Approaches to examination of Liquidity and Volatility Risk Pricing in Stock Markets–Implications for Indian Case

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Abstract. Liquidity and Volatility Risks is twin asset pricing issues that altogether affect the operational functioning and pricing in stock markets all over the globe. In developed countries as well in emerging markets, the researchers have put in large efforts to find the liquidity and volatility risk structures in individual stocks and well as market as a whole. There is also an on-going research to explore whether there is a common uncertain factor across these risk classes. In this paper we provide a conceptual framework of the issue of liquidity and volatility and also the approaches used by researchers to measure the liquidity and volatility risk.

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Key Words: Liquidity Risk, Volatility Risk, Commonality, Stock Market

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1. Introduction

The financial systems throughout the globe is undergoing a tremendous change making the markets, particularly the financial markets fragile with large concerns of liquidity and volatility that create a devastating impact on the overall functioning of the economies. The markets in the developing world, especially the emerging markets are growing at a faster pace. Financial liquidity (which may be understood in terms of stocks as increased trading levels in the trading allows minimum disturbance in buying and selling) is an elusive notion, yet of paramount importance for the well functioning of the financial markets and institutions. In the recent years financial market tensions especially that of the year 2008 has led the researchers to measure the liquidity variations and their impact on the market movements.

Along with liquidity risk the proposal focuses on Volatility risk which may be in simple words understood as the risk of fluctuation in the value of a financial asset due to change in its volatility. The prior literature work found on measuring liquidity risk premium is vast but more or less focused on comparing future realized volatility (RV) with current Black-Scholes implied volatilities (IV) in a regression framework. There has also been an extensive use of the GARCH family models. We are motivated to present the various evolving measures of liquidity and

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volatility risk, the issue of joint pricing and the research gaps that need exploration in case of Indian stock markets.

2. EVOLVING MEASUREMENT MEASURES

Liquidity Measures

Various measures of liquidity have evolved globally by the researchers to measure the liquidity risk. The present section provides the detail about liquidity measures in the following section. We define Amihud (2002) for stock 'i' in month 't' as follows:

$$A_{i,t} = \frac{1}{d_t} \sum_{j=1}^{d_t} \frac{|r_{i,j}|}{dvol_{i,j}}$$

where $r_{i,j}$ denotes the ith asset returns on jth day, d_t denotes the trading days (nos.) in a month and $dvol_{i,j}$ denotes the ith asset volumes on jth day. Acharya and Petersen (2005) and Korajczyk and Sadka (2008) defined the ratio of the market capitalization of the market index as a liquidity measure. Research also used 'turnover' as a liquidity measure which is defined as the ratio of volumes to the outstanding shares. It can be computed using the following formulae:

$$TO_{i,t} = \frac{\sum_{j=1}^{d_t} vol_{i,j}}{SO_{i,t}}$$

where $SO_{i,t}$ denotes the outstand shares at the end of month t. The third popular measure is relative spread. The difference between the bid and ask prices divided by the average of the two is called as the 'relative spread' and is calculated using the following formulae.

$$RS_{i,t} = \frac{1}{d_t} \sum_{j=1}^{d_t} \frac{Ask_{i,j} - Bid_{i,j}}{midpt_{i,j}}$$

Roll (1984) has developed a measure based on covariance. Assuming constant spread between the bid and ask prices, Roll calculated the spread using the following formulae:

$$\hat{s} = 2\sqrt{-Scov}$$

where S_{cov} denotes the covariance of daily returns.

Volatility measures

Conventional approach to examine volatility is the use of absolute measure of risk i.e. variances. The estimate of realized variance can be defined as-

$$RV_{i,t} = \sum_{j=1}^{d_t} r_{i,j}^2$$

where $r_{i,j}$ denotes the ith asset returns on jth day, d_t denotes the trading days (nos.) in a month. Researchers engaged in forecasting modeling of time series, such as inflation, foreign exchange rates, stock prices have identified the significant variability in the forecasting errors from one time period to another. This variability could very well be due to prevailing information, political upheavals, government fiscal policies, volatility in financial markets, speculations, and the like. Stock Market Volatility increases during crisis, social unrest and with the effects of macroeconomic variables such as inflation, employment, GNP. Sharpe (1964) explained the importance of volatility in the asset pricing model and the option pricing model were explained by Black and Scholes (1973). The authors suggested that the variance of forecast errors are not constant and varies with the time. There exists some kind of autocorrelation in the residual terms.

GARCH models are defined by conditional density function that provides the Likelihood function of data set, which can be maximized to give optimal parameter estimates. For daily returns r_t of a particular stock linked with the previous time t, Let I_{t-1} be the set of information up to time t-1 i.e. $I_{t-1} = \{ r_{t-1}, r_{t-2}....\}$. While investors are aware about their investment decision in the previous period t-1, they know the information in I_{t-1}. Given I_{t-1}, the expected stock return and volatility are the conditional expected value and conditional variance of r_t denoted by μ_t and h_t respectively. The unexpected stock return at time t is $e_{t-1} = r_{t-1} - \mu_t$. (In the following empirical research, r_t = log (p_t) - log (p_{t-1})). The conditional variance of the current error in the GARCH

model is specified as a function of the past errors and conditional variances. Thus, GARCH process of orders *p* and *q (p>0, q≥0),* denoted as GARCH (*p, q*) can be described as follows.

$$r_t \mid I_{t-1.} \sim F(\mu_t, h_t) ,$$

$$h_t = \omega + \sum_{i=1}^{p} \alpha_i e_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} \ .$$

whereh_t is a (measurable) function of e_s, s < t, and the (continuous) i.i.d. (0,1) random variables $z_t = \frac{r_t - \mu_t}{\sqrt{h_t}}$ are independent of { e_s, s < t }.There are four parameters μ, α, β, ώ satisfy the conditions ώ ≥ 0, α ≥ 0, $\beta_j \geq 0$, *i*=1,2,…,p, *j*= 1,2,…,q. $F(\mu_t, h_t)$ is the conditional distribution of the variable, with conditional mean μ_t and variance h_t.

Garman-Klass in 1980 have developed a volatility estimator in 1980 mainly as an extension of the Parkinson measure that includes opening and closing prices. “The relative efficiency of an estimator is defined as the ratio of variance of the benchmark estimator to the variance of the estimator under consideration”. Garman and Klass estimator combined the traditional estimator and Parkinson’s estimator, thus incorporating more intraday information is

$$\sigma_{gk} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left[\frac{1}{2}\left(ln\frac{H_t}{L_t}\right)^2 - (2\,ln2 - 1)\left(ln\frac{C_t}{O_t}\right)^2\right]}$$

GK is believed to be 7.4 times as efficient as the close-to-close estimator but suffers from the limitation of discrete sampling that leads to a low estimate of the range. Yang and Zhang (2000) have offered an extension to the Garman and Klass historical volatility estimator by including logarithm of open and close prices.

$$\sigma_{yz} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left[\left(ln\frac{O_t}{C_{t-1}}\right)^2 + \frac{1}{2}\left(ln\frac{H_t}{L_t}\right)^2 - (2\,ln2 - 1)\left(ln\frac{C_t}{O_t}\right)^2\right]}$$

Where σ denotes the volatility, T is the number of trading days, C_{t-1} and C_t are the closing prices of the previous and the current day respectively, O_t, H_t, L_t, denotes the open, high and low prices,

Ln represnts the natural log. Researchers have also used the VAR regressions on the liquidity and volatility measures and their groups to examine the short term structures and VECM for the long term effects.

3. LIQUIDITY AND VOLATILITY RISK PRICING ISSUES

Many authors contributed in a way to measure and model liquidity adjusted pricing (Acharya and Pedersen, 2005; Liu, 2006; Wang and Chen, 2012; Kim and Lee, 2014) and incorporating liquidity risk using the value at Risk approach (Saout, 2002; Francois-Heude and Van Wynendaele, 2001; Roy, 2005; Johnson, 2008; Stange and Kaserer, 2010; Nagel, 2012). Value at risk (VAR) refers to a risk indicator of the maximum loss of a financial asset at a time horizon associated with a certain probability. This is a well-known risk management tool and one of the most popular currently used by market professionals and regulators for measuring market risk across financial institutions.

Some of the earlier works have found the existence of commonality in Liquidity: it refers to the co-movement in liquidity over time both for individual stocks and for the market as whole (Huberman and Halka, 1999; Chordia*et. al.,* 2000; Hasbrouck and Seppi, 2001; Kuntara and Nuttawat, 2009; Karolyi*et. al.* 2012) and that investors are more interested and demand premium from illiquid market. Many researchers have identified that liquidity risk are important and are associated to asset returns and cannot be immediately traded in the market. However, the conventional Value at Risk (VAR) models based on normality assumption of the asset's return is severely constrained while dealing with liquidity risk over the market risks. Assuming standard value at risk (VaR), the quantity of securities can be traded with no influence of the market prices. In fact markets are not liquid and is difficult to find trading activities in the market of these securities. The scenario best fits to emerging markets like India which are in process of sector reforms.

Earlier research contribution by Harvey in 2012 advocated the advantages to invest in the emerging markets as they lead to higher expected yields and offer higher opportunities of growth. Indeed the emerging markets are more volatile and not only having the impact of market environment but also the conditions like political instability and governance problems. In this context, studies dealing with risk valuation are of great help for market professionals and regulators.

There have been instances of crisis due to liquidity risks in stock markets like India, and illiquidity risks associated with market have been undermined and are not found an appropriate place in modeling VaR. The Indian market participants and financial organization faces difficulty to offload the securities in their portfolios in the face of sudden and persisting off-market prices. As a result, most of securities have very low turnover levels in the secondary segment of the debt market. It has also noticed that measures of market risk in most cases fail to capture the costs of carrying illiquid assets in their portfolio. This becomes a restricting factor in the consistency of the market growth.

Mostly research studies used on an Inter-day basis, which takes only one observation to characterize the activity of the entire day. In present dynamic environment and the availability of information to the investors, the integration of the intraday information becomes then a necessity. Bangia *et. al.*(1999) used the relative spread to measure the liquidity, which was later criticised by Saout in 2001. According to Le Saout, during periods of extreme variations large spreads are unobservable and thus leading to overestimation of risk with VAR approach. He also proposed to use value weighted spread to take into account the market resiliency. In continuation of the works initiated by Bangia*et.al.* (1999) and Saout (2001), the integration of liquidity risk into a standard parametric VaR needs exploration. In Indian stock markets, there are no studies that have used liquidity-adjusted value at risk measure to examine the liquidity risk pricing structures.

4. COMMONALITY ISSUES

Various studies have considered both liquidity and volatility risk significant when considered separately. Liquidity risk is caused due to market trading frictions whereas volatility risk is caused due to fluctuation in the price of an asset. The studies focusing on importance of volatility and liquidity separately as a systematic risk factor have been done in the past not much efforts are made to link the two. Commonality in liquidity represents the impact of a common or market wide liquidity factor on an individual class of assets expressed in terms of spreads of bid-ask spreads and their depths. Commonality in liquidity and volatility has been studied by various researchers like Chordia*et al.* (2000), Brockman and Chung (2002), Fabre and Frino (2004) in developed markets. *Band et al.* (2008) analyzed using a small sample the liquidity and volatility risk and volatility risk jointly at the market level. The study concluded that liquidity risk and

volatility risk are important factors when they are taken separately but when they are to be considered together, then volatility risk is more significant this may be due to underlying presence of uncertainty risk (which is risk associated with a situation where a person has no idea about future outcome) of which volatility is a better measure. There has been on-going research to examine that whether the individual firm's level effects are significantly influenced by changes in exchange-level parameters.

5. REMARKS

The studies on the emerging markets like India have been observed with high volatility and riskier and which is not only due to market scenario but also to specific situations such as political upheavals, sudden announcements government fiscal policies, volatility in financial markets market environment. In this context, the research studies on risk valuation help regulators and policy makers to appropriately make structural and regulatory changes in order to have a transparent and liquid trading environment for the Indian investors and attracting foreign institutions. Researchers have established that the liquidity and volatility factors can be orthogonalized to the common factor to better isolate the liquidity and volatility risks.

A research gap is quite evident on intraday liquidation of risk in Indian stock market. Examination of the cross-sectional pricing of liquidity and volatility risk and exploration of common uncertainty risk factors is a direction for research. We also argue that the measures of liquidity and volatility risk that have been evolved by the researchers needs to be applied in the modified form when examining the Indian stock markets.

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