, r_{bond} is the first principal component of returns for the on-the-run Treasuries, and of_{bond} is the first principal component of net order flow for the on-the-run Treasuries. To conserve space, estimates for lags 4 and 5 are not shown, and only estimates for the cross-market order flow terms are presented. *(**)[***] indicates statistical significance at the 10% (5%)[1%] level.

Panel A			
Explanatory Variables	Dependent Variable: Common factor of equity returns		
	December 1993	November 1996	August 1998
$of_{bond,t}$	-0.009	0.091***	-0.065***
	-0.75	*7.68*	*-7.25*
$of_{bond,t-1}$	-0.007	0.003	0.022**
	-0.55	*0.20*	*2.23*
$of_{bond,t-2}$	0.026**	-0.0002	0.010
	2.04	*-0.02*	*0.99*
$of_{bond,t-3}$	0.025**	0.006	0.011
	1.98	*0.40*	*1.11*
Panel B			
	Dependent Variable: Common factor of bond returns		
$of_{equity,t}$	-0.002	0.042***	-0.125***
	-0.22	*4.06*	*-11.59*
$of_{equity,t-1}$	0.024**	0.022**	-0.012
	2.43	*2.05*	*-0.97*
$of_{equity,t-2}$	-0.016*	0.0008	0.009
	-1.69	*0.07*	*0.73*
$of_{equity,t-3}$	0.002	0.019*	0.031**
	0.21	*1.81*	*2.49*

Table 10. This table shows Pearson Correlation coefficients for all of the individual securities appearing throughout the sample and the CBOE Volatility Index (VIX). The variables used are the sum of the vector autoregression parameter estimates which measure the importance of cross-market order flow in explaining security returns, and the average level of the VIX index. Variables are estimated on a monthly basis for the January 1993 through August 2000 period. P-values for testing the null hypothesis that the correlation is zero are shown in italics.

3 month	**6 month**	**1 year**	**2 year**	**5 year**	**10 year**	**30 year**
-0.145	0.017	-0.051	-0.294	-0.310	-0.227	-0.022
0.168	*0.871*	*0.628*	*0.004*	*0.003*	*0.030*	*0.832*

AA	**AXP**	**BA**	**CAT**	**DIS**	**EK**	**GE**
-0.446	-0.502	-.291	-0.462	-0.434	-0.289	-0.516
<0.0001	*<0.0001*	*0.005*	*<0.0001*	*<0.0001*	*0.005*	*<0.0001*

GM	**IBM**	**IP**	**KO**	**MCD**	**MMM**	**MO**
-0.611	-0.468	-0.245	-0.490	-0.389	-0.463	-0.357
<0.0001	*<0.0001*	*0.019*	*<0.0001*	*.0001*	*<0.0001*	*0.0005*

MRK	**PG**	**T**	**UTX**	**DD**
-0.257	-0.411	-0.490	-0.424	-0.465
0.013	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*

Fig. 1: Monthly Stock-Bond Return Correlations, January 1993-August 2000
This figure presents the monthly correlation between the first principal component of one-minute equity returns (based on the 30 Dow stocks) and the first principal component of one-minute Treasury returns (based on the on-the-run Treasuries). The principal components analysis is done on a month-by-month basis for the period of January 1993 through August 2000.

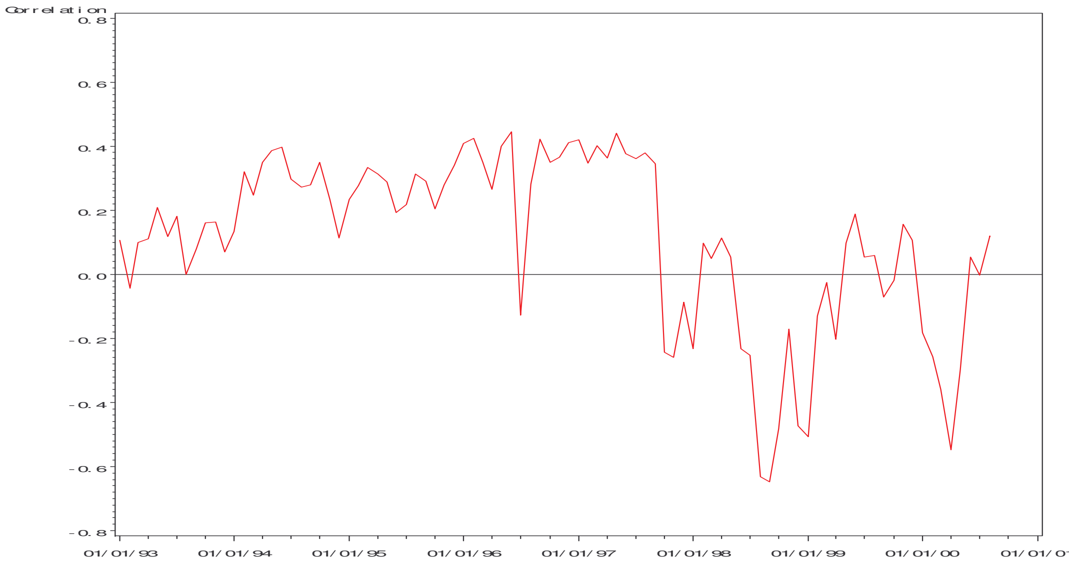

Fig. 2: CBOE Volatility Index (VIX), January 1993-August 2000
This figure shows the monthly average level of the CBOE Volatility Index from January 1993 through August 2000. Monthly averages are calculated by averaging the closing VIX across all days in a given month.