

## **The Effects of Launching Liquidity Products on Market Volatility and Investors' Confidence - an Empirical Investigation of Pakistan Stock Market**

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**Abstract:** Prior conceptual work barely provides worthwhile knowledge on the effects of market liquidity on volatility and investors' confidence in stock markets. In the absence of knowledge base it could only be a wild guess as how market liquidity affects volatility and how much impact it leaves on investors' confidence. Hence launching of a liquidity product without awareness on its effects would be a pointless effort especially in Pakistani scenario. Accordingly, an earnest endeavor was made to provide a knowledge base, though limited, to the decision makers for taking informed decision while launching such products in stock market. Despite barriers posed by the scarcity of the literature on the subject, the study hinged on whatever was available in the literature. Liquidity Product being independent variable was measured through the factors including COT (Carryover Trade) and CFS (Continuous Funding System). The historical data of KSE-100 index and Yahoo finance was used for the study. Each factor (of liquidity product) was analyzed separately while measuring their respective relationship with other variables. The investors' confidence being dependent variable was measured through market volume, which is a quantitative attribute. The market volatility being a dependent variable was measured using market index. Econometric methodology was adopted during this research-work, based on the weekly closing index data of Pakistani stock market from Jan 1993 to Dec 2012. ARCH, GARCH and TGARCH techniques were taken up to measure the volatility in the market and impact of launching liquidity product. Liquidity products launched in Pakistani stock markets from time to time failed to leave any substantial and sustainable impact on the market. This failure was linked to the reasons like corruption, malpractices, lack of monitoring infrastructure and lack of transparency etc. whereas, this study suggests that launching of liquidity products has insignificant effect on market volatility and investors' confidence. This study leaves some findings as food for thought for future researchers to dwell their work on this subject.

**Key words:** Liquidity Products • Volatility • Market Return • Investor Confidence

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### **INTRODUCTION**

Stock markets act as backbone of a country's economy and it is considered liquid when there are huge volumes through substantial transactions with little effect on stock prices. In addition to the other aspects, the liquidity of stock markets is usually deemed as the preeminent instrument to determine the stock market efficiency. Karachi Stock Exchange being the most prominent and matured stock market of the Pakistan has been inconsistent due to worsening law and order situation, lack of investors' confidence (domestic and foreign) and market liquidity. In order to attract the

investors and develop business friendly environment, various liquidity products were introduced in Pakistan from time to time, including: Badla Financing(COT – Carryover Trade - 1994 – 2006) and CFS (Continuous Funding System - 2005-2009). In these products financiers and banks used to pump in their idle money for guaranteed interest. These were apparently useful liquidity products but some of the brokers and investors used it for their vested interests that caused these products to diminish and the equity prices kept crumbling. Since 2009, there have been some efforts to introduce another leverage product like Marginal Trading system (MTS) in Pakistan, which could not be launched as yet.

Currently, Pakistani stock markets are operating without any liquidity product, which is believed to be a major reason for the downfall in the index and volume of trading. Some stakeholders believe that the investors are currently confronted with the dilemma of non-availability of adequate resources that does not provide them enough flexibility to invest freely and they have to only rely on the available cash with them. Another cause of their failure was scarcity of knowledge on “effects of these liquidity products on volatility and investor’s confidence” which also prevented the launching of any vibrant liquidity product.

Prior conceptual work mostly converges on establishing “relationship between margin requirements and volatility” and “correlation between the liquidity products and to the changes in stock price” etc and on the relation between the expected value and the volatility of the nominal excess return on stocks. Since little efforts have been focused on establishing “linkage between liquidity, volatility and investors’ confidence” especially in Pakistani scenario, therefore, this study focused to investigate the missing link.

The present paper presents a study carried out in Pakistani stock market with intention to bridge the existing knowledge gap and generate fresh knowledge on the impact of liquidity products on volatility and investors’ confidence in order to provide some knowledge to the concerned authorities for taking informed decisions.

**Literature Review:** Glen (1994) describes liquidity as the potential to transact rapidly without any substantially significant changes in the prices. Pagano and Röell (2012) highlighted the need for transparency in trading process that enhances market liquidity. Bakaert, Harvey and Ludblad (2006) referring to the emerging markets, suggested that implication of liquidity on asset pricing is more significant and critical in rising and developing market instead of the markets that are already developed. It depicts that the current and prospective investors from emerging markets are more concerned about illiquidity than the investors belonging to liquid and developed markets and it supports the point of view that there is a requirement of liquidity product in Pakistani stock exchanges. Levine (1996) observed empirical evidences in literature addressing and emphasizing that the emerging markets look at and consider the impact of institutional changes on the liquidity of market, which points towards major reforms in the emerging market like Pakistan. Moore (1996) and Officer (1973) empirically checked the effect of market liquidity on volatility.

Moore (1996) identifies that total margin loans are positively correlated to the liquidity products and to the changes in stock price. This implies that an increase in credit buying stabilizes the market. An increase in credit leads to higher liquidity, because margin credit makes it easier for investors to enter a position hence enhancing his confidence. This evidence suggests that binding Margin Requirements magnifies the stability. Thus, Moore concludes that Margin Requirement is an effective regulatory tool for stabilizing the market fluctuations. This finding suggests that before introducing any liquidity product in Pakistani Markets Margin Requirement may be used as a regulatory tool especially to retrieve investor’s confidence. Officer (1973) while establishing the relationship between change in standard deviation of market return and change in margin requirement, he established that margin requirements are not effective methods to control variability of market. However, Salinger did not completely agree with these findings. Introduction of liquidity through an instrument reduces market volatility (Kupiec, 1998). Glosten, Jagannathan and Runkle (2012) have suggested that there is a positive but insignificant relationship between conditional mean and market volatility of access return on stocks. Debt or liquidity products are the need of the hour for a stock market to function efficiently. David L. Scott, Wall Street defines liquidity as “A large position in cash or in assets that is easily convertible to cash”. He opines that liquidity produces flexibility for investment in low risk position, but decreases profit at times. Liquidity of the market means how easily and frequently an investor can make stock transactions. Hence for a market to run efficiently it is important to ensure enough liquidity by governments in the system to help leverage products. The liquidity product may vary in working and dimension as the purpose is to pump in more money for investment. The example of the liquidity product can include buying on margin (1993’s in Wall Street), Carry-Over Trade (COT) / Badla Financing (1994-2006), Continuous Funding System (2005-2009) in Pakistan stock markets and planned Margin Trading System (MTS).

**Variables and Methodology:** There are three variables in the following study. First is Liquidity Product, it is an independent variable and has been measured through the factors including COT and CFS. The historical data of KSE-100 index and Yahoo finance was used for the study. Each factor (of liquidity product) was analyzed separately while measuring their respective relationship with other

variables. The investors' confidence is a dependent variable that was measured through market volume taken from the historical data available on KSE-100 index and Yahoo finance. Though investors' confidence is qualitative attribute and can't be measured in quantitative terms, therefore, market volume that is a quantitative attribute and was chosen as indicator to measure investors' confidence. This approach was adopted because usually investors invest more in the market when their confidence is high and market volume increases. High market volume would reflect higher investors' confidence and vice versa (market volume was considered directly proportional to investors' confidence). And the third variable is the market volatility it is also a dependent variable that was measured through market index taken from the historical data available on KSE-100 index and Yahoo finance. High market index would reflect higher market volatility and vice versa (market index was considered directly proportional to market volatility).

**Modus Operandi for Measurement:** In order to measure the impact of each liquidity product on investors' confidence and market volatility, dummy variables were taken to measure the qualitative effect of liquidity products on investor's confidence and market volatility.

Econometrics was used in this empirical research-work, based on the weekly closing index data of Pakistani stock market from Jan 1993 to Dec 2012. Weekly data was used due to the volatility that was expected to be high in case of adopting weekly data as there is usually a higher uncertainty and variance in the data at the lower order. To measure the volatility in the market and impact of launching liquidity product in the market the volume of trading stock was taken by using the ARCH, GARCH and TGARCH techniques at the different order. E-views software was used to perform this analysis.

**Rationale of Techniques Used:** For the convenience of the readers and to recall their knowledge the techniques used in the study are being explained in the ensuing paragraphs.

**ARCH: (Auto Regressive Conditional Heteroskedasticity):** The ARCH model used and developed by the Engle (1982) suggested that the today's volatility is dependent on the volatility of yesterday. Its mean today's return is dependent on the yesterday return. ARCH is applied only if the conditional heteroskedasticity and volatility is found in the data. According to Engle (1982) variance can be modeled at different levels by using the ARCH technique.

**GARCH: (Generalised Auto Regressive Conditional Heteroskedasticity):** Engle (1995) introduce another technique to capture the variance in the data at the higher order. This technique is more appropriate than the ARCH. Because at the higher order ARCH does not calculate the accurate variance as compare to the GARCH. GARCH is also used to measure the volatility in the data of the stock market.

**TGARCH: (Threshold Generalised Auto Regressive Conditional Heteroskedasticity):** Threshold GARCH model was introduced by the Zakoian (1994) and Glostan (2012) *et al.* The main target of this model is to capture the asymmetries in the market result of positive and negative shocks. It also estimates the result of particular incident on the return of stock market by using the dummy variables in the data.

**Population, Sampling and Data Collection:** Our population comprised all listed companies of KSE-100 index. Our sample was KSE-100 index and the data available on liquidity products (COT and CFS). Secondary data of each liquidity product covering period from Jan 1993 to Dec 2012 was used on Weekly basis.

**Discussion and Findings:** The analysis is conducted in three parts. The first part focuses on volatility and dependence of return of the weekly KSE100 index from Jan 1993 to Dec 2012. The second part determines the impact of the liquidity products (COT and CFS) on market volatility. Third part analyzes the impact of the liquidity products (COT and CFS) on investors' confidence.

**Return of the Market:**

$$\begin{aligned} \text{Return} &= \text{LN}(\text{Today's Price} / \text{Yesterday's Price}) \\ &= \text{LN}(\text{PT}/\text{PT}-1) \end{aligned}$$

The graph at Table 1 indicates that the variance was not constant and we had to apply ARCH on the data.

**Volatility and dependence of return of KSE100 index Pre ARCH Test:** Before applying the ARCH it was checked whether the volatility existed in the data of Market from 1993 to 2012. Accordingly, the volatility was measured by calculating the return of the Market.

**AR (Auto Regression):** OLS (Ordinary least Square) method was used to measure the dependence of return. If dependence exists that means today's market price is

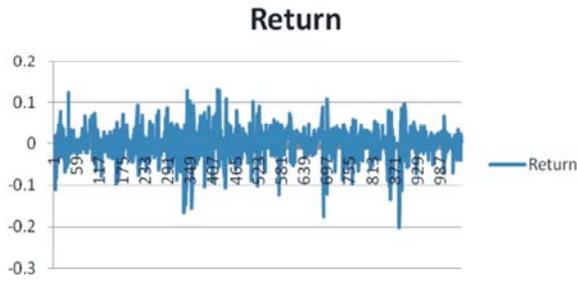


Table 1: Volatility Graph of the Return

Table 2: Return Dependence

Dependent Variable: R				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001511	0.001167	1.294687	0.1957
R(-1)	0.173962	0.030565	5.691507	0.0000

Table 3: Volatility Dependence

Heteroskedasticity Test: ARCH				
F-statistic	69.78342	Prob. F(1,1037)	0.0000	
Obs*R-squared	65.50963	Prob. Chi-Square(1)	0.0000	
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001057	0.000103	10.23802	0.0000
RESID^2(-1)	0.251099	0.030059	8.353647	0.0000

Table 4: Outcome of ARCH

Dependent Variable: R				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001760	0.001105	1.592707	0.1112
R(-1)	0.213452	0.029544	7.224988	0.0000
Variance Equation				
C	0.001022	3.56E-05	28.65961	0.0000
RESID(-1)^2	0.279205	0.043592	6.404972	0.0000

Table 5: Outcome of GARCH

Dependent Variable: R				
Method: ML - ARCH (Marquardt) - Normal distribution				
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001685	0.001034	1.629597	0.1032
R(-1)	0.180634	0.032238	5.603138	0.0000
Variance Equation				
C	0.000197	2.66E-05	7.401236	0.0000
RESID(-1)^2	0.169479	0.024803	6.833042	0.0000
GARCH(-1)	0.687849	0.036820	18.68162	0.0000

based on yesterday's price. Results of return dependence are reflected in Table 2. Since the result in table 2 indicates that the probability of R (-1) is 0.0 which reflects significant relationship between yesterday's and today's price, therefore, AR is present in the data.

$$R_t = \beta_0 + \beta_1 R_{t-1}$$

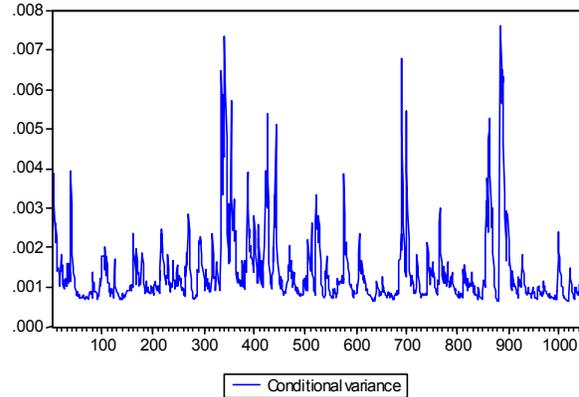


Table 6: Outcome Graph of GARCH

**CH (Conditional Heteroskedasticity):** CH means today's volatility in return is based on previous day's volatility behavior. If conditional Heteroskedasticity exists then variance is not constant. Results of volatility dependence are reflected in Table 3

$$\sigma_t^2 = \omega + \alpha_1 u_{t-1}^2$$

As the result indicates that the variance is not constant and heteroskedasticity is present in the data. The variance of the residual is 0.0 which is highly significant for the presence of heteroskedasticity is present in the data.

**Application of ARCH: (1,0):** The results as reflected in Table 4 calculated at the first order of ARCH show that there is presence of ARCH effect in the data because the probability of R(-1) and Resid (-1)^2 is 0.0.

**GARCH :( 1, 1):** To check the persistent volatility in the return, GARCH model is applied at the level of ARCH=1 and GARCH=1. According to Engle (1995) GARCH is more appropriate to capture the variance at different lags. Results are shown in Table 5. The GARCH results indicate that its capture higher order of ARCH at higher order. GARCH captures the 68.78% variance in data whereas, ARCH capture 16.9% variance in data.

**Conditional Variance Graph at GARCH (1, 1):** The Graph is the indication of Volatility in the KSE 100 index on the basis of weekly data.

**Impact of the Liquidity Products (COT and CFs) on Market Volatility**

**COT (Carryover Trade):** COT was launched in the era from 1994-2006 in the stock market. To, capture the impact of COT on the stock market we used dummy variables.

Table 7: COT Volatility

Dependent Variable: R				
Method: ML - ARCH (Marquardt) - Normal distribution				
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*COT				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001702	0.001060	1.605670	0.1083
R(-1)	0.180815	0.032371	5.585659	0.0000
Variance Equation				
C	0.000197	2.73E-05	7.241710	0.0000
RESID(-1)^2	0.169044	0.025980	6.506659	0.0000
GARCH(-1)	0.681665	0.039111	17.42899	0.0000
COT	1.2005	2.32006	0.516019	0.6058

Table 8: Impact of COT on market return.

Dependent Variable: R				
GARCH = C(3)+C(4)*RESID(-1)^2+C(5)*RESID(-1)^2*(RESID(-1)<0)+C(6)*GARCH(-1) + C(7)*COT				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001750	0.001125	1.556373	0.1196
R(-1)	0.180126	0.032418	5.556394	0.0000
Variance Equation				
C	0.000197	2.7605	7.145675	0.0000
RESID(-1)^2	0.173074	0.035405	4.888408	0.0000
RESID(-1)^2*(RESID(-1)<0)	-0.006964	0.037850	-0.183989	0.8540
GARCH(-1)	0.682347	0.039376	17.32881	0.0000
COT	1.09005	2.32405	0.469372	0.6388

Table 9: Impact of CFS on Market Volatility

Dependent Variable: R				
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*CFS				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001741	0.000949	1.833551	0.0667
R(-1)	0.180980	0.030783	5.879128	0.0000
Variance Equation				
C	0.000122	2.38E-05	5.125256	0.0000
RESID(-1)^2	0.178787	0.024736	7.227667	0.0000
GARCH(-1)	0.718112	0.031364	22.89620	0.0000
CFS	0.000130	2.16505	6.026783	0.0000

Table 10: Impact of CFS on Market Return

Dependent Variable: R				
GARCH = C(3)+C(4)*RESID(-1)^2+C(5)*RESID(-1)^2*(RESID(-1)<0)+C(6)*GARCH(-1) + C(7)*CFS				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001850	0.001032	1.792771	0.0730
R(-1)	0.179978	0.030930	5.818859	0.0000
Variance Equation				
C	0.000122	2.43E-05	4.999298	0.0000
RESID(-1)^2	0.186622	0.035146	5.309969	0.0000
RESID(-1)^2*(RESID(-1)<0)	-0.014373	0.036712	-0.391497	0.6954
GARCH(-1)	0.718541	0.032349	22.21229	0.0000
CFS	0.000130	2.2005	5.924109	0.0000

To capture the long term impact of COT, a TGARCH model was used. The main target of this model was to measure the asymmetries in positive and negative shocks terms.

**Impact of COT on Market Volatility:** Table 7 reflects results of COT Volatility. The impact of launching COT in stock market is found to be insignificant because the probability of COT on the basis of weekly market data is insignificant, as COT probability >.05. The impact of COT (liquidity product) on market volatility was found to be insignificant. Hence it can be established that the market volatility was not impacted due to COT but may other unknown factors.

**Impact of COT Market Return:** Table 8 covers results of Impact of COT on market return. To check the impact of COT on price of the shares we applied TGARCH. TGARCH measures the impact of particular event occurrences on the price of the shares. The coefficient of RESID(-1)^2\*(RESID(-1)<0) is negative and statistically insignificant and it shows that there is insignificant impact of launching COT on market return by launching. Hence it can be established that the market return was not impacted due to launch of COT but may other unknown reasons.

**CFS (Continuous funding System)**

**Impact of CFS on Market Volatility:** Table 9 reflects outcome of impact of CFS on Market Volatility. The result indicates that CFS had significant impact on volatility of KSE 100 index because the probability of launching CFS is 0.0 that is less than the probability of 0.5. Therefore, on these bases we can determine that CFS created had impact on volatility in the Market. The variance of the market did not remain constant.

**Impact of CFS on Market Return:** Table 10 shows the results pertaining to the Impact of CFS on Market Return. There is no impact on the Return of the stock market with respect to the CFS because the coefficient of RESID (-1)^2\*(RESID(-1)<0) shows negative value. We can hence, conclude an insignificant impact of CFS on market return.

**Impact of COT and CFS:** On the basis of results of both COT and CFS we can conclude there was insignificant impact of launching these liquidity Products in Pakistani Market. Both liquidity products failed to achieve the trust of the investors to diversify their investment hence diminished being un-attractable Portfolio for Investment.

**Impact of the Liquidity Products (COT and CFS) on Investors' Confidence:** It was difficult to measure the level of confidence of the investor being an intangible attribute.

Table 11: Average Annual Volume Data

Year	Traded Volume (Millions)						
1993	0.40	1998	1.79	2003	36.24	2008	17.26
1994	0.51	1999	3.73	2004	19.33	2009	4.23
1995	0.84	2000	7.91	2005	53.70	2010	9.21
1996	1.89	2001	6.06	2006	20.38	2011	11.14
1997	1.32	2002	6.46	2007	7.23	2012	3.66

The investors' confidence was measured through market volume. Since investors' confidence is a qualitative attribute and can't be measured in quantitative terms, therefore, market volume that is a quantitative attribute was chosen as indicator to measure investors' confidence. This approach was adopted because usually investors invest more in the market when their confidence is high and market volume increases. High market volume would reflect higher investors' confidence and vice versa (market volume was considered directly proportional to investors' confidence). It was difficult to interpolate the weekly volume data from Jan 1993 to Dec 2012; therefore, the average annual volume data was used for convenience. Table 11 shows average annual volume data for the above duration.

The COT was launched in 1994-2006. The results of traded volume show that before the launching of liquidity product in the Market there was a little trade in the Market. But after launching of the COT back in 1994 the volume of trade increased on continuous basis. Results in the table indicate a Continuous growth as compare to the Year 1993 and 1994. The result reveals that investors' confidence continued due to higher trade regardless of higher return or volatility. COT was terminated in 2006 after as CFS was launched back in 2005. With the exception of first year after the launch of CFS, when the traded volume reached 20.38 million, the investors' confidence had a downward trend as the traded volumes continued to decrease. The results show that liquidity products do not offer anything worthwhile to the investor in stock market.

### CONCLUSION

Prior conceptual work on the subject was found to be scarce as there was hardly any effort undertaken. In the absence of any existing knowledge, launching of a liquidity product would be a futile effort. Feeling the need for some research work on the impact of liquidity product on volatility and investors' confidence, an earnest endeavor was made to provide a knowledge base, though limited, to the decision makers for taking informed decision while launching such products in stock market. Before the conduct of this study there was a

misperception that liquidity products play a positive role in growth of stock market and boost investors' confidence. Various liquidity products launched in Pakistani stock markets failed to gain investor's confidence and diminished overtime. This failure was linked to other reasons like corruption, malpractices, lack of monitoring infrastructure and lack of transparency etc., whereas, this study suggests that launching of liquidity products has insignificant effect on market volatility and investors' confidence. Results refute this misperception as the liquidity products launched in Pakistan in fact failed to succeed in the market and died their natural death. Moreover, liquidity products did not play a positive role in growth of stock market and could not help boost investors' confidence. This is quite in line with the findings of Glosten *et al.* (2012). This study has opened a new dimension for the researchers setting a benchmark for them to dwell further on this basic study to determine other reasons of the failure of the liquidity products and further areas unexplored by this study

**Limitations:** The scarcity of the literature on the subject posed some serious barriers; however, the study hinged on whatever was available in the literature. Moreover the secondary data used for the study was taken on weekly basis only. However, if data was taken on daily or monthly basis it could have given different findings and changed the dimension of the study. The use of daily or monthly data can be tried by future research works in Pakistani scenario. There are other possible approaches and variables that can be selected by other researchers in the future. Another limitation was to measure qualitative attribute like investor's confidence. Dummy variables were also used while testing impact of liquidity products on market volatility.

**Recommendation:** Extensive research work is recommended to explore other related areas of this study. Future researchers may conduct the study in Pakistani scenario, taking data on daily basis instead of weekly basis to confirm the findings of this study, the results may drastically vary with this approach as the volatility is likely to be increased by taking data on daily basis.

## REFERENCES

1. Bekaert, G., C.R. Harvey and C. Lundblad, 2006. Growth volatility and financial liberalization. *Journal of international money and finance*, 25(3): 370-403.
2. Bekaert, G., C.R. Harvey and C. Lundblad, 2007. Liquidity and expected returns: Lessons from emerging markets. *Review of Financial Studies*, 20(6): 1783-1831.
3. Cornell, B. and E.R. Sirri, 1993. The reaction of investors and stock prices to insider trading. *Journal of Finance*, 47: 1031-1059.
4. Cornell, B., and E.R. Sirri, 2012. The reaction of investors and stock prices to insider trading. *The Journal of Finance*, 47(3): 1031-1059.
5. Demirgüç-Kunt, A. and R. Levine, 1996. Stock markets, corporate finance and economic growth: An overview. *The World Bank Economic Review*, pp: 223-239.
6. Engle, R.F., 1982. Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica: Journal of the Econometric Society*, pp: 987-1007.
7. Engle, R.F. and K.F. Kroner, 1995. Multivariate simultaneous generalized ARCH. *Econometric theory*, 11(01): 122-150.
8. Glen, J.D., 1994. An introduction to the microstructure of emerging markets(No. 24). World Bank Publications.
9. Glosten, L.R., R. Jagannathan and D.E. Runkle, 2012. On the relation between the expected value and the volatility of the nominal excess return on stocks. *The Journal of Finance*, 48(5): 1779-1801.
10. Kupiec, P.H., 1998. Margin requirements, volatility and market integrity: What have we learned since the crash? *Journal of Financial Services Research*, 13(3): 231-255.
11. Levine, R. and S. Zervos, 1996. Stock market development and long run growth. *World Bank Economic Review*, 10: 323-39.
12. Moore, T.G., 1996. Stock market margin requirements. *The Journal of Political Economy*, 74(2): 158-167.
13. Officer, R.R., 1973. The variability of the market factor of the New York Stock Exchange. *Journal of Business*, pp: 434-453.
14. Pagano, M. and A. Röell, 2012. Transparency and liquidity: a comparison of auction and dealer markets with informed trading. *The Journal of Finance*, 51(2): 579-611.
15. Salinger, M.A., 1989. Stock market margin requirements and volatility: Implications for regulation of stock index futures. *Journal of Financial Services Research*, 3(2): 121-138.
16. Zakoian, J.M., 1994. Threshold heteroskedastic models. *Journal of Economic Dynamics and control*, 18(5): 931-955.