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How does public information affect the frequency of trading in airline stocks?

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ABSTRACT

This paper examines how firm specific and macroeconomic announcements affect transaction rates in U.S. airline stocks. Using a version of the autoregressive conditional hazard framework of Hamilton and Jordà (2002) that incorporates market microstructure variables, we show that on average, trading intensity spikes prior and consequent to macroeconomic announcements, but decreases around firm-specific releases. Further, when we use intraday crude oil futures returns as a proxy for industry relevant and globally important news we find that their effects are statistically significant, with higher oil futures returns increasing the probability of trade.

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1. Introduction

There is abundant evidence that news events affect intraday trading in financial markets. Numerous studies suggest a significant and instantaneous response of asset prices, return volatility, and trading volumes to macroeconomic and company news. Somewhat surprisingly, the impact of information arrival on the time patterns in trade has not yet been extensively studied, despite the popularity of the autoregressive conditional duration (ACD) model that Engle and Russell (1998) developed to study the time between trades, and related work in Dufour and Engle (2000) that finds that time between trades informs the price discovery process. This paper studies the links between information arrival and the rate at which trading takes place, by assessing how news events and variables with information content affect the frequency of transactions.

The theoretical motivation for our study can be found in work by Bagehot (1971), Kyle (1985), Admati and Pfleiderer (1988), Easley and O'Hara (1992) and many others who have modeled the influence of informed traders on market liquidity. Such work assumes that market participants trade in response to changes in their information set, and it follows that the rate at which this trade takes place then plays an important role in determining the subsequent dynamics of the market. Empirical study of time variation in trading frequency is therefore of interest, not only because it provides a measure of news arrivals, but also because trade frequencies themselves carry information and influence how quickly prices, volatility, and volume will respond to news arrivals and how long a response might last.

The ACD model is specified in "transaction time", which is not well suited for incorporating information that arrives between trades. We circumvent this difficulty by working with the closely related Autoregressive Conditional Hazard (ACH) model proposed by Hamilton and Jordà (2002), which is set in calendar time. The ACH model enables the inclusion of conditioning variables (such as announcements) that occur at particular times, and it facilitates the calculation of impulse response functions, which are most easily interpreted when graphed against fixed units of time. We use the ACH model in a high frequency setting to study the conditional probability of trade in U.S. airline stocks, and we condition on the occurrence of scheduled and unscheduled macroeconomic and company specific news events in addition to microstructure variables. We also condition on crude oil futures returns, since they provide a readily quantifiable information source about a major component of U.S. passenger airline operating costs.

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Our work differs from previous work that assesses the effect of news on market liquidity because we focus on the link between information and the probability of trade. Further, we study equity rather than bond or foreign exchange markets,[1] and we consider a broader range of news indicators. Related literature on equity markets includes Adams et al. (2004) who consider market reactions to macroeconomic announcements, Patell and Wolfson (1984), who consider market reactions to the release of news on dividends and earnings news, and Brooks et al. (2003), who analyze the impact of unexpected negative company news events (such as plane crashes or plant explosions) on equity markets.

We study airline stocks, which to our knowledge have not yet been studied in a high frequency setting, and we supplement the usual types of macroeconomic and company specific announcements with intraday data on crude oil futures. We believe that oil price futures data is a particularly useful indicator of information in this context, because futures prices incorporate a broad spectrum of information that is relevant for investors, and oil price futures not only carry news about costs specific to the airline industry, but carry macroeconomic and global information as well.

The remainder of the paper is organized as follows: Section 2 discusses the most important features of the ACH model and its usefulness in modeling the frequency of trade. Data and its statistical properties are described in Section 3. Section 4 presents model estimates and summarizes the effects of new releases and crude oil futures returns on trading frequency. Section 5 offers conclusions.

2. Modeling the impact of news on transaction rates

The autoregressive conditional duration (ACD) model Engle and Russell (1998) is designed to measure the expected waiting time between events, and it provides the standard way of modeling trade durations in financial transaction data. The ACD model is specified in transaction times because trades are observed irregularly, and the expected waiting time until the next trade is defined as a function of the past waiting times. The "transaction time" setting of the ACD model makes it difficult to include time specific variables such as announcements in the conditioning information set, because such variables are observed *between* trades. This difficulty partially explains why the empirical literature on the effects of news on the timing of trades has not developed very quickly.

Zhang et al. (2001) use a threshold ACD model to account for structural breaks that correspond to information events, but this approach is unappealing if one wants to study response times to many information events. Related to this is the question of interest, because although it might be useful to estimate the waiting time until the next trade given an information event, it might be more useful to estimate the likelihood of trade in the next 5 or 15 s, given that information event. The ACH framework concentrates on the latter question whilst also utilizing past durations as conditioning variables. The ACD and ACH frameworks are explained in detail in Engle and Russell (1998) and Hamilton and Jordà (2002), and we sketch the most important features of the ACH model in the context of modeling high-frequency data below.

2.1. Autoregressive conditional hazard model

The autoregressive conditional hazard (ACH) model of Hamilton and Jordà (2002) belongs to a class of models known as hazard models that are commonly used in statistics to analyze duration/survival data (for an excellent introduction see Lancaster (1990)). The *hazard rate* (or *hazard function*) is defined as a (limiting) conditional probability of an event occurring at time t (the next time period), given the information set Ω_{t-1} known at time $t-1$. Hamilton and Jordà (2002) and Demiralp and Jordà (2001) used the ACH model to predict the probability that the Federal Reserve Board would change the Federal Funds target rate, and Andersen et al. (2010) used it to predict the probability of jumps in S&P 500 futures and U.S. Treasury bond futures returns. In our case, we predict the probability of a trade occurring by the end of the time interval t, given information available at time $t-1$.

Consider a stochastic process that is a sequence of trade arrival times $\{t_1, t_2, \ldots, t_n\}$ with the nth trade arriving at the end of time t_n and $t_1 < t_2 < \cdots < t_n$. Also consider an associated *counting process* $N(t)$, which is the cumulative number of trades that have occurred by the end of time t (so $N(t) = N(t-1)$ if a trade does not occur in the interval $(t-1, t]$ and $N(t) = N(t-1)+1$ if it does). The length of time (the interval) between the $(n-1)$th and the nth trade arrival times is called a *duration* u_n, that is, $u_n = t_n - t_{n-1}$. The ACD (p, q) model predicts that the conditional expectation of the duration u_n is a weighted average of p past durations and q past expectations, that are known at time t_{n-1}. That is, given past observations $u_{n-1}, u_{n-2}, \ldots$, the ACD (p, q) model implies that

$$\mathbb{E}[u_n|u_{n-1}, u_{n-2}, \ldots] \equiv \psi_n = \omega + \sum_{j=1}^{p} \alpha_j u_{n-j} + \sum_{j=1}^{q} \beta_j \psi_{n-j}. \tag{1}$$

Using the definition of the counting process, Hamilton and Jordà (2002) rewrite Eq. (1) as

$$\psi_{N(t)} = \omega + \sum_{j=1}^{p} \alpha_j u_{N(t)-j} + \sum_{j=1}^{q} \beta_j \psi_{N(t)-j}, \tag{2}$$

where the expectation $\psi_{N(t)}$ is formulated at time t_{n-1}. The expected conditional duration written as (2) is a *step function* that only changes if the trade occurs during time interval $(t-1, t]$, i.e. only when $N(t) \neq N(t-1)$. In this setting the *hazard rate* h_t is defined as

$$h_t \equiv \Pr(x_t = 1|\Omega_{t-1}) = \Pr(N(t) \neq N(t-1)|\Omega_{t-1}), \tag{3}$$

where $x_t = 1$ if a trade occurs within $(t-1, t]$ and $x_t = 0$ otherwise.[2]

As with the GARCH and ACD models, Eq. (2) can be easily generalized to account for linear effects of covariates $\mathbf{z}_{t-1}$ known at time $t-1$, such as public news releases, crude oil futures returns, and market microstructure variables. However, the exogenous covariates can change even if a trade does not occur. Indeed, the attractive feature of the ACH model is its ability to study effects of information that arrives *between* trades. This implies that the expected conditional duration ψ_t can change at the end of every (calendar) time interval, through

$$\psi_t = \psi_{N(t)} + \boldsymbol{\delta}\mathbf{z}_{t-1}, \tag{4}$$

where $\boldsymbol{\delta}$ denotes a vector of parameters.

The relationship between the hazard rate and the conditional duration can be derived using properties of the geometric distribution. The expected length of time until the next trade is

$$\psi_t = \sum_{j=1}^{\infty} j(1-h_t)^{j-1} h_t = \frac{1}{h_t}, \tag{5}$$

or

$$h_t = \frac{1}{\psi_t}. \tag{6}$$

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[1] Well known examples based on bond markets include Ederington and Lee (1993), Fleming and Remolona (1999), Bollerslev et al. (2000) and Balduzzi et al. (2001), while examples based on foreign exchange markets include Bollerslev and Domowitz (1993) and Andersen et al. (2003).

[2] We follow Hamilton and Jordà's (2002) definition of the hazard rate. However, in the duration literature a definition of an instantaneous rate of event occurrence per infinitesimally unit of time is often used. That is $h(t) = \lim_{\Delta t \to 0} \frac{\Pr(x_{t+\Delta t}=1|\Omega_t)}{\Delta t}$. Scaling by Δt implies that the hazard rate can be any positive number. This is in contrast to the hazard rate implied by Eq. (3), which is bounded between 0 and 1.

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