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On high frequency dynamics between information asymmetry and volatility for securities

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ABSTRACT

This paper investigates the relationship between the volatility of Volume Synchronized Probability of Informed Trading (VPIN) and future short-term volatility of stock returns. We construct a transaction-signed version of VPIN (TR-VPIN) based on tick by tick data on securities traded in the Athens Stock Exchange (ASE) during the Greek sovereign debt crisis. The results show a positive and statistically significant correlation between the volatility of TR-VPIN and future short-term volatility for securities that are exposed to asymmetric information during the period under examination. This evidence expands the existent literature which shows that the absolute order imbalance forecasts absolute returns, suggesting that TR-VPIN is a real-time informative indicator of the Probability of Informed Trading (PIN) in the high frequency domain. Further, the long-range dependence between the conditional volatilities of TR-VPIN and stock returns becomes more significant as we move towards securities which display stronger long memory. This is perfectly in line with the recent empirical evidence in microstructure literature that large past shocks of flow toxicity can lead to volatility through liquidity shortages.

1. Introduction

One of the most recent developments in Microstructure Theory is the Volume Synchronised Probability of Informed Trading (VPIN) as a real-time measurement of flow toxicity. As the central focal point in Microstructure Theory, the order flow is assumed to contain significant information which affects subsequent price movements. Easley, Kiefer, O'Hara, and Paperman (1996) defined the Probability of Informed Trading (PIN) as a measure of asymmetric information. Subsequently, many studies concluded on an empirically significant positive relationship between inside information and stock returns, clearly establishing the asymmetric information as a risk factor which should be rewarded by the respective risk premium. The development of High Frequency Trading (HFT) provides new data sets to test the principles of the Microstructure Theory.

The assessment of information asymmetry from high frequency data commences in Easley, Lopez, and O'Hara (2011a, 2011b, 2012a and 2012b), ELO henceforth. By employing the basic sequential trade model, as suggested by Easley et al. (1996), the Volume-Synchronized Probability of Informed Trading (VPIN) is introduced as a real-time measurement of the probability faced by market makers that an incoming order contains spurious information. For the construction of VPIN, the

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concept of volume time is adopted, instead of the classic clock time, following the idea that trading time elapsed between two trades contains important information. By employing this approach, ELO (2011a) report that the VPIN metric from one-minute bar observations of the E-mini S&P 500 futures contracts on the Chicago Mercantile Exchange could not only be related with future short-term volatility of returns, but could also predict the 6 May 2010 "Flash Crash". Karyampas and Paiardini (2011) provide evidence on a positive relationship between flow toxicity and volatility, using the S&P 500 SPDR exchange trade fund (ETF) traded on Amex and adding the number of jumps and the VPIN variable to a Heterogeneous Autoregressive model of Realized Volatility (HAR-RV).

The efficiency of VPIN as predictor of short-term volatility is, however, an open debate. Andersen and Bondarenko (2014a, 2014b), henceforth AB, challenge the striking findings of ELO, supporting that their VPIN measure tend to overestimate its relationship with future volatility. As they argue, the construction of the VPIN metric, based on the classification of time-bars of aggregated trades and not of raw transactions, produces biased estimates of the VPIN–volatility correlation. An increase in trading activity implies that there are more trades per time bar and, thus, a smaller number of bars involved in computing the Order Imbalance (OI) measure within a volume bucket. This raises the expected value of the OI measure, independent of any characteristic of the underlying trades. As a result, the OI measure is mechanically correlated with trading volume and as such with volatility of returns, irrespective of the actual order. Their findings suggest that after controlling for this bias, the ELO VPIN not only is peaking following the Flash Crash, but also may display a negative correlation with volatility.

According to AB, the key to the forecast power of VPIN is the indirect inclusion of dynamic volume and volatility information during the implementation stage. Although AB confirmed that VPIN was highly correlated with volume and volatility innovations for the E-mini S&P 500 futures, any spike in VPIN was associated with unusually large volume or volatility innovations over the preceding hours. Thus, the critical question becomes *"what causes what?"* When inserting simultaneity controls for the volatility and volume effects (tick classification instead of bulk volume), they found the predictive power of VPIN to drop precipitously and it appears to be no incremental predictive power in the VPIN metric beyond what is already incorporated in standard volatility forecast procedures.

In response, Easley, Lopez de Prado, and O'Hara (2014) argue that the peak of VPIN after the Flash Crash is subject to the use of different data. Most importantly, even then, the VPIN shows a significant increase before the Flash Crash, implying that it is an adequate metric for order toxicity which can increase volatility through a liquidity shortage. Wu, Bethel, Gu, Leinweber, and Ruebel (2013) use five and a half years of trading data for about 100 most liquid futures contracts and confirm that VPIN is a strong predictor of liquidity-induced volatility.

Driven by this open debate, as well as the increasing demand for a real-time stress indicator, we test the VPIN–volatility relationship in an extremely turbulent market, the Athens Stock Exchange (ASE), for the period June 2009–May 2010. This period covers the Greek sovereign debt and the Greek bail-out rescue loan package by the IMF/EU/ECB. Our economic motivation is to test the VPIN–volatility relationship in an environment which is affected by a significant exogenous asymmetric information shock (i.e. the Greek crisis). Furthermore and from an institutional point of interest, the ASE undertook various initiatives and reforms before the crisis in order to establish more efficient price discovery mechanisms.[1] To this extent, the ASE provides a unique testing environment.

This paper contributes the existent literature in the following aspects. First, we construct a Transaction-sign based VPIN (TR-VPIN) as mentioned in ELO, taking into account the "technical" correlation mentioned by AB. Secondly, we expand the existent work on the use of absolute order imbalances to forecast future absolute returns, by focusing on the relationship between the variability of flow toxicity (TR-VPIN) and future volatility of returns. Our motivation is that not only the increases, but also the decreases of flow toxicity should be associated with the volatility of returns. Thirdly, in contrast to previous studies which focus on the market level (through the proxy of an ETF), our analysis is conducted on securities level. Fourth, we test the existence of long-range dependence between the conditional volatilities of TR-VPIN and stock returns into a Fractionally Integrated GARCH framework in order to assess the ability of TR-VPIN as a real time stress indicator.

The results show a positive and statistically significant relationship between the volatility of TR-VPIN and future short-term volatility, particularly for stocks that are exposed to higher levels of asymmetric information. These securities are mostly influenced by the Greek sovereign debt crisis and its consequences in Cyprus, the asymmetric information due to M&A activity and/or simple microstructure parameters. This evidence supports that the TR-VPIN metric is not only an appropriate estimator of Probability of Informed Trading (PIN) on the high-frequency domain, but there also exists an endogenous relationship between its volatility and future short-term volatility of returns. Furthermore, the long-range dependence between the conditional volatilities of stock returns and the changes of TR-VPIN becomes more significant as we move towards securities which display stronger long memory. This long memory property affirms the market intuition that flow toxicity shocks exhibit long range dependence which could lead to extreme, long range volatility through liquidity shortages. The latest suggests TR-VPIN as a sufficient real time stress indicator for signalling future Flash Crashes.

The remaining of this paper is organized as follows. Section 2 discusses the construction of the TR-VPIN metric. Section 3 illustrates the FIGARCH–Constant Conditional Correlation (CCC) framework. Section 4 presents and analyses the data, the empirical results are displayed, analysed and discussed in Section 5, while Section 6 concludes.

[1] These initiatives include price limits, IPO regulation and daily volatility fluctuations in an attempt to be established a more liberated market with decreasing asymmetric information effects.