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Order flow and volatility: An empirical investigation ☆

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ABSTRACT

We study the relationship between order flow and volatility. To this end we develop a comprehensive framework that simultaneously controls for the effects of macro announcements and order flow on prices and the effect of macro announcements on volatility. Using high-frequency 30-year U.S. Treasury bond futures data, we find a statistically and economically significant relationship between the absolute value of order flow and volatility. Moreover, this relationship is robust, inter alia, to a number of factors including the introduction of liquidity effects, use of data measured over a different frequency, and market conditions.

1. Introduction

One of the most fundamental questions in financial economics is what drives asset prices and volatility. Theory predicts that asset prices adjust when new information arrives. In this context it is useful to distinguish between public information and information revealed by the trading process. The first type of information concerns news that becomes available to all market participants at the same point in time. As all investors are equally informed at the same time, the arrival of public information typically triggers an immediate reaction in asset prices. By contrast, the second type of information usually refers to news that is distributed asymmetrically among market participants and can be thought of as private information. The presence of such private information may change the asset price more slowly. This is because informed investors trade the asset based on their privately held knowledge, which in turn leads to further price adjustments as other investors make inferences on this private information.[1] The purpose of the current paper is to examine the

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[1] This idea was first formalized by Kyle (1985) and Glosten and Milgrom (1985).

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importance of these information flows within the US Treasury market, with prominent attention to the relation between volatility and the flow of orders which may capture private information.

The empirical evidence concerning how prices and volatility relate to public information, in the form of macro announcements, has been established for many financial markets; see e.g. Andersen et al. (2003, 2007), Balduzzi et al. (2001), Bartolini et al. (2008), Berry and Howe (1992), Boyd et al. (2005), Brenner et al. (2009), Cutler et al. (1989), Ederington and Lee (1993), Faust et al. (2007), Fleming and Remolona (1999), and French and Roll (1986). Andersen et al. (2007), for example, document the link between macro announcements and prices and volatility in equity, foreign exchange and Treasury markets. Specifically, using high-frequency intraday data they demonstrate that surprises in macro announcements (i.e. the difference between the actual release and the consensus market expectation) affect the conditional mean and volatility of returns in these markets.

Recent literature also documents relations between returns and the information revealed by trading, for equity (Albuquerque and Vega, 2009; Albuquerque et al., 2009; Hasbrouck, 1991), foreign exchange (Evans and Lyons, 2008), and Treasury (Brandt and Kavajecz, 2004; Green, 2004; Li et al., 2009; Menkveld et al., 2012; Pasquariello and Vega, 2007) markets. These studies typically use order flow as the measure of information captured by the trading process, where order flow is defined as the difference between the volume in buyer-initiated transactions and the volume in seller-initiated transactions. Within the context of the Treasury market, extant studies show that the effect of order flow on yields is permanent and largely due to private information rather than liquidity or inventory control considerations; see e.g. Green (2004), who also provides several alternatives for the interpretation of private information in the Treasury market, such as information about endowments or the interpretation of macroeconomic news due to differential information processing skills.

The literature on volatility and the informational role of trading (private information) is less extensive. However, a limited number of studies have been conducted. For instance, Berger et al. (2009) examine the relationship between volatility and information flow in the foreign exchange market. Specifically, they take a long term perspective and find that variation in volatility can be explained by variation in information flow and by the market's reaction to this information flow. Alternative (indirect) approaches have also been considered. Evans and Lyons (2008) use a variance decomposition of the conditional mean of foreign exchange returns, which implies that they consider a link between unconditional volatility and order flow. Likewise, He et al. (2009) start with a structural model for price changes due to public information shocks and information asymmetry and obtain a model-implied variance of price changes in the US Treasury market.

The goal of the current paper is to extend this literature by examining whether volatility is related to order flow. We investigate this issue empirically for the 30-year U.S. Treasury bond futures using high-frequency (5 min) intraday data for the period 2004 to 2009. In our work the term volatility implies a parameterization of the conditional volatility. Consequently, we are able to estimate the relationship between order flow and volatility directly.[2]

To achieve the above goal we develop a modeling framework that allows us to simultaneously assess the relationship between macro announcements/order flow and returns and volatility.[3] Specifically, we propose a model specifying the dynamics of both returns and volatility in such a way that both equations can be estimated jointly. We split volatility in two (multiplicative) components, following the Spline-GARCH model of Engle and Rangel (2008). One component describes the effects of order flow and public information, while the other captures short-run GARCH-type behavior. This joint modeling approach extends and improves upon the specification of Andersen et al. (2003, 2007). In their set-up, equations for return and volatility effects are estimated separately. Thus, parameter uncertainty in the return equation is neglected when estimating the volatility equation and, consequently, the parameters of both equations are not estimated efficiently. In addition, the approach could suffer from negative fitted values of the time-varying conditional volatility. In our framework, both return and volatility equations are estimated jointly by means of (quasi) maximum likelihood, such that the parameters are estimated efficiently. Also, by construction, our model automatically avoids negative values of the volatility.

The results in the current paper demonstrate that order flow and volatility are positively related. This positive relation is significant in both statistical and economic terms. A one standard deviation shock in order flow is associated with a volatility increase of around 2.2%. Moreover, if one is willing to accept order flow as a measure of private information and macroeconomic announcements as an important component of public information (within the Treasury market), then our results can be interpreted as measures of the relations between public and private information flow and volatility. Our approach differentiates itself from the majority of previous studies in which private information has primarily been used in empirical models to describe returns.

We provide several robustness checks and extensions of our main result. First, we use the bid–ask spread, the volume of trades and the illiquidity ratio of Amihud (2002) to control for liquidity effects.[4] Inclusion of these variables does not change the main result that

[2] Other studies have considered alternative measures of private information flow within a conditional volatility context. For instance, Jones et al. (1994) identify private and public information by comparing periods with and without trading.

[3] We follow the extant literature by assuming that returns and volatility are the endogenous variables within this framework, which in turn is based on economic theory that predicts causality from order flow to prices (as in Kyle, 1985; Glosten and Milgrom, 1985). Consequently, we focus of the 'impact/effect' of order flow on these variables without formally establishing the exogeneity of the independent variables used in the study. We do acknowledge that causality could run the other way, that is, returns and/or volatility could cause the independent variables.

[4] There is a large literature that considers the relationship between volatility, trading volume, order flow and liquidity. Clark (1973) and Tauchen and Pitts (1983) develop the mixture of distribution hypothesis for the joint movement of squared returns and volume based on an unobserved information arrival variable. Andersen (1996) modifies this framework to include both information asymmetry and liquidity needs, and shows that it is useful for analyzing the economic factors behind volatility clustering. Further empirical evidence on the volume–volatility relation is provided by Karpoff (1987). Finally, there is also a link between order flow and liquidity. For example, Green (2004) finds that information asymmetry increases when liquidity is high (cf. Brandt and Kavajecz, 2004), while Deuskar and Johnson (2011) find that order flow explains a large fraction of aggregate stock market volatility and link their findings to the time-varying risk-bearing capacity of investors, with flows representing a combination of net trade demand and the price impact of that demand. Hence, this finding relates order flow with liquidity rather than private information.