Estimating the Impact of Interest Rate Variation on Stock Market Liquidity

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Abstract

Liquidity of stock market is multi-dimensional phenomena concerning ease of trading of security without much more variation in their prices (Amihud, Mendelson, and Pedersen 2005). According to O' Hara (2004), "liquidity is hard to define, but easy to feel it". Liquidity facilitates the trading of a security that is key factor in deciding whether to invest or not. Liquidity of any stock market ensures the growth of that market and reflects the strength of financial system. Interest rate is key guiding factor besides the investment decision taken by any investor. Impact of interest rate variation is reflected on stock market in terms liquidity mismatch with the diffusion of the information.

This paper is exploring the relation and assessing the impact of interest rate variation on stock market liquidity. Repo rate is used as a proxy of interest rate and Stock illiquidity proposed by Amihud (2002) is used as measure of liquidity of the Indian stock market. For the analysis, daily data of both repo rate and liquidity, ranging from April 2015 to March 2016 is used. Database of repo rate and stock market liquidity is collected from the web portal of Reserve Bank of India (RBI) and Bombay Stock Exchange (BSE). For the analysis, unit root test followed by co-integration is used to examine the association between repo rate and liquidity. This paper uses vector auto regressive model (VAR) and granger causality analysis to characterize the dynamics of liquidity to interest rate shocks.

Keywords- illiquidity, repo rate, VAR, Co-integration

1. Introduction

Financial market of the country is the barometer for measuring the growth of the economy. Integration of the world economies makes the financial market more volatile and liquidity of the stock market is becoming key factor for making investment decisions. According to Ologunde, Elumilade and Asaolu (2006), financial market ensures the long-term commitments in any economy. Efficiency of any market can be measured and judged by the way market accommodate and adjust the economic shocks. Stock market ensure the economic health and confidence for the global and domestic investors (Alam and Uddin, 2009). Invention of the century information technology (IT) and its application in financial market makes the investors more sensitive and responsive towards micro and macro- environment changes. Information availability and accessibility makes the investors more dynamic and predict the efficiency of the market (Maysami et. Al., 2004).

From the last two decades, several research and theory advocated that the stock market liquidity is sensitive towards macro-economic variables. Bekaert and Harvey (1997) clearly points out that the behavior of emerging markets is changing significantly over time with respect to their degree of integration with the global economy. Therefore, It is important to examine the possible changes in the liquidity of these markets over time and to explore the impact of such changes on equity returns. Liquidity of stock market is ease of trading of security without much more variation in their prices (Amihud, Mendelson and Pedersen 2005). According to O' Hara (2004), "liquidity is hard to define, but easy to feel it". Liquidity facilitates the trading of a security that is key factor in deciding whether to invest or not. Liquidity of any stock market ensures the growth of that market and reflects the strength of financial system. Interest rate is key guiding factor besides the investment decision taken by any investor. Impact of interest rate variation is reflected on stock market in terms liquidity mismatch with the diffusion of the information.

A liquid market, on arrival of new information, keeps the noise and sudden price changes minimal. On other hand, in efficient markets prices moves fast as the new information arrives. So, more liquidity leads to less efficient market. Amihud and Mendelson (1986) lay emphasis on the direct relationship between liquidity and cost of capital. High liquid markets are attractive to investors because of the easy exit from firm's ownership. This in turn reduces the opportunity cost of capital significantly. Saar and Lybek (2002) classified liquidity measures into four categories based on their ability to capture a particular characteristic. The measures are Transaction cost measures, volume-based (breadth and

depth), equilibrium price based measures (resiliency) and market-impact measures (resiliency and speed of price discovery).

Measure of Illiquidity-

As per Keynes (1930), an asset is more liquid if it is immediately realized without loss. An investor may either insist on immediate execution at the current bid or ask price or wait to transact at a favorable price. The quoted ask (offer) price includes a premium for immediate buying, and the bid price similarly reflects a concession required for immediate sale. Thus, the spread between the bid and ask prices is a measure of illiquidity, which is the sum of the buying premium and the selling concession.

According to Amihud (2002), Stock illiquidity (ILLIQ) is defined here as the average ratio of the daily absolute return to the trading volume on that day. This ratio gives the absolute (percentage) price change per dollar of daily trading volume, or the daily price impact of the order flow. This follows Kyle's concept of illiquidity-the response of price to order –flow and Silber's (1975) measure of thinness, defined as the ratio of absolute price change to absolute excess demand for trading.

The illiquidity for each stock can be measured through the following equation-

$$ILLIQiy = \frac{1}{Diy} \sum_{i=1}^{Diy} |Riyd| \, / VOLDiyd$$

Where, D_{iy} - the number of days for which data are available for stock i in year y

Ri_{yd} - the return on stock i on day d of year y

$VOLD_{iyd}$ - the respective daily volume in dollars

2. Review of Literature

Liquidity is one of the important factors to attract investors in emerging markets as highly liquid stocks are considered to be cheaper in trading costs. In addition, it is suggested by research that liquidity helps to promote economic development (Levine & Zervos, 1998). Since Amihud and Mendelson (1986) suggested that stock returns are an increasing function of illiquidity, numerous successive studies investigated this relationship. Indeed, the empirical literature generally confirms the theoretical proposition that investors demand higher gross returns as compensation for holding less liquid stocks. Stocks are expected to be more liquid if market participants can cheaply finance their holdings and perceive low risk of holding assets. Since monetary policy influences both the costs of financing and the perceived risk of holding securities, it follows that monetary policy affect stock market liquidity.

Similarly, Brunnermeier and Pedersen (2009) develop a model that addresses the interaction between funding liquidity and asset liquidity. Their model suggests that traders who face capital constraints experience difficulties to meet margin requirements and therefore fail to provide liquidity to the market. The other way around, a deterioration of market liquidity reduces traders' funding liquidity through higher margin requirements. This may lead to a loss spiral and a lower liquidity, higher margin equilibrium.

Few academic studies empirically examine the relationship between monetary policy and aggregate stock liquidity, and their results are to some extent ambiguous. Goyenko and Ukhov (2009) document strong evidence for the U.S. market (NYSE and AMEX) that monetary policy predicts liquidity for the period from 1962 to 2003. A tightening of monetary policy, as indicated by positive shocks to the federal funds rate and negative shocks to non-borrowed reserves, is shown to decrease stock market liquidity. Chordia et al. (2005) report only modest predictive power of monetary policy for stock market liquidity. For a sample of NYSE traded stocks they find that an expansionary monetary policy is associated with a contemporaneous increase in aggregated liquidity only during periods of crisis. Soederberg (2008) in their study finds that the policy rate is able to predict market liquidity on the Copenhagen stock exchange, whereas broad money growth plays a major role on the Oslo stock exchange and short-term interest rates and mutual fund flows predict liquidity on the Stockholm stock exchange.

Thorbecke (1997) examined the relation between monetary policy and stock returns. He showed that expansionary monetary policy increases stock returns. Booth and Booth (1997) using Federal funds rate and discount rate have confirmed these results. They showed that a restrictive monetary policy stance lowers monthly returns of both large and small stock portfolio. They concluded

that monetary policy has explanatory power in forecasting stock portfolio returns. Patelis (1998) confirmed these findings by estimating a VAR model to examine the impact of the Federal Reserve monetary policy on US markets. Changes in the interest rate affects the investors required rate of return, i.e. the discount rate, and therefore stock prices. Because of this relationship, it is expected that interest rate and stock prices should have a negative relationship. Furthermore, changes in both short-term and long-term rates are expected to affect the discount rate in the same direction (Mukherjee and Naka, 1995). However, Mukherjee and Naka (1995) find that while the Japanese stock prices are positively related with short-term interest rate (SIR), its relationship with long-term rate is negative. They argue that the long-term interest rate (LIR) may serve as a better proxy for the nominal risk-free component of the discount rate in stock valuation models for Japan. Bulmash and Trivoli (1991) also find a negative relationship between LIR and stock prices for the USA. Stock markets may affect economic activity through the creation of liquidity. Many profitable investments require a long-term commitment of capital, but investors are often reluctant to relinquish control of their savings for long periods. Liquid equity markets make investment less risky--and more attractive--because they allow savers to acquire an asset--equity--and to sell it quickly and cheaply if they need access to their savings or want to alter their portfolios. At the same time, companies enjoy permanent access to capital raised through equity issues. By facilitating longer-term, more profitable investments, liquid markets improve the allocation of capital and enhance prospects for long-term economic growth. Further, by making investment less risky and more profitable, stock market liquidity can also lead to more investment. Put succinctly, investors will come if they can leave (Levine 1996).

This study aims to determine the impact of interest rate variation on stock market liquidity extent of through co-integration and causality analysis. Rest of the paper is organized as follows. Section 2, summarizes the previous literature on stock markets interdependence. Section 3, formulate hypothesis. Section 4, discusses econometric methodology. Section 5, explains empirical results. Final section concludes the paper.

3. Methodology

Repo rate is used as proxy of interest rate and Amihud (2002) illiquidity (ILLIQ) measure is used as a proxy of stock market liquidity. The data related to interest rate is collected from the web portal of RBI (Reserve Bank of India) and closing value of stock turnover of market is collected from the web portal of BSE (Bombay Stock Exchange). Most of the researchers have used yearly and monthly data that overlooked small variations while taking average. To address this issue in this study includes daily data of both variables from April 1, 2015 to March 31, 2016.

3.1. Hypothesis

There is ambiguity in relation between both the variables. The association is oscillating between positive and negative depending on the different time frame. Most of the scholarly studies advocating negative association among both the variables. Based on literature, the hypothesis is:

H_{01}: Interest rate and stock market liquidity are co-integrated.

H_{02}: Interest rate granger causes stock market liquidity.

4. Method of Data Analysis

The ARDL bounds testing procedure and VECM approaches are used for testing the hypothesis. The ARDL bounds testing approach is used to examine the long-run co integration relationship between the variables. The ARDL approach is involved to estimate the following unrestricted VECM by assuming that Z and W are two variables:

$$\Delta Zt = \lambda 0 + \sum_{i=1}^{p} \theta i \, \Delta Z \, t - i + \sum_{i=0}^{p} \lambda i \; W \, t - i + \alpha 1 \, Z \, t - 1 + \alpha 2 \, Wt - i + \nu 1t \; \ldots\ldots \quad (1)$$

$$\Delta Wt = \gamma 0 + \sum_{i=1}^{p} \delta i \, \Delta \, Wt - i + \sum_{i=0}^{p} \gamma i \; \Delta Zt - i + \beta 1 \, Zt - 1 + \beta 2 Zt - i + \nu 2t \; \ldots\ldots\ldots \; (2)$$

Where Z represents the dependent variable shows the independent variable in the equation (1) and reversely in equation (2) and ν_{1t} and ν_{2t} are the error-correction term.

The overall F- and t-statistics are used to determine the presence of the long-run relationship. The null hypothesis is tested by using the generalized F-statistics. The test involves asymptotic critical – value bound, depending on whether the variables are integrated of order 0 or 1 [i.e.I(0) or I(1)]. Two sets of critical values are generated. One set refers to the I(1) series; the other refers to the I(0) series. The critical values for the I(1) are said to be the upper- bound critical values; the critical values for the I(0)

series are referred to as lower- bound critical values (Narayan and Smyth,2005; Pesaran *et al.*,2001,2000; Pesaran and Shin,1999; Pesaran and Smith,1998;Pesaran and Pesaran,1997). To determine the order of integration of the series, we used the augmented Dickey-Fuller test (Dickey and Fuller,1981) unit root test.

If the computed F-statistics are above the upper bound, the null hypothesis of co-integration needs to be rejected, indicating evidence of a long-run equilibrium relationship between the variables, regardless of the order of the integration of the variables. If the test statistics fall below the lower bound, we cannot reject the null hypothesis of co-integration, indicating the absence of long run equilibrium relationships. If the test statistics falls between the bounds, a conclusive inference cannot be made without knowing the order of the integration of the underlying regressors. The order of lags in the ARDL model is selected by minimizing the Schwarz Bayesian criterion and Akaike information criterion.

According to Granger (1969), if variable Z forecast other variable X, that means Z Granger-causes X. If Z causes X and X does not causes Z, this is unidirectional causality. If Z does not cause X and X does not cause Z, both the variable are independent.

For Granger analysis, autoregressive with lag length q (or p) estimate following model-

$$X_t = \gamma_1 + \sum_{i=1}^{q} a_{1i} X_{t-I} + \sum_{j=1}^{q} b_{1j} Z_{t-j} + \mu_{1t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$Z_t = \gamma_2 + \sum_{i=1}^{q} a_{2i} X_{t-I} + \sum_{j=1}^{q} b_{2j} Z_{t-j} + \mu_{2t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

5. Results and discussion:

In regression analysis, stationary of a time series is minimum requirement to minimize the problem of spurious regression that might arise if the series is non-stationary. Stationary of time series refers, variance and mean should be constant and co-variance value depends on the distance of two time periods. The Augmented Dicky-fuller unit root test (Dicky and Fuller, 1979) is used to check stationary of the time series.

The statistics of ADF test in Table-I confirms that interest rate series is stationary at first difference as null hypothesis of unit root is rejected. Stock market liquidity becomes stationary at level at 5% significance level. So, the Interest rate is integrated of order one i.e. I(1) and stock market liquidity of order zero i.e. I(0).

Table I: Results of Unit Root Test

Variable	**ADF test**	**Comments**	**Order of integration**
Interest Rate	-2.807398	Failed to H0	
D(Interest Rate)	-11.31971	Rejected H0	I(1)
Liquidity	-8.098539	Rejected H0	I(0)
Test critical values:	1% level	-3.46358	
	5% level	-2.87605	
	10% level	-2.57458	

*MacKinnon (1996) one-sided p-values.

For selecting optimal lag, traditionally VAR model is repeated by reducing the lag length value from large value to minimum. We select the optimal lag for which Akaike information criterion and Schwarz criterion have smallest value (Grasa, 1989; DeJong etal., 1992; Maddala and Gujarati, 2003). For the present study selected optimal lag is 2. As both the series are integrated of the order 1 and zero ,so F-

statistics is applied to check the existence of long-run co-integration among variables. ARDL bound test is preferable over Johansen co-integration test for co-integration analysis.

Table II indicate the results of bound testing. The lower (I_0) and upper bound (I_1) critical values for F-statistics are taken from Narayan (2005). F-statistics value greater than lower and upper bound value confers the rejection of null hypothesis of no long-run relationship. There exists bi-directional long-run relationship among both the variables. In the first combination of interest rate and stock market liquidity, when liquidity as dependent variable the long run relationship exists that confirms interest rate affects stock market liquidity. The long –run coefficient indicate that 1% increase in the interest rate enhances liquidity by 2.47 percent. In alternatively, when interest rate is dependent variable, the 1 percent increase in liquidity is associated by .404 percent increase in interest rate.

Table II ARDL Bounds Test

Null Hypothesis: No long-run relationships exist

Test Statistic	**Value**	**k**	**Dependent Variable**
F-statistic	9.471992	1	Interest Rate
F-statistic	34.27749	1	Liquidity

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	4.04	4.78
5%	4.94	5.73
2.50%	5.77	6.68
1%	6.84	7.84

Short-run relation results are presented in Appendix A1. As the adjusted R^2 is .4425 that concludes that 44% of variation interest rate is explained by liquidity. This indicates that there are some other macro-economic factors which explain rest of the 56% variation in interest rate. The scope for first or higher order auto-correlation is completely rejected. The error terms are homoskedastically normal and independent with no specific errors.

To capture the long run pattern between both the variables as both the variables are co-integrated, error correction term (ECT) (that is lag of the residuals generated through the model estimated at their levels) is included in the short-run equation. Error correction term's negative value shows the speed of adjustment in long-run and is significant at 10 % level. ECT absolute value less than one refers stable error correction mechanism as short-term dis-equilibrium converges to the long-term equilibrium level. The coefficient of ECM (-1) is equal to -0.671919 for short run model implying that the deviation from the long-run inequality is corrected by about 67 % each day. The Durbin-Watson statistics are 2.002 which show the absence of serial correlation.

For identifying the bilateral or unidirectional causality among the interest rate rate and stock market liquidity, Granger causality (1969) is applied. The result is table no-III suggest that there is uni-directional causality relationship exist between interest rate and stock market liquidity. As, at 10% significance level we reject the null hypothesis of no causality that means interest rate granger causes stock market liquidity.

Table-III Pair-wise Granger Causality Tests

Null Hypothesis:	**Obs.**	**F-Statistic**	**Prob.**
Liquidity does not Granger Cause interest rate	245	0.14595	0.8643
Interest rate does not Granger Cause Liquidity		2.27020	0.1055

6. Conclusion

In this paper an effort has been made to estimate the impact of interest rate on stock market liquidity. There is a bi-directional long-run relationship exists between interest rate and stock market liquidity, and interest rate leads to stock market liquidity and also stock market liquidity leads to interest rate. The long run elasticity of interest rate with respect to stock market liquidity is 0.404, and long-run elasticity of stock market liquidity with respect to interest rate is 2.47. Results accept the null hypothesis of co-integration between both the variables. As the value of adjusted R^2 is .44, means 44% of variation interest rate is explained by liquidity. Error correction term value confers that the deviation from the long-run inequality is corrected by about 67 % each day. There is a unidirectional casualty from interest rate (repo rate) to stock market liquidity thereby supporting past study done by Lee, Yong and Zhang (2006). In present globalised era, it has become important to understand how interest rate variations affect stock market. The study signifies the role of interest rate in controlling and keeping the market as desired equilibrium. Interest rate variation defines the direction of stock market performance that is justified through the study.

This analysis provides basis to investor's sentiment in decision making, as stock market is still most attractive avenue for sound return and with less volatility. This analysis is a reflection of not only the stock market but give overview about economy and investors behavior towards interest rate changes. As reactions (increase or decrease in interest rate) guide and control the market movements.

7. Implications and Future scope

The present study can be extended for longer period and results can be analyzed for other market indices too.

Stock market returns is the focal point of all kind of investors emotions and sentiments. The major implication of this study can be for investors, as they can understand how the variation in interest rate guide and control the market in long-run or short-run and variation may become more predictable.

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Appendix

A1- Vector Error Correction Estimates

Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
Liquidity (-1)	1.000000	
Interest Rate (-1)	-2.472825	
	(2.46863)	
	[-1.00170]	
C	-3.366507	
Error Correction:	D(Liquidity)	D(Interest Rate)
CointEq1	-0.671919	-0.002452
	(0.09166)	(0.00268)
	[-7.33094]	[-0.91570]
D(Liquidity (-1))	-0.168356	0.004135
	(0.08413)	(0.00246)
	[-2.00106]	[1.68267]
D(Liquidity (-2))	0.021379	0.002693
	(0.06433)	(0.00188)
	[0.33232]	[1.43324]
D(Interest Rate (-1))	1.334891	-0.577174
	(2.15845)	(0.06305)
	[0.61845]	[-9.15422]
D(Interest Rate (-2))	-2.784192	-0.253902
	(2.09506)	(0.06120)
	[-1.32893]	[-4.14883]

C	-0.034278	-0.000426
	(0.45900)	(0.01341)
	[-0.07468]	[-0.03178]
R-squared	0.442514	0.262179
Adj. R-squared	0.430802	0.246679
Sum sq. resids	12227.38	10.43329
S.E. equation	7.167674	0.209374
F-statistic	37.78327	16.91432
Log likelihood	-823.7613	38.34337
Akaike AIC	6.801322	-0.265110
Schwarz SC	6.887318	-0.179114
Mean dependent	-0.017535	0.001148
S.D. dependent	9.500501	0.241230

Determinant resid covariance (dof adj.)	2.250242
Determinant resid covariance	2.140935
Log likelihood	-785.3136
Akaike information criterion	6.551751
Schwarz criterion	6.752408

A 2- Vector Error Correction Estimates

Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
Interest Rate(-1)	1.000000	
Liquidity (-1)	-0.404396	
	(0.05406)	
	[-7.48115]	
C	1.361401	
Error Correction:	D(Interest Rate)	D(Liquidity)
CointEq1	0.006062	1.661539
	(0.00662)	(0.22665)

	[0.91570]	[7.33094]
D(Interest Rate (-1))	-0.577174	1.334891
	(0.06305)	(2.15845)
	[-9.15422]	[0.61845]
D(Interest Rate(-2))	-0.253902	-2.784192
	(0.06120)	(2.09506)
	[-4.14883]	[-1.32893]
D(Liquidity(-1))	0.004135	-0.168356
	(0.00246)	(0.08413)
	[1.68267]	[-2.00106]
D(Liquidity (-2))	0.002693	0.021379
	(0.00188)	(0.06433)
	[1.43324]	[0.33232]
C	-0.000426	-0.034278
	(0.01341)	(0.45900)
	[-0.03178]	[-0.07468]
R-squared	0.262179	0.442514
Adj. R-squared	0.246679	0.430802
Sum sq. resids	10.43329	12227.38
S.E. equation	0.209374	7.167674
F-statistic	16.91432	37.78327
Log likelihood	38.34337	-823.7613
Akaike AIC	-0.265110	6.801322
Schwarz SC	-0.179114	6.887318
Mean dependent	0.001148	-0.017535
S.D. dependent	0.241230	9.500501
Determinant resid covariance (dof adj.)		2.250242
Determinant resid covariance		2.140935
Log likelihood		-785.3136
Akaike information criterion		6.551751
Schwarz criterion		6.752408