VPIN MEASURE ON TURKDEX

FULL PAPER

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Abstract
The Flash Crash, May 6th 2010, is the biggest one-day point drop in the history of the Dow Jones Industrial Average Index (998.5 points) and the third highest volume day ever (and one of the most illiquid). After the "Flash Crash" on May 6, 2010, non-institutional traders had to do high-frequency trading with order flow imbalance or "toxicity" by current global financial market which have new dynamics. Flash events or short-term (like five seconds / a minute/ an hour period) illiquidity crises in the market occur when high-frequency or algorithmic trading firms that acted like liquidity provider, suddenly stop trading in response to a high level of flow toxicity, resulting in a sudden drop of prices and big wave volatility . Thus, flow toxicity refers to the risk raised by the case where liquidity providers trades with traders who have better information than they do. This is a contradiction to popular believe the "Flash Crash" was not caused by a "fat finger" or one single High-Frequency Trading (HFT) firm. The Volume-Synchronized Probability of Informed Trading or VPIN (Easley, Lopez de Prado and O'Hara, 2011) measures the imbalance of buy and sell orders to overall volume over periods that vary based on how much trading occurs. VPIN captures the market dynamics in event time, as measured in equal increments of trading volume, rather than in calendar time. In this paper, we implement VPIN measure, using tick price data for order flow on the ISE-30 futures contract at the Turkish Derivatives Exchange.

Key words: *VPIN, High-Frequency Trading, Order Flow Toxicity, Volume Imbalance, Order Imbalance, Flash Crash, Volatility Forecasting, Market Microstructure*
JEL Classification: C02, D52, D53, G01, G14

[1] Any opinions expressed in this article are those of the author and may not necessarily reflect the opinions of Turkish Derivatives Exchange (Vadeli İşlem ve Opsiyon Borsası A.Ş.).

1. Introduction

Globalization has sharply affected the daily life by the means of technology and concepts newly emerged. This is a process which is reinforced by its own creation and destruction. In this new era, especially after 1990s, the fields of finance and economics have started to question itself and the line between economics and finance become ambiguous. An increase in the number of articles considering behavioural finance and new methodologies in finance and economics is disclosed in order to decrease this ambiguity.

In this new era the crisis has also changed structure. Moreover the appearance of the frequency of the crisis has also increased. This frequency and changing structure has brought its own concepts such as volatility, toxicity, fat finger, flash crash, noise traders and high-frequency trading. These concepts are not easy to understand and comment on them as we know the basic rules of supply and demand. Financial markets now become the playground of physiology, econometrics, statistics, physics and a small amount of finance and economics. This complicated material necessitates different fields to meet in a common place. However this is not a clear solution to end the ambiguity, sharp volatility and new crisis in financial markets.

The main purpose of this study is to explore a pre-signal to detect a "flash" movement and liquidity crunch in the markets. New concepts of finance literature on detection of timing and reasons of flash crashes in the financial markets are underlined. By using the methodology known as Volume-Synchronized Probability of Informed Trading, we intend to catch the flash crash and illiquidity dynamics of the market. This effort might help to understand the concepts in a more broad sense and might be useful for the investors as additional information or signal to detect high volatilities in the financial markets. Investors in financial markets can be categorized in many different segments according to their age, sex, risk aversion, amount of capital or investment strategy. However, we know that all types of investors are affected by high volatilities or flash crashes. The aim of this study is to apply this new methodology to a market with newly developing derivative exchange.

2. VPIN Methodology

Volume-Synchronized Probability of Informed Trading (VPIN), developed by Easley, Prado and O'Hara (2011a, 2011b, 2011c) is a market microstructure model to understand the behaviour of prices in the minutes and hours prior to a downward or upward crash, and is a proxy for the order flow imbalance or toxicity. In other words, VPIN measures order toxicity, or the probability which the market is going to have persistent order imbalances that are going to damage market makers. Easley, Prado and O'Hara (2011a, 2011b, 2011c) express the order flow toxicity when it adversely selects market makers, who may be unaware that they are providing liquidity at a loss.

Order flow toxicity can be measured in the probability that informed traders adversely select uninformed traders. VPIN as flow toxicity metric, delivers a real-time estimate of provided liquidity conditions. If the order flow becomes too toxic, market makers are forced out of the market. When market makers or other liquidity providers withdraw, liquidity disappears, which increases even more the concentration of toxic flow in the overall volume.

Since informed traders move faster than other type of traders to trade in market and generally buy and sell at the same time or in sequential more often than other traders. Market makers or traders or high frequency trading programs as market makers tend to lose more money when order imbalances increase. The VPIN gauge measures the imbalance of buy and sell orders to overall traded volume over periods that vary based on how much trading occurs. Tracking imbalances relative to the intensity of trading instead of set periods is a variant of existing models adjusted for high-frequency strategies.

Microstructure models view trading as a game between liquidity providers, position takers and other type of traders that is repeated over trading periods. Easley et all (1996) expressed the structure of a trading process given in Figure 1, called Probability of Informed Trading (PIN), where α is the probability of an information event, δ is the probability of bad news, μ is the rate of informed trade arrival, and ε is the rate of uninformed buy and sell trade arrivals.

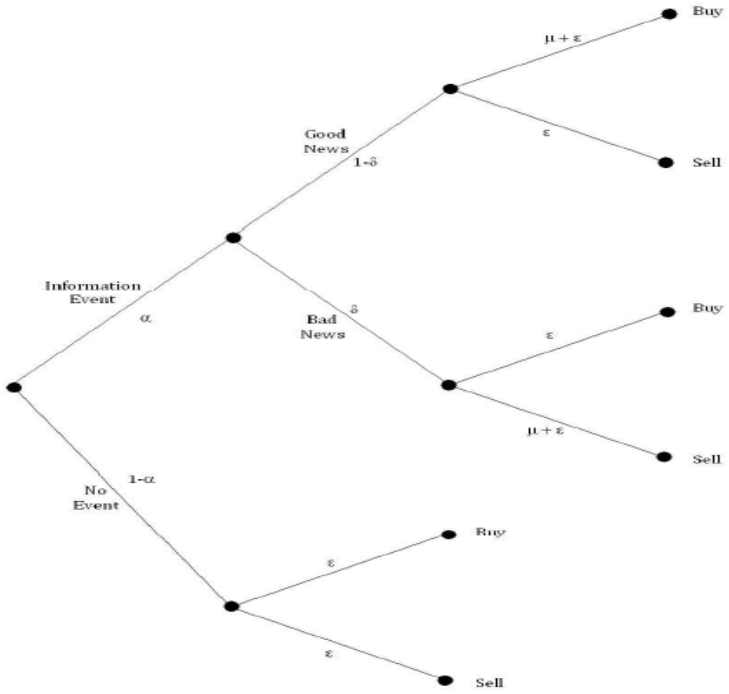

Figure 1. A diagram of trade process (Easley et all, 2011)

The arrival of new information to the marketplace is updated randomly. This new information covers total number of trades, due to the fact that the number of buys and sells contain the information about arrival rates of both informed and uninformed traders. Expected arrival rate of informed trades is computed by the investors to update the arrival rate estimates. The expected value of the total trades will be given by the sum of the Poisson arrival rates of informed and uninformed trades:

The expected value of the trade imbalance is given by $E[S-B]=\alpha\mu(2\delta-1)$. When the probability of bad news (δ) is not exactly one-half, the expected value of the trade imbalance provides information on the arrival of informed trades. The absolute value of the trade imbalance is $E[S-B]\approx\alpha\mu$. Easley et al. (2011b) group trades into equal volume buckets of an exogenous size V. τ =1,2,..., L is the index of equal volume buckets. Within

each volume bucket trades are classified as buys, V_τ^B, and sells, V_τ^S. V=V_τ^B + V_τ^S for each τ. Thus, the expected arrival rate of informed trade becomes $E\left[V_\tau^B + V_\tau^S\right] = \alpha\mu(2\delta - 1)$, and the expected absolute value is $E\left[V_\tau^B + V_\tau^S\right] = \alpha\mu$ (Karyampas and Paiardini, 2011).

Utilizing the binary trade indicator we construct the signed order imbalance (SOI) measure (Andersen and Bondarenko, 2011),

$$SOI = \frac{V^B - V^S}{V} = \frac{V^B - V^S}{V^B + V^S}$$

Motivated by the market microstructure theory, detailed in Easley et al. (2011c), the focus of Easley et al. (2011a) is on the absolute order flow imbalance relative to the total volume for the given bucket. Hence, they define their order imbalance measure as (Andersen and Bondarenko, 2011),

$$OI = |SOI| = \frac{\left|V^B - V^S\right|}{V} = \frac{\left|V^B - V^S\right|}{V^B + V^S}$$

The expected arrival rate of total trades is;

$$\frac{1}{L}\sum_{\tau=1}^{L}\left(V_\tau^B + V_\tau^S\right) = V = \underbrace{\alpha(1-\delta)(\varepsilon+\mu+\varepsilon)}_{Volume\ from\ good\ news} + \underbrace{\alpha\delta(\mu+\varepsilon+\varepsilon)}_{Volume\ from\ bad\ news} + \underbrace{(1-\alpha)(\varepsilon+\varepsilon)}_{Volume\ from\ no\ news}$$
$$= \alpha\mu + 2\varepsilon$$

Easley et al. construct the VPIN metric as the moving average of the order imbalance for the preceding L volume buckets of size V, so the computation exploits the last L.V contracts traded. Formally, let $\tau_0 \le \tau_1 \le \ldots \le \tau_L = t$ denote the sequence of times corresponding to the endpoints of the relevant volume buckets prior to time t, and let OI_l denote the order imbalance measure for the volume bucket that ends at time τ_l. Then, making the dependence on the underlying time bar explicit.

The Volume-Synchronized Probability of Informed Trading (VPIN) is computed as follows (Karyampas and Paiardini, 2011),

$$VPIN = \frac{\alpha\mu}{\alpha\mu + 2\varepsilon} = \frac{\alpha\mu}{V} = \frac{\sum_{\tau=1}^{L}\left(V_\tau^S - V_\tau^B\right)}{(2\delta-1)nV} \approx \frac{\sum_{\tau=1}^{L}\left|V_\tau^S - V_\tau^B\right|}{nV} \text{ or } = \frac{1}{L}\sum_{\tau=1}^{L} OI_\tau$$

3. Empirical Result

We focus on the VPIN metrics for most active the ISE-30 futures contract on Turkdex with ticker 111F_IX030 for the time period between January 1st 2007 and August 26th 2011. The sample consists of tick data (time stamp, traded price, traded volume) for the IX030 futures contracts. We compute daily average volume for the contract and then estimate a VPIN value for each time period that corresponds to the (1/50) part of this volume

(L = 50) . This procedure results in an average of 50 VPIN metric values per day, except on very active days when VPIN metric is updated much more frequently. 111F_IX030 futures contract's trading characteristic change as years go by. Thus, we set volume bucket according to daily volume and corresponding roughly to $(1/50)^{th}$ of the daily trading volume. VPIN value after the first 10 trade imbalance samples (n = 10) is computed.

Figure 2 shows the evolution of the IX030 futures contract (red line- trade price) and its daily average VPIN metric value (blue line). Apparently the VPIN metric generally fluctuates, although it clearly exhibits high volatility. Of particular importance, we investigate the extreme cases after 2007 phenomenon due to weakness of trading activities and the VPIN metric reaches its highest level for this sample on Jan 8th 2009, before the beginning of stand-by meeting between IMF and Turkey.

The Constitutional Court announced the decision about the closure case for the Justice and Development Party (AKP) on July 30, 2008. The VPIN metric decreases and the IX030 futures contract price increased at the beginning of the court's debate meeting on AKP's closure case on July 28, 2008, providing a theoretical explanation that "uncertainty".

As the same manner of Turkey's credit rate upgrades: on Sep 18, 2009 by Moody's and S&P and on Dec 3, 2009 and Nov 24, 2010 by Fitch, the VPIN value increases one week before the credit upgrade news. Like the credit upgrade news, the good news about IMF's increasing expectation of Turkey's economic growth rate, the VPIN value was increased approximately one week before the news.

Figure 2 also shows that the increasing levels of the VPIN metric before the beginning of the Greek crisis at the end of December 2009 and it continues until the announcement of Moody's Turkey's Credit Rate upgrade on Jan 8, 2010.

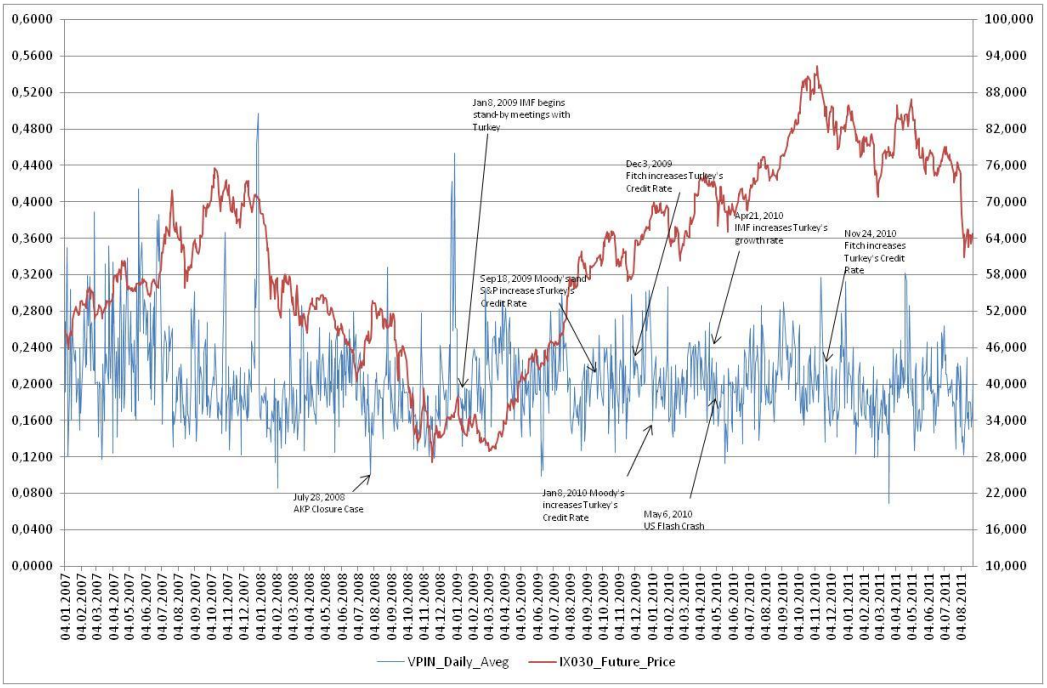

Figure 2. IX030 Futures Contracts' Price and Daily Average of VPIN

In the concept of high frequency world, the evolution of the IX030 futures contract trade price and its VPIN metric value are shown in Figure 3,4,5,6,7. Figures represent the trades and VPIN values in 2007, 2008, 2009, 2010 and 2011, respectively. Note that there are two interesting seasonal effects in the IX030 futures contract. The first seasonal effect is shown in the period between the beginning of the Turkdex daily trading session at 09:15 and the beginning of the Istanbul Stock Exchange (ISE), Turkey's spot market, daily trading session at 09:50. The VPIN metric generally increases more in defined periods. Thus, the lower volume is accompanied by a larger proportion of informed and uninformed trading. The reason in this seasonality is clear: "the reflection of the price volatility in US and Asian financial markets to Turkey's financial markets with Turkdex". The second effect is shown around the end of the year. Specifically, volume in IX030 futures markets slowly wanes every year after Dec 24th, and the VPIN metric generally increases. What causes this seasonality is not obviously clear, but one significant opinion among market participants is that most fund traders close out their positions in the developing countries before the end of the year. rising volume, reflecting that informed traders are "done for the year in developing countries".

VPIN implementation on TURKDEX does not give significant insights regarding the expectations to detect global crashes before it occurs based on the data for the given period. There might be more than one possible reason for this result. First of all VPIN methodology was used to detect crashes in S&P which is one of the financially deepest and mature exchanges in the world. Moreover, US markets open on 16:30 in Turkish time and Turkish capital markets are open until 17:35. Thus, different structure of the exchanges might not let to detect the anomalies in exchange in Turkey. In addition, the exchanges in emerging countries are generally the “follower” exchanges because of less trading liquidity and the size of country wealth.

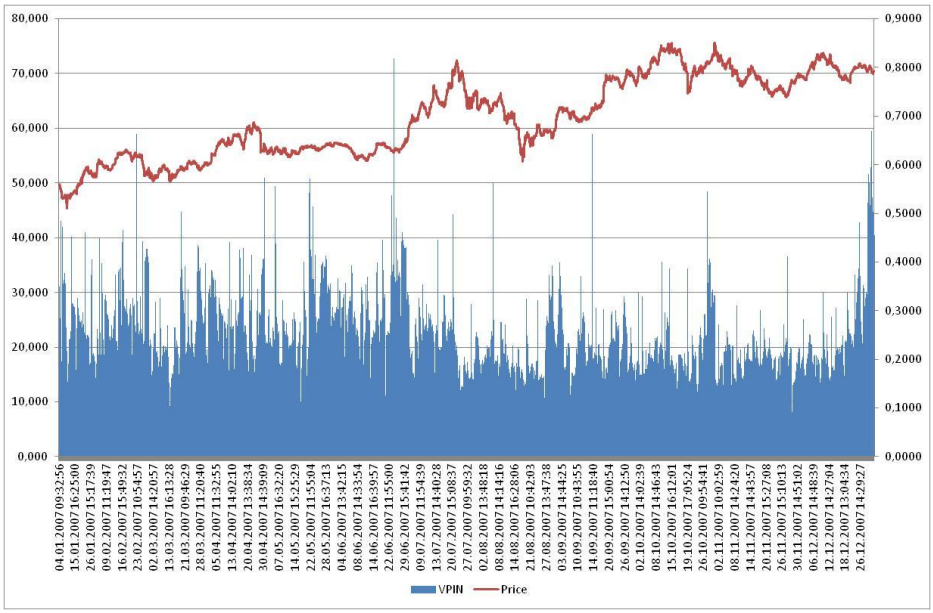

Figure 3. IX030 futures' VPIN and trade price in 2007

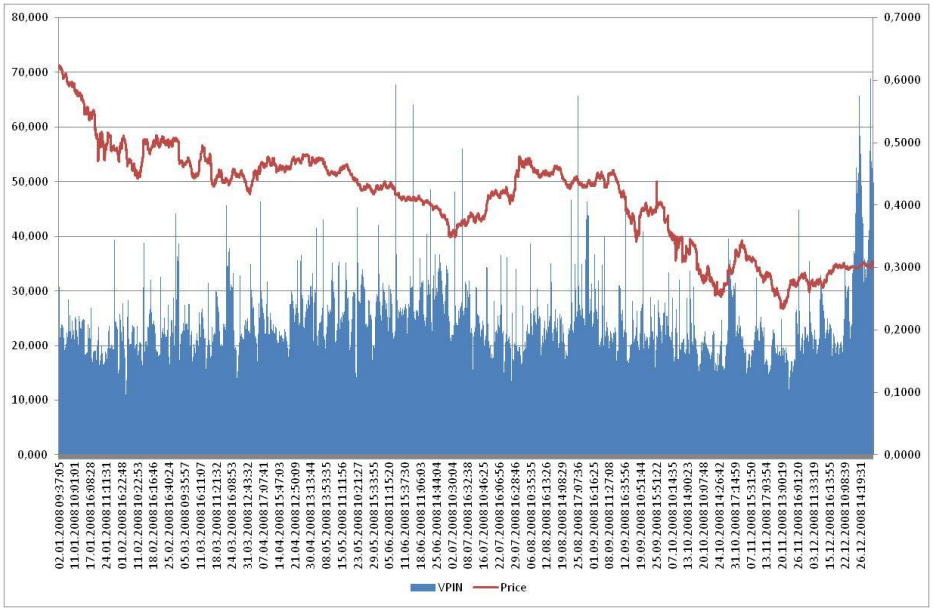

Figure 4. IX030 futures' VPIN and trade price in 2008

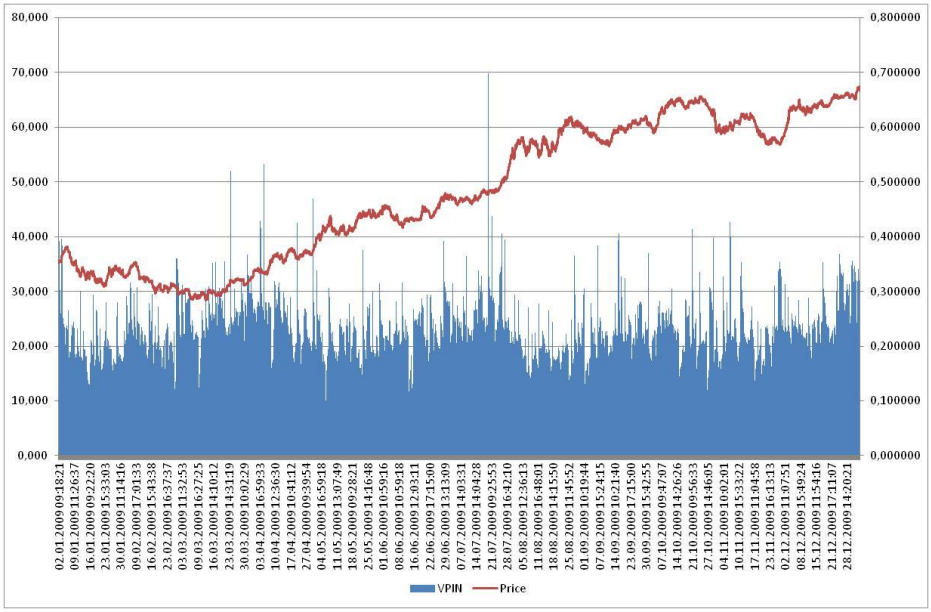

Figure 5. IX030 futures' VPIN and trade price in 2009

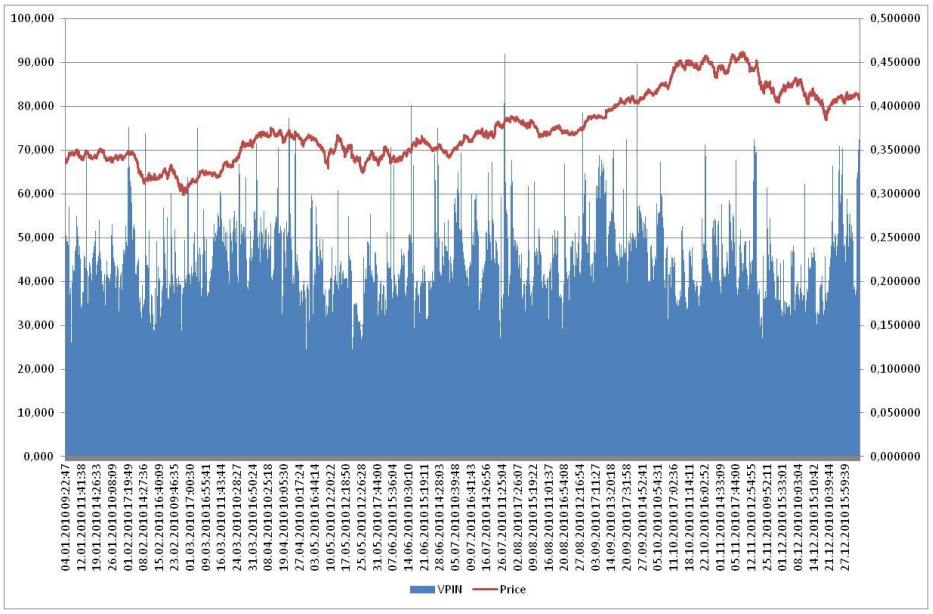

Figure 6. IX030 futures' VPIN and trade price in 2010

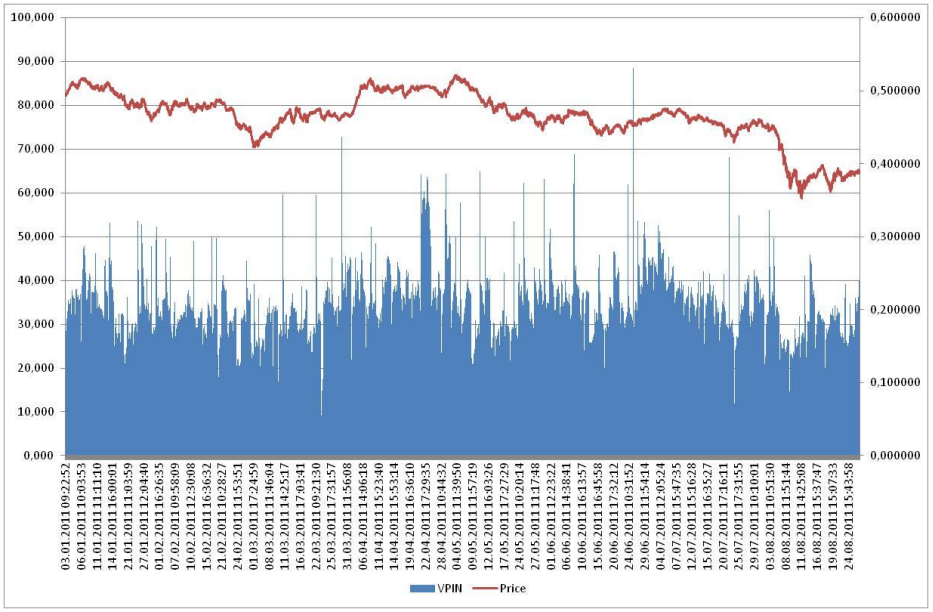

Figure 7. IX030 futures' VPIN and trade price in 2011

4. Conclusion

VPIN implementation on Turkdex is not powerful as for the deep markets. The exchanges in emerging countries are generally the "follower" exchanges. However, VPIN methodology detects some local crashes based on country specific local news such as announcement of changes in credit rating of Turkey. VPIN values start to increase approximately one week before these announcements. Thus we may infer that VPIN methodology works better to detect the local crashes than global crashes for the "follower" exchanges.

Moreover Turkdex starts its trading sessions at 09:15 and Istanbul Stock Exchange (ISE), which possesses the underlying asset for future contracts of Turkdex, starts its trading sessions at 09:50. VPIN detects highly volatile values for Turkdex until ISE starts its morning session. In Turkey, previous night's effect which is the sum of world's financial market is realized firstly in Turkdex. In line with this idea since it is a follower exchange, this effect arises in this period between 09:15 and 09:50 a.m. and cause high VPIN values until 09:50 a.m.

For further research, volatility, volume and average statistics of exchange will be considered and used to adopt to the VPIN methodology in the analysis of different exchanges in order to detect the crashes before it occurs.

References

Andersen, T.G. and Bondarenko, O., 2011, "VPIN and the Flash Crash". Available at SSRN: http://ssrn.com/abstract=1881731.

Easley, D., N.M. Kiefer, M. O'Hara, and J.B. Paperman, 1996, "Liquidity, Information, and Infrequently Traded Stocks", Journal of Finance, 51, 1405-1436.

Easley, D., M. L'opez de Prado, and M. O'Hara, 2011a, "The Microstructure of the "Flash Crash": Flow Toxicity, Liquidity Crashes, and the Probability of Informed Trading", Journal of Portfolio Management, 37 (2), 118-128.

Easley, D., M. L'opez de Prado, and M. O'Hara, 2011b, "The Exchange of Flow Toxicity", Journal of Trading, 6 (2), 8-13.

Easley, D., M. L'opez de Prado, and M. O'Hara, 2011c, "Flow Toxicity and Liquidity in a High Frequency World". Johnson School Research Paper Series No. 9-2011. Available at SSRN: http://ssrn.com/abstract=1695596.

Karyampas D. and Paiardini, P., 2011, "Probability of Informed Trading and Volatility for an ETF", Birkbeck Working Papers in Economics and Finance 1101, Available at : http://econpapers.repec.org/paper/bbkbbkefp/1101.htm.