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INFLUENCE OF MARKET REGULATORY INSTRUMENT (TICK) ON PRICE PERCEPTION MECHANISM AND RETURN ON INDEX FUTURE

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Abstract

Various researchers document change of volatility, widening of spread, increase cost of negotiations due to imposition of ticks as internal market regulatory instrument. We argue in this paper, that essentially imposition of ticks does not affect market quality. We test effect of ticks on price perception Korean Stock Futures on the return of Kospi 200 Index futures using 1-minute data of uptick and downtick. We build up two proxy measures that mimic market direction and speed of price change. We show that neither of these measures emits any effective signal which would help the investor in forming their price perception. We further document insignificant relationship between return and both these measures. The evidences on informational content of ticks tend to establish that ticks cannot be used as a signaling device for making additional return. All the evidences put in this paper tend to support our contentions that tick is unimportant for market moderation.

Keywords: Tick, Index Futures, high frequency data, uptick minus downtick, uptick plus down tick, regression analysis.

JEL Classification: G1

INTRODUCTION

The tick is the minimum movement of prices both upward and downward of the stocks that are traded in stock markets and is imposedby the stock market regulator as a regulatory instrument. Its history can be traced back to even during middle ages in Britain and Holland. In the US, following stock market crash in 1929, the tick rule is introduced there in 1930s. The rule prohibits short sales of securities except on uptick. The "tick rule" is most debated in finance literature. It is a regulatory market internal that discourages short sellers. Exponents of short sellers point to the fact that short sellers help restoration of equilibrium position of temporary demand and supply mismatch, by providing liquidity. The overvaluation of the security is corrected, thereby revealing true value of the security and bringing in market efficiency. It appears, therefore, that any regulation that impedes short selling prevents market efficiency and discourage efficient price discovery. Ackert *et al.* (2001) finds that short selling, provides equilibrating force in the market, improves ability of the pricing mechanism and allows traders to move prices to levels justified by fundamentals. Argument against short selling revolves round that short selling could be used as a market manipulator as unrestricted short selling may create an artificial demand and supply imbalance that is skewed towards supply side leading to accelerated price decline ending in a crash. The introduction of "tick rule" is to prevent such eventuality. From an investor's point of view the "tick rule" (you can only short sell at the uptick price of the last traded price) acts as a buffer to avert short selling and panic selling that drives the prices below their fundamental values. The researchers are divided in their conclusion on upholding or discarding usefulness of the "tick rule". We reason, however, that in an efficient market the effect of "tick rule" would be absorbed and the price would always find its efficient value. If a short seller predicts that the price would decline, he would nevertheless sell the security at the uptick price. Jones, et.al (2002) point out that stocks that are expensive to short or which enter borrowing market have high valuation and low subsequent return. They also find that despite high cost it is profitable to short. In other words, even if "tick rule" is imposed, market mechanism would react in its own way rather than in regulated manner.

The tick size also has a role in determining market quality. Large tick size makes bid-ask spread wide, while small tick size lead to narrow spread, decrease of market depth, increase in negotiation cost, etc. The effect of tick in both the cases, as it seems, tends to delay price-discovery process. Studies by Ronen and Weaver, (2001) point out that tick, imposes binding constraints on bid-ask spread. Imposition of tick by market regulator leads to reduced market depth (Harris, 1997), while Grossman *et al.* (1997) findincreased negotiation cost. The tickreduces value of private information (Anshuman & Kalay, 1998). It is also documented by Bhargava & Konku, (2010) that elimination of ticks leads to increase of inter-day and intraday volatility. This paper attempts to balance the above arguments and examines the effect of ticks on price discovery mechanism of the index future. Any short selling impediment on the stock is likely to affect its spot price and would have an effect on its future price. The examination of behavior of future from the perspective of ticks would allow us to understand tick's behavior on trading in futures. The use of index future, whose underlying asset is index, is adopted in this paper, as the index is expected to contain sum total effect of ticks on all index constituent stocks. The short-selling costs (borrowing cost of the security) on spot market can be avoided in future markets. The paper adds to the existing literature by providing an analysis of how tick as market regulatory internal affects price perception by investors and return.

Our research contributes to the existing literature in the following way: (1) we show that ticks, both up and down, are not likely to help in forming price perception of the investors. The evidence tends confirm that imposing ticks as market internals may not help the regulator to a large extent for market moderation and (2) our research also documents effect of tick on return. The return is found to be little associated with number of ticks. Therefore, ticks can hardly be used to influence the price discovery, thus affecting the impact on return. In other words, our evidences suggest that ticks hardly affect the price discovery mechanism.

LITERATURE SURVEY

Various research studies are available investigating behaviour of tick as market regulatory instrument. Harris (1994) argues that large tick sizes affect the traders adversely as they act as binding constraints on spreads. Ho (1996) documents increased volatility of stock return in Singapore stock exchange when short sales are restricted by imposition of ticks. Grossman et al. (1997) find that even small tick sizes affect traders because of large negotiation costs. Ronnen and Weaver (1998) find, inter alia, that volatility is directlyrelated to tick size and they report significant decreases in both daily and transitory volatility, trade behavior and market quality. Chung and Shin (2010)find in Korea Stock Exchange, that increasing tick sizes are detrimental to market quality but the adverse effect of binding constraints is somewhat mitigated by lower negotiation costs. Hsieh, Lee and Lin (2010) report that in Taiwanese Stock Exchange, the reduction of tick size leads to decrease of noise variance, intrinsic variance, speed of adjustment and volatility of prices. The tick is also reported to have a different property, that is, it is responsible for compass rose return pattern. The pattern looks like a compass where originating rays from the nucleus are pointing towards different directions, but the most prominent rays are pointing towards a definite direction as observed in a compass. The phenomenon is first observed by Crack and Ledoit (1996). Since then many theories are advanced to explain the phenomenon. The most important one is developed on tick/volatility ratio. For example, Gleason *et al.* (2000)put forward evidences that demonstrate that tick / volatility ratio over a certain threshold level is a determinant to the compass rose pattern. In the field of studying tick size and market efficiency, Porter and Weaver (2005) examine inter alia, the impact of a reduction in minimum tick size on market quality on the Toronto Stock Exchange for March and May, 1996, and find decline of execution cost for low-priced and high-volume stock with a reduction in quoted market depth. They also find that reducing tick size has a negligible impact on internalization and member profits and might result in higher commission profits. Importantly, tick as market regulatory instrument is used to enforce market discipline particularly in the area of short selling of stocks. It is rational that when an investor has a negative view on a security, he would sell the stock, even when he does not own that stock. Constraining this sale, that is short-sale, is likely to bias the price of the stock. However, there are evidences that both contradict and support the above notion. Miller (1977) argues that price of risky assets would rise differentially higher during restrictions on short sales with respect to prices when restrictions are not in place. Jarrow (1980) reports that in two equivalent markets differing only with respect to short selling restrictions, the risky asset prices, in general, can either rise or fall due to short sale constraints. Jarrow (1980) also finds that under a homogeneity of belief for the covariance matrix of future prices, short sale constraints lead to increase of risky asset prices. Researchers to an extent agree that in an efficient market, with little risk of abuse, benefits of short selling towards liquidity and informational efficiency are exceedingly more than its perceived distortion of the market efficiency. It has been seen therefore that, failure of market regulator to restrain short sellers from abusing and manipulating the stock prices is not due to bad policy decision but lax enforcement of market rules. Verousis et.al. (2018) report that a decrease in the minimum tick size decreases transaction costs of securities. It leads to an increase in market liquidity but the incentive to provide market making activities decreases. They document:

> *"a strong link between the minimum tick size regulations and the recent increase in high frequency trading activity. A smaller tick enhances the price discovery process".*

Furthermore, they concluded that from a policy perspective, clearly regulators have been primarily concerned with the effect of tick size changes on the trading price of the firm. But the decision to change the minimum tick size ultimately has an effect on firm valuation. Some recent studies also report effect of tick on market behavior. In an effort to understand dynamics between tick size and market quality, Zhao, *et al.* (2020) find that market:

> *"quality was generally weakened as tick-size value increased, with expanded bid-ask spreads, elevated market volatility, and reduced market efficiency".*

Similarly, Chakraborty, *et al.* (2021), in a recent study,*report "significant changes in the relative price discovery of U.S. markets after the implementation of the SEC's Tick Size Pilot Program".*

The imposition of tick by market regulators is connected with an aim to reduce short selling of stocks. Diamond and Verrecchia (1987) study effects of short-sale constraints on speed of adjustment to private information of security prices. They find prohibition for shorting reduces the adjustment speed of prices to private information thereby reducing market efficiency, while non-prohibitive costs are unlikely to reverse the effect. Inactive trades show downward bias to returns and an unexpected increase in short selling is considered as bad news.

Brunnermeier and Oehmke (2014) find justification for temporary restrictions on short selling of stocks of vulnerable financial institutions. They reason:

> *"When the stock of a financial institution is shorted aggressively, leverage constraints imposed by short-term creditors can force the institution to liquidate long-term investments at fire sale prices. For financial institutions that are sufficiently close to their leverage constraints, predatory short selling equilibria co-exist with no-liquidation equilibria (the vulnerability region) or may even be the unique equilibrium outcome (the doomed region). Increased coordination among short sellers expands the doomed region, where liquidation is the unique equilibrium".*

Cornelli and Yilmaz (2015) find that, even with short selling constraints the price of security converges to its fundamental value if informed traders do not face significant short selling constraints. However, when short sellers face large costs, the prices may drift away from fundamental values even in the presence of large informed traders with noisy private signals. In other words, under certain conditions, short sales introduce both efficiency and bias in price discovery process. The short-selling ban around the world is also examined. Beber and Pagano (2013) find in this context a reduced liquidity in the market, accompanied by distorted price discovery process. In a recent paper, Sahin and Kuz (2021), document short selling improves information efficiency.

Accordingly, the issue relating to effect of 'tick' on the security price is still not settled and a wide gap persists.

DATA

We use high frequency data of 1-minute interval of uptick and downtick in respect of Kospi 200 Index Futures (day time) obtained from Korea Stock Exchange. The underlying asset is Kospi 200 Index. The Korea Stock Exchange (KSE) is the largest stock exchange in Asia. It is a fully automated trading platform and regular day time session is from 9:00 hours to 15.30 hours (Korean Standard Time). Trading on the KSE takes place five days a week from Monday through Friday. The KSE employs a multiple tick system in which tick sizes become larger as the stock prices are higher. The tick size and value of Kospi 200 Index futures are 0.05 point and KRW 25000 (tick value 0.05 x KRW 500,000 (multiplier)) respectively. The upper and lower limit in case of 1st Phase price limit is ± 8% of the base price. The data relates to the entire month of June 2020, consisting of 8580 time series observations for each variable. The total tick is the summation of number of uptick and downtick in 1-minute interval. The month of June 2020 is selected due to the reason that during this time South Korea had substantially recovered from COVID19 pandemic and the stock market volatility due to COVID19 is expected to be stabilizing. In other words it is likely to bring out how partially post- COVID19 pandemics, the Korean stock market behaved with respect to a market regulatory factor, that is, tick size. Secondly, there was no exchange holiday during the month of June 2020. Accordingly, there was a continuous volatility roll over without usual break.

The ratio (number of upticks minus number of downticks)/(number of upticks plus number of downticks), which is an indicator for buying and selling investment strategies over its threshold level of +100 and –100, is found to range between 100 and –100, for June 2020. Under this condition, it gives an opportunity to investigate additionally the buying and selling behavior of the investors based on ticks.

EMPIRICAL RESULTS

The descriptive statistics are given in Table -1. The mean return is positive, which is expected as mean difference between uptick and downtick is also positive. The positive tick difference indicates a upward market during the period. The price perception is positive, as a result of upswing market. The correlation shows (Table 2) that volatility is positively associated with upticks plus downticks (UPD), to a certain degree. The relation is expected as larger number of aggregate ticks means more movement of price, which in turn would increase volatility. The price perception also shows the expected relation. Since investor's behavior on price perception is partly dependent on volatility, we observe a moderate positive association. The correlation between price perception and instantaneous return is found to be low and positive. It shows that investor's perception for the direction of market movement is to an extent correct during the period. The vector uptick minus downtick (UMD) which obliquely points to the course of market movement is found to be less associated with volatility and return. It appears, therefore, that market discounts direction of price movement as apparently shown by the ticks. The multicollinearity amongst variable is discounted because most of the correlation coefficients are low.

UNIT ROOT TEST

The Augmented Dickey-Fuller test is conducted for all the variables in level and the results are displayed in Table - 2A along with their corresponding critical values in level. They indicate that hypothesis of existence of nonstationary in level is rejected for all the variables.

BEHAVIOR OF TICKS AND INVESTOR'S PRICE PERCEPTION

In earlier studies, effect of tick system on market quality posits various results. For example, tick sizes can affect traders as a result of binding constraints on spreads (Ronen & Weaver 2001) and due to high transaction costs (Grossman *et al.* 1997). In other words, the studies point that tick tends to influence the price discovery mechanism. If the spot market has certain inhibition due to tick, the same would also be reflected on futures, as price discovery mechanism would be affected in the same way as that of for futures. To examine the effect on price discovery, we introduce a proxy measure for price discovery and we expect a positive relationship between the proxy measure and the uptick and downtick. The proxy for the price discovery is the extent of consistency in price perception of the investors in respect of the underlying and is given by spread of high and low price divided by the spread between closing and opening price during a quantum of time t. It is seldom possible to buy at low and sell at high. However, it is possible to buy and sell both at open and close prices. As a result investor's consistency of the perceived price is likely to be revealed by the ratio of actual spread (high minus low) and the effective price spread (close minus open) during time t. We also include volatility as a control variable. The following regression equation is used for the purpose:

$$PRPt = \alpha_0 + \alpha_1 UPDt + \alpha_2 VOLt + \varepsilon, \quad (1)$$

Where, PRPt is the ratio high minus low price divided by closing minus opening price during a quantum of time t (1-minute), VOLt is the volatility of the Kospi 200 index future, UPD is number of upticks plus downticks during the period t (1-minute), while α_0 , α_1 and α_2 are regression coefficients and ε is the error term. The volatility during the period t (1-minute) is calculated in the following way using Garman and Klass (1980) method:

$$VOLt\ (\sigma 21\text{-min}) = 0.5(Ht - Lt\ )2 - 0.386\ (Ct - Ot\ )2,$$

where, Ht , Lt , Ct , Ot are the high, low, closing and open quotes of the future index during 1-minute interval.

The regression coefficient á1 would enable us to determine whether the ticks as a whole put constraints on price discovery mechanism of the futures index, thereby increasing the inconsistency of the price perception of the investors. It is therefore expected that the regression coefficient α_1 would be negative and significant. The regression equation is run using time-series data on 1-minute interval. The Table 3 displays the results. It shows that the coefficient α_1 is positive, low (.00011) and significant. The evidence points out that the ticks do not appear to put a substantial degree of impact on price discovery process. In other words, market quality based on investor's consistency in price perception seems to be not affected by imposition of ticks on futures, as regulatory market internal. The regression coefficient α_2 for volatility is positive, relatively large (3.988) and statistically significant. It follows that market's own mechanism helps the investors towards price determination largely rather than by ticks as market internal. The DW statistics is 1.98, which indicates absence of auto-correlation in the series. We have examined the behavior of ticks on price determination with a control variable volatility during time t. We now remove the control variable in order to find out how much impact is made by the ticks. We use the following equation:

$$PRPt = \alpha_0 + \alpha_1 UPDt + \varepsilon, \quad (2)$$

The coefficient á1 is very small (.000296) and the adjusted R2 is .25, (Table – 4) which imply that the effect of ticks on price perception is indeed not substantial. Accordingly, the evidence suggests that ticks may not seem to be an important factor for predicting investors' price perception.

Our next analysis on price perception is based on difference of numbers between uptick and downtick. If the number of upticks is more than the number of downticks, it is expected that the price would tend to go up; reversely the price would tend to go down. The ticks may therefore play an important constraint on the futures and thereby on the market moderation. However, such constraints would impact price discovery process only temporarily. The investors' decisions would be more affected by their relatively long term assessment of price perception. The UMD (number of uptick minus number of downtick) shows the direction of market movement. A positive magnitude shows more uptick than downtick which indicates increase of price, while a negative magnitude gives an indication of decrease of price. If the investors react on instantaneous direction of market, in that event UMD would be strongly correlated with price perception and return. The investors in many instances are reluctant to trade based on very short term market direction due to their behavioral consonance and dissonance. Under such conditions, their investment decisions may not be instantaneous but belated. As a result the variable UMD would not likely to make greater impact on price perception and return.

Accordingly, we apply regression analysis to establish our hypothesis that UMD is not likely to impact price perception significantly. We also use here volatility as the control variable. If the coefficient for volatility is relatively high, it would mean that the price is predominantly determined by the volatility during time t.

We use the following regression equation to test our above premise:

$$PRPt = \alpha_0 + \alpha_1 \text{ UMDt} + \alpha_2 \text{ VOLt} + \varepsilon t, \tag{3}$$

where, UMDt is the difference of the number of up ticks and down ticks during time t, while other variables are same as defined earlier.

The regression coefficient α_1 is expected to be negative, as it is a constraint on price perception, and small as argued above. The results are shown in Table 5. The coefficient α_1 is statistically significant, positive and very small (.000642). On the other hand, the regression coefficient α_2 for volatility is relatively very high (4.9962) and significant. The adjusted R2 is .51. The value of α_1 implies that ticks have a limited effect on investor's price perception even when the market direction of price movement is predictable. In other words, ticks' relative impact on market moderation as binding constraints on the price movement is observed to have a little potential. On the other hand, since the regression coefficient for volatility α_2 is high, it suggests that volatility imparts much greater degree of impact on price perception. Further removing the variable volatility from the above equation (5) does not improve adjusted R2 but it reduces to

0.15, with the coefficient for UMDt remains the same. Accordingly, price discovery process seems to be little affected by the imposition of ticks.

Since, we find some impact, although very low, of ticks on the price perception, it is of interest to find out if the information content of ticks have lagged impacts. If the lagged impacts are found to be low, it would follow that imposition of ticks as a deterrent to short selling, would not likely to have any effective impact. We, therefore, examine investor's perception of price on lagged UPDs and UMDs. The traders would likely to base their opinion on speed of change of value of the underlying as well as the direction of such change. The direction of change as is surrogated by UMD and is expected to be stronger than speed of the change, as proxied by UPD, for the formation of investors' perception of price of the underlying. The following regression equation is used:

$$PRPt = \alpha_0 + \alpha_1 UPDt + \alpha_2 \Delta\, UPDt\text{-}1 + \alpha_3\, \Delta UPDt\text{-}2 + \alpha_4\, \Delta UPDt\text{-}3 + \alpha_5 UMDt + \alpha_6\, \Delta UMDt\text{-}1 + \alpha_7\, \Delta UMDt\text{-}2 + \alpha_8\, \Delta UPDt\text{-}3 + \varepsilon, \quad (4)$$

where, UPDt and UMDt are total of uptick and downtick and up minus down tick at time t, ΔUPDt-1, ΔUPDt-2, ΔUPDt-3, ΔUMDt-1, ΔUMDt-2 and ΔUMDt-3, are lagged differences of UPD and UMD during time, t, t-1, t-2 and t-3 respectively, while α_0, α_1 … α_8 are regression coefficients and ε is the error term.

The results of the regression are shown in Table - 6. Both the coefficients of UPDt and UMDt are low, being .000392 for UPDt and .008 for UMDt, which indicate that direction of change is stronger than speed of change, as hypothesized above. The coefficients of ΔUPDt-1 and ΔUMDt-1 are extremely small being .0000388 and .0000976 respectively, which point out that neither speed of change nor direction of change is important aspects for the investors at time t-1, to form their price perception. We observe further lowered values of coefficients of subsequent terms (UPDt-2, ΔUPDt-3, ΔUMDt-2 and ΔUMDt-3) which indicate that ticks are not responsible for delay, if any, in price perception, alternatively, in price discovery mechanism. In effect the results do not show any appreciable effect of ticks on price perception.

BEHAVIOR OF TICKS AND MARKET RETURN

In this section, we examine how return and volatility influence total ticks (UPD) In a volatile market, UPD will tend to move upward, because high volatility would witness large number of ticks. The research studies have documented asymmetric relationship between return and volatility and if volatility is associated with negative return, the same relationship would likely to occur for total ticks. Since an unexpected increase in number of ticks is likely to increase the risk-adjusted discount rate, therefore, under condition of constant cash-flow, the return decreases. Therefore return would be negatively associated with total ticks. The above explanation leads us to infer that higher total ticks tend to give negative returns. Accordingly, market moderation through ticks may not be feasible. However, effect of tick size on spread is not examined here and therefore market moderation in its totality is not commented upon. We use the following regression equation, to understand how UPD is affected cross-sectionally by return and volatility characteristics:

$$UPDt= \alpha_0 + \alpha_1 \, RTNt + \alpha_2 \, VOLt + \varepsilon, \qquad (5),$$

where RTNt is the 1-minute return calculated on closing price. The other variables are as defined earlier.

The Table 7 summarizes the results. The coefficient for return variable is found to be negative, significant and large. The increase in number of ticks is likely to increase the risk adjusted discount rate, which coupled with unchanged expectation of cash-flow, leads to reduced return.

Since the ticks are intended to hinder, to an extent, short selling, thereby not allowing the investor to make abnormal gain from such activities, we expect that ticks would play an important role in restricting the returns of the underlying. One of the conditions of efficient market is instantaneous reflection of information in the prices of the underlying. Consequently, it is expected that the instantaneous return may also be affected by total ticks and since the difference of ticks gives indirectly an indication of market direction, the variable UMD may be significant, but low, as the effect on return may not be substantial.

In order to examine the above hypothesis, we employ the following equation using lagged differences of UPD and UMD.

$$RTNt = \alpha_0 + \alpha_1 UPDt + \alpha_2 \Delta UPDt\text{-}1 + \alpha_3 \Delta UPDt\text{-}2 + \alpha_4 \, \Delta UPDt\text{-}3 + \alpha_5 \, UMDt + \alpha_6 \, \Delta UMDt\text{-}1 + \alpha_7 \, \Delta UMDt\text{-}2 + \alpha_8 \, \Delta UPDt\text{-}3 + \varepsilon, \qquad (6)$$

where, UPDt and UMDt are total of uptick and downtick and up minus down tick at time t, ΔUPDt-1, ΔUPDt-2, ΔUPDt-3, ΔUMDt-1, ΔUMDt-2 and ΔUMDt-3, are lagged differences of

UPD and UMD during time, t and t-1, t and t-2 and t and t-3 respectively, while α_0, α_1 … α_8 are regression coefficients and ε is the error term. RTNt is the instantaneous return at time t.

The results are shown in Table 8. It is observed that none of the coefficients containing UPD terms are insignificant. The regression coefficients of the term UMD on the other hand are significant for ΔUPDt and ΔUPDt-1, with extremely low value being 0.0000025 and 0.000003 respectively. It is therefore apparent that instantaneous return is not dependent on ticks, while the direction of the price movement has an extremely low impact on instantaneous return.

Further, in order to understand how the ticks influence the lagged return, we continue our investigation with lagged return as dependent variable, replacing the instantaneous return. The following equations are used for the purpose.

$$RTNt\text{-}1 = \alpha_0 + \alpha_1 UPDt + \alpha_2 \Delta UPDt\text{-}1 + \alpha_3 \Delta UPDt\text{-}2 + \alpha_4 \Delta UPDt\text{-}3 + \alpha_5 UMDt + \alpha_6 \Delta UMDt\text{-}1 + \alpha_7 \Delta UMDt\text{-}2 + \alpha_8 \Delta UPDt\text{-}3 + \varepsilon, \quad (7)$$

and

$$RTNt\text{-}2 = \alpha_0 + \alpha_1 UPDt + \alpha_2 \Delta UPDt\text{-}1 + \alpha_3 \Delta UPDt\text{-}2 + \alpha_4 \Delta UPDt\text{-}3 + \alpha_5 UMDt + \alpha_6 \Delta UMDt\text{-}1 + \alpha_7 \Delta UMDt\text{-}2 + \alpha_8 \Delta UMDt\text{-}3 + \varepsilon, \quad (8)$$

The results are observed to be similar to instantaneous return and are shown in Table 9 and Table 10. In both the cases, the coefficients of the term UPD are not significant. On the other hand, for dependant variable RTNt-1, the coefficient for UMDt-2 is significant and is extremely low (–) 0.0000033. In respect of RTNt-2 as dependent variable, the UMDt is significant and low being – 0.0000089. In addition, of all the coefficients of UMDs, only ΔUMDt-2 and ΔUMDt-3 are significant with extremely low values of (-) 0.0000003 and (-) 0.0000035 respectively.

Accordingly, it tends to establish that ticks have only a negligible influence on the instantaneous return and also lagged returns. The signals as generated by directional magnitude of up and down ticks are extremely low (negligible) and can hardly influence the characteristic returns.

CONCLUSION

We argue in this paper, that essentially imposition of ticks does not affect market quality and moderation even during contraction of world economy. Using a proxy measure for investor's price perception, we show that aggregate ticks UPD (Uptick plus Downtick) would not necessarily help the investor forming price perception. We also document insignificant relationship between return and investors' proxy measures UPD and UMD (Uptick minus Downtick). When the lagged differences of UMD and UPD are used for testing their influence on price perception and return, we find only extremely low relationship with UMD and not with UPD. All the evidences put in this paper tend to support our contentions that imposition of tick as market internal is immaterial for market moderation.

Table 1
Descritive Statistics

	PRP	*RTN*	*UMD*	*UPD*	*VOL*
Mean	0.132654	0.002	1.89872	175.1192	0.008655
Median	0.98442	0.0046	-0.51922	119.652	0.004977
Maximum	1.49976	0.0157	595	1654.352	0.29543
Minimum	0.0011	-0.04876	-662	3.879	0.29543
Std. Dev.	0.12004	0.0141	31.4215	209.0259	0.00745
Skewness	2.758252	-87.1157	-0.43197	3.053	8.138048
Kurtosis	18.48951	7609.313	12.81348	16.51	117.3148
Jarque-Bera	86176.16	1.85E+10	30934.95	70050.27	4249824.
Probability	0.0000	0.0000	0.0000	0.0000	0.0000

PRP is the investor's price perception.
RTN is the instantaneous return.
UMD is the number of uptick minus number of downtick.
UPD is the number of uptick plus number of downtick.
VOL is the volatility

Table 2
Correlation Coefficient

	PRP	*UMD*	*UPD*	*VOL*	*RTN*
PRP	1.0000	0.381656	0.509124	0.590088	0.001777
UMD	0.381656	1.0000	-0.02793	-0.01038	-0.00052
UPD	0.509124	-0.02793	1.0000	0.710401	-0.03032
VOL	0.590088	-0.01038	0.710401	1.0000	-0.02261
RTN	0.001777	-0.00052	-0.03032	-0.02261	1.0000

PRP is the investor's price perception.
UMD is the number of uptick minus number of downtick.
UPD is the number of uptick plus number of downtick.
VOL is the volatility
RTN is the instantaneous return.

Table 2A
Unit Root Test

	PRP	*RTN*	*UMD*	*UPD*	*VOL*
ADF Coeff. in level	-7.71885	-10.5033	-6.80155	-9.94939	-6.29386
ADF Critical Value in level	-3.5402	-3.55406	-3.5402	-3.5402	-3.5421

Table 3
The regression result of the following equation PRPt = α0 + α1 UPD t + α2 VOLt + ε,

Where PRPt is the ratio high minus low price divided by closing minus opening price during 1 minute interval (t), UPD is the number of upticks plus number of downticks during the period t, VOLt is the volatility of the underlying during time t, while α_0, α_1 and α_2 are regression coefficients and ε is the error term. The regression is run under Newey-west heterostatistically consistent coefficient covariance.

Variable	*Coefficient*	*t-stat*	*Adj R2*	*F- stat*	*DW -stat*
α_0	0.069	25.49*	0.39	2076.8	1.98
α_1	0.00011	6.29*			
α_2	3.988	12.76*			

* Significant at 1% level

Table 4
The regression result of the following equation:
PRPt = α0 + α1 UPD t + ε,

Where PRPt is the ratio high minus low price divided by closing minus opening price during 1 minute interval (t), UPD is the number of upticks plus number of downticks during the period t, while α_0 and α_1 are regression coefficients and ε is the error term. The regression is run under Newey-west heterostatistically consistent coefficient covariance.

Variable	*Coefficient*	*t-stat*	*Adj R2*	*F- stat*	*DW -stat*
α_0	0.068	25.97*	0.25	2848.91	1.91
α_1	0.000296	17.27*			

* Significant at 1% level

Table 5
The regression result of the following equation:
PRPt = α0 + α1 UMD t + α2 VOLt + ε,

Where PRPt is the ratio high minus low price divided by closing minus opening price during 1 minute interval (t), UMD is the number of upticks minus number of downticks during the period t, VOLt is the volatility of the underlying during time t, while α0, α1 and α2 are regression coefficients and ε is the error term. The regression is run under Newey-west heterostatistically consistent coefficient covariance.

Variable	*Coefficient*	*t-stat*	*Adj R2*	*F- stat*	*DW -stat*
α_0	0.0879	32.52*	0.51	3762.69*	2.00
α_1	0.000642	24.58*			
α_2	4.9962	25.83*			

* Significant at 1% level

Table 6
The regression result of the following equation:
RTNt = α0 + α1UPDt + α2ΔUPDt-1 + α3ΔUPDt-2 + α4 ΔUPDt-3 + α5 UMDt + α6 ΔUMDt-1 + α7 ΔUMDt-2+ α8 ΔUPDt-3 + ε,

where, UPDt and UMDt are total of uptick and downtick and up minus down tick at time t, ΔUPDt-1, ΔUPDt-2, ΔUPDt-3, ΔUMDt-1, ΔUMDt-2 and ΔUMDt-3, are lagged differences of UPD and UMD during time, t, t-1, t-2 and t-3 respectively, while α_0, α_1 … α_8 are regression coefficients and ε is the error term. RTNt is the instantaneous return at time t.

The regression is run under Newey-west heterostatistically consistent coefficient covariance.

Variable	*Coefficient*	*t-stat*	*Adj R2*	*F- stat*	*DW -stat*
α_0	0.0663	26.12*	0.43	692.9*	1.95
α_1	0.000392	21.05*			
α_2	0.0000388	3.32*			
α_3	-0.000021	-1.53			
α_4	0.000019	1.62			
α_5	0.008	19.54*			
α_6	0.0000976	5.58*			
α_7	0.000017	0.89			
α_8	0.0000008	0.97			

* Significant at 1% level

Table 7
The regression result of the following equation:
UPDt = α0 + α1 RTNt + α2 VOLt + ε,

Where UPDt is the number of upticks plus number of downticks during the period t, RTNt is the 1-minute (t) return of the future index (Kospi200), VOLt is the volatility of the underlying during time t, while α0, α1 and α2 are regression coefficients and å is the error term. The regression is run under Newey-west heterostatistically consistent coefficient covariance.

Variable	*Coefficient*	*t-stat*	*Adj R2*	*F- stat*	*DW -stat*
α_0	95.92	15.42*	0.49	3726.23	1.16
α_1	-215.16	(-)8.22*			
α_2	8923.69	11.48*			

* Significant at 1% level

Table 8
The regression result of the following equation:
RTNt = α0 + α1 UPDt + α2 ΔUPDt-1 + α3 ΔUPDt-2 + α4 ΔUPDt-3 + α5 UMDt + α6 ΔUMDt-1 + α7 ΔUMDt-2+ α8 ΔUPDt-3 + ε,

Where, RTNt is the return of the Kospi200 Index futures at time t, ΔUPDt-1, ΔUPDt-2, ΔUPDt-3, ΔUMDt-1, ΔUMDt-2 and ΔUMDt-3, are lagged differences of UPD and UMD during time, t, t-1, t-2 and t-3 respectively, while α0, α1 … α8 are regression coefficients and ε is the error term. The regression is run under Newey-west heterostatistically consistent coefficient covariance.

Variable	*Coefficient*	*t-stat*	*Adj R2*	*F- stat*	*DW -stat*
α_0	-0.00007	-0.95	0.003	15.61*	1.00
α_1	-0.0000003	-0.92			
α_2	0.000004	1.00			
α_3	0.00000043	0.88			
α_4	0.0000002	1.33			
α_5	0.0000025	10.66*			
α_6	0.000003	10.63*			
α_7	0.00000069	1.99			
α_8	0.00000001	0.77			

* Significant at 1% level

Table 9
The regression result of the following equation:
RTNt-1 = α0 + α1 UPDt + α2 ΔUPDt-1 + α3 ΔUPDt-2 + α4 ΔUPDt-3 + α5 UMDt + α6 ΔUMDt-1 + α7 ΔUMDt-2+ α8 ΔUPDt-3 + ε,

Where, RTNt-1 is the return of the Kospi200 Index futures at time t-1, ΔUPDt-1, ΔUPDt-2, ΔUPDt-3, ΔUMDt-1, ΔUMDt-2 and ΔUMDt-3, are lagged differences of UPD and UMD during time, t, t-1, t-2 and t-3 respectively, while α0, α1 … α8 are regression coefficients and ε is the error term. The regression is run under Newey-west heterostatistically consistent coefficient covariance.

Variable	*Coefficient*	*t-stat*	*Adj R2*	*F- stat*	*DW -stat*
α_0	0.000002	0.79	0.005	5.02*	2.00
α_1	0.00000061	1.01			
α_2	0.0000039	1.02			
α_3	-0.0000034	-1.00			
α_4	-0.000001	-0.98			
α_5	-0.0000089	-2.18			
α_6	0.00000018	0.07			
α_7	-0.0000033	(-)9.03*			
α_8	-0.00000048	-1.98			

* Significant at 1% level

Table 10
The regression result of the following equation:
RTNt-2 = α0 + α1 UPDt + α2 ΔUPDt-1 + α3 ΔUPDt-2 + α4 ΔUPDt-3 + α5 UMDt + α6 ΔUMDt-1 + α7 ΔUMDt-2+ α8 ΔUPDt-3 + ε,

Where, RTNt-2 is the return of the Kospi200 Index futures at time t-2, ΔUPDt-1, ΔUPDt-2, ΔUPDt-3, ΔUMDt-1, ΔUMDt-2 and ΔUMDt-3, are lagged differences of UPD and UMD during time, t, t-1, t-2 and t-3 respectively, while α0, α1 … α8 are regression coefficients and ε is the error term. The regression is run under Newey-west heterostatistically consistent coefficient covariance.

Variable	*Coefficient*	*t-stat*	*Adj R2*	*F- stat*	*DW -stat*
$\alpha\pm_0$	0.000006	0.77	0.007	7.08*	1.97
α_1	0.00000067	0.88			
α_2	0.0000008	1.00			
α_3	0.000005	1.01			
α_4	-0.0000036	-0.89			
α_5	-0.0000089	(-)4.11*			
α_6	0.0000083	-1.76			
α_7	-0.0000003	(-)5.19*			
α_8	-0.0000035	(-)8.33*			

*Significant at 1% level

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