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## Article

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## **Inter-Linkages between Liquidity and Stock Returns: An Empirical Investigation through Panel Cointegration**

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### **Abstract**

This study examines long term and short term inter-linkage between liquidity dimensions and equity returns in oil and gas sector of an emerging stock market for the time period 2009-2015. Conventional liquidity ratio and Amihud ratio are used to capture Price impact. Roll estimator is employed to quantify the effective spread and transaction cost aspect of liquidity. The depth of market is measured through volume and turnover rate.

Pedroni cointegration, Granger causality and vector error correction model have been applied in panel data setting. The Pedroni cointegration analysis provides evidence about the existence of long term interaction between liquidity indicators and the equity returns. The VECM reports that liquidity influences equity returns in short run and speed of adjustment is high. Moreover, bi directional casualty is observed between liquidity and equity returns. The results suggest that local market liquidity is an important driver of expected returns. The study further implies that liquidity is vital for asset pricing. Average liquidity is priced and liquidity also predicts future returns. Moreover liquidity shocks are positively correlated with return shocks. Therefore, investors must be vigilant about liquidity trends while making investment decisions.

**Key words:** equity returns, price impact liquidity, market depth liquidity, transaction cost liquidity, Amihud ratio, panel co-integration, granger causality, error correction model.

### **1. Introduction**

Traditionally capital asset pricing theory assumes that financial market is frictionless and tradable assets are perfectly liquid in nature. Amihud and Mendelsen (1986) discuss that investor has to incur the transaction cost to immediate liquidate his position. It means assets are not perfectly liquid and affect the future cash flows of asset. Therefore, variation in stock returns can be described through liquidity. More over Kerry (2008) describes the relationship of price, quantity of shares and market liquidity in the form of demand and supply. Investor has to pay price per unit volume to acquire the asset. That price is the bid price or transaction cost of asset for the buyer. Bid price is usually greater than intrinsic worth of liquid asset paid by the investor. Liquid market has more market depth if the bid price does not increase with the increase in order flow. If the bid price increases with the increase in quantity of buy orders price impact will be greater and the

market will be illiquid. To complete the transaction, seller receives the amount as ask price. The ask price is usually less as compared to the price of perfectly liquid asset. Ask price is going to decrease incrementally with the increase in number of selling orders and widens the bid - ask spread. Therefore price impact is significant in illiquid market as compared to liquid market

The enviable feature of well-functioning financial markets is liquidity. Liquidity is important to investors, financial markets and listed companies. Handa and Schwartz (1996) argue that three things are demanded by the investors from the markets. These three things are liquidity, liquidity and liquidity. Liquidity is stated as the ability of a security to quickly trade in bulk at low cost and without an upward movement in its price. Holden et al. (2014) argue that one of the essential features of financial market is liquidity. In liquid market the trading of a considerable quantity of shares at low cost with minimum price impact is possible. As short term investors prefer liquid stocks. Liquid stocks have less spread, low price impact and can be traded in large volume. Therefore, returns of liquid stocks are less as compared to illiquid stocks. On the other hand, long term investor wants to invest in less liquid stocks for higher returns. (Foucault et al., 2003). Harris (2003) argues that one of the interests of the regulators for financial market is long run liquidity because less volatile markets are able to attract large number of buyers and sellers with low level of uncertainty in the context of transaction cost, price impact, and traded volume. Therefore, long run liquidity is essential for proper functionality of stock markets. Moreover, Amihud and Mendelsen (1986) demonstrate that investors' return includes compensation for risk and transaction cost he bears on trading of financial securities. Liquidity is considered an important aspect in evaluating the performance of financial markets. Liquid market is able to receive more order flows as compared to illiquid market. Moreover, listed companies are also concerned to liquidity because decisions regarding issue of new securities are linked with liquidity. Saar and Lybek (2002) & Liu (2006) reveal that liquidity is a multidimensional concept. It has five dimensions: depth, breadth, tightness, timing and resiliency. The current study is done in Pakistan with the objective to empirically examine the multi-dimensional role of liquidity in explaining the equity returns.

Previous studies including Mustafa and Nishat (2008) and Khan and Rizwan (2008) have a focus on breadth and depth aspects of liquidity. The study conducted by Akram (2014) uses bid and ask spread for measuring the transaction cost feature of liquidity in Pakistan. The above studies empirically examined one or two aspects of liquidity. The current study is different from previous research in the sense that it explores the multiple dimensions of liquidity proposed by Liu (2006) jointly in Pakistani financial market. The dimensions of liquidity include price impact, transaction cost and market depth. This study attempts to answer the questions; Does short term and long term inter-linkage exist between various dimensions of liquidity and equity returns in the financial market of Pakistan? Which dimension of liquidity is more priced in the Pakistani equity market? This study, in fact, extends the work of Jankowitch et al. (2011), Vo and Bui (2016) and Dinh (2017) in an emerging market where the inter-linkage among various dimensions of liquidity and equity returns in short run and long run has not been sufficiently investigated. The present study in this context is an attempt to enhance the literature of liquidity in finance by filling this gap. Therefore, this study may be a pioneering work for potential studies in domestic and regional markets.

This study is also important for international investors as Pakistan is an important emerging market and MCSI has declared it as the best emerging market in 2015. Due to 16% consistent growth during last five years, Pakistan is in the list of top ten best performing emerging markets and is recognized as the best frontier market. Therefore, international investors desire more insight about this market. The focus is on oil and gas sector which is considered as most prominent sector as it has historically attracted maximum foreign portfolio investment and has 40% weightage in Pakistani stock market index i.e. PSX-100. Moreover, it is directly linked to all major sectors of economy. High international prices of crude oil and the start of liquefied natural gas terminal at port Qasim have made oil and gas sector attractive for research as compared to any other sector. Therefore, this study is conducted in oil and gas sector, a very active sector in Pakistan stock exchange. The results of the study facilitate the investors in formulating their investment strategies and portfolios in short and long run. This also facilitates the policy makers to design effective policies that encourage more capital inflows in Pakistan stock market.

The paper has four sections. Section II illustrates the theoretical and empirical literature on research topic. Data and methodology are discussed in section III. Results of the research are analyzed in section IV and conclusion is given in section V.

## 2. Literature Review

The section sheds light on historical development of “liquidity” theoretically as well as empirically. Liquidity in literature is discussed in the context of funding and trading liquidity. The current study focuses only on trading liquidity. Holden et al. (2014) define price impact liquidity as; asset is liquid if it is quickly sold at a competitive price in the market. Liu (2006) considers various dimensions of trading liquidity and describes it in the context of price impact, transaction cost and market depth. The elaborated concept of liquidity proposed by Liu (2006) is, asset is liquid in nature if it has an ability to quickly trade in bulk at low cost at a competitive price. Different features of liquidity that is market depth (trade in bulk), transaction cost (low cost) and price impact (competitive price) show liquidity is multidimensional. Therefore attempt to conduct studies on different dimensions of liquidity continuous to be an area of research.

The studies focused on price impact liquidity have been conducted by Minovic (2012) and Grunditz and Hardig (2012) in Croatian stock exchange and Stockholm stock exchange. Minovic (2012) uses three liquidity proxies such as turnover ratio, price pressure due to non-trading and zero return to see the behavior of price impact liquidity in Croatian financial market and found that price impact liquidity has an impact on Croatian stock exchange. Similarly Grundig and Hardig (2012) investigate that liquidity is one of the determinants in elucidating the variation of returns in Stockholm stock exchange during 1990-2010. The findings of research reveal that stock return varies with illiquidity in stock market. A significant price impact has been observed due to increase in market illiquidity in this stock exchange. On the other hand Qiao and Pukthuanthong (2018) reports weak relationship between equity returns of privately and publicly owned enterprises and price impact liquidity after reforming split structure for shares.

Different dimensions of liquidity are discussed by Trang (2013) in explaining the variation of equity returns in UK stock market. The study uses liquidity proxies including Amihud Ratio, bid ask spread, trading volume, turnover rate, and intraday price range of

all the companies listed on FTSE from 2009-2012. Panel estimation reveals that trading volume has negative insignificant relationship with equity returns. Stock returns in financial market are positively correlated with Amihud illiquidity and turnover rate. Bid-ask spread is not significant, it has no contribution to measure return in U.K stock market during the sample period. Therefore the findings of the study support price impact, market depth liquidity in UK stock market. In line with Trang (2013) transaction cost and market breadth aspects of liquidity have been examined by Chikore et al. (2014) in Zimbabwe Stock Exchange. This study employs four proxies to measure transaction cost and market breadth liquidity using turnover, trading volume, effective spread and relative bid ask spread. Vector auto regression model is applied on the stocks listed in Zimbabwe stock exchange during 2009-2012. The result shows that stock returns are negatively influenced by liquidity because investor's potential prices for stocks include illiquidity premium.

A comparative analysis of market liquidity and stock index return in developed and emerging markets has been performed by Hartian and Sitorus (2015) using turnover ratio and observe contrasting behavior of liquidity on change in prices of developed and emerging stock indices. In emerging markets, market liquidity leads to higher market returns whereas returns in developed stock markets negatively respond to liquidity. The study concludes that market depth- liquidity exists both in developed and emerging markets. Vo and Bui (2016) examine Vietnam stock exchange to find out the positive or negative impact of liquidity on equity prices. The study examines price impact and market depth aspects of liquidity in the stock exchange of Vietnam during the financial period 2007 -2012. Their findings illustrate positive effect of liquidity on equity returns and report no evidence in variation of returns due to fluctuations in price impact and breadth features of liquidity in capital market. The results of the research are in contrast to empirical literature on liquidity. Dinh (2017) investigates liquidity, risk and return relationship using high frequency trading in Oslo stock exchange and shows that returns of the market are affected by liquidity. In contrast to Dinh's study, Leirvik et al. (2017) has found no liquidity and return relationship in Norwegian stock market

The above discussion reveals that liquidity-return relationship is mixed. The negative association between liquidity- return is demonstrated by Chikore et al. (2014), Minovic (2012), Trang (2013) and Qiao and Pukthuanthong (2018). Minovic (2012) and Qiao and Pukthuanthong (2018) empirically illustrate that subsequent price change in liquid stock is less as compared to change in volume. Therefore investors do not demand liquidity premium on such stocks and receive less return as compared to illiquid stocks. On the other hand Chikore et al. (2014) examine that investors have to incur transaction cost on illiquid stock so they demand risk premium of illiquidity in their return. Hence illiquid stock yield more returns. Hartian and Sitorus (2015) and Vo and Bui (2016) report that investors usually pay premium for liquid stocks which lead to increase the return of liquid stocks. Therefore the literature shows the traces of positive association between equity return and liquidity. The current research is an attempt to study both long and short term association between multiple facets of liquidity and stock returns in Pakistan stock market.

Chen et al. (2001) examine dynamic liquidity and return relationship in nine countries using volume. The study reports that return is the cause of liquidity in some countries relative to other countries. Similarly the study conducted by Lee and Rui (2002) also demonstrates that returns of US and Japanese stock markets influence the liquidity but in

UK stock market return does not cause liquidity. Kumar et al. (2009) also investigate lead-lag liquidity- return relationship in Indian financial market and found liquidity is dependent upon direction of price change.

Another phase came in which liquidity in the context of liquidity risks and asset pricing has been studied. Lam and Tam (2011) conduct research in Hong Kong stock exchange and employ four factor model of liquidity on asset pricing. The result of the study concludes that equity returns in capital market of Hong Kong are affected by liquidity, firm size and book to market ratio. Vu et al. (2015) employs liquidity adjusted model in Australia. The study uses Amihud ratio to measure liquidity and test various co variances of liquidity including commonality liquidity, depressed wealth effect of liquidity and flight to liquidity in developed market. The study concludes that all liquidity risks are priced in Australian stock market during 1995-2010. Moreover Kim and Lee (2014) also test liquidity adjusted model in New York stock exchange using high frequency measures of liquidity to test various co variances of liquidity during 1962-2011. The results of the study indicate the pricing of liquidity risks in New York stock exchange. At global level, Chiang and Zheng (2015) have studied the international markets using Amihud ratio as illiquidity risk measure and found liquid equities have less illiquidity risk and return as compared to illiquid equities.

The above studies in liquidity literature demonstrate either the impact of liquidity on returns or use liquidity risk as one of the factors in asset pricing but the long term and short term inter-linkage between multiple facets of liquidity and equity returns is missing. This motivates to do a study that tests long run and short run relationship among all aspects of liquidity and return using low frequency measures of liquidity mostly used in emerging markets. Moreover, the study also tests the bi-directional or unidirectional relationship among multiple aspects of liquidity and equity returns. The present study uses Liu (2006) concept of liquidity and focuses on three dimensions of liquidity transaction cost; price impact; and depth. Different proxies have been used in studies mentioned in literature to measure price impact, market depth and transaction cost liquidity. The study has selected the proxies proposed by Lybek and Sarr (2002) , Amihud (2002) and Chordia et al. (2001) including Amihud illiquidity measure and conventional liquidity ratio for price impact trading volume and turnover rate are used for measuring depth. Roll estimator is used for measuring transaction cost aspect of liquidity. Bid –ask spread, Effective spread and tick size have not been used in the study because high frequency data is not maintained in emerging markets including Pakistan.

### **3. Theoretical Framework**

Earning and spending are the desires of investors. Investors save if earning is more than consumption. On the other hand borrowing results if investors consume more than they earn. Investment decisions are dependent on trade-off between present and future consumption. Investor usually takes risk when he invests his savings to get high return in future. The first theory that discusses risk and return relationship is Capital asset pricing model. The model assumes that financial markets are frictionless. The cost of trading the asset does not exist in the financial market and all assets are perfectly liquid for trading. In reality assets are not perfectly liquid and price of the stock affects with the subsequent change in trading volume of asset. Keeping in view the deficiency of Capital asset pricing model, Amihud and Mendelsen (1986) studied liquidity and return relationship for the first time using bid ask spread and found liquid stocks have less spread that leads to low return as compared to illiquid stocks. Brennan & Subrahmanyam (1996) empirically test negative

liquidity-return relationship by employing Fama and French (1993) model along with other measures such as, price, book to market and size. Amihud and Mendelsen (1986) discussed one aspect of liquidity. In 2006, Liu introduced the multi-dimensional theory of liquidity.

The research adopts the interdependent multi- dimensional concept of liquidity defined by Liu (2006). Liquidity is the ability of immediate trading of stocks in bulk at low cost and small price impact. The operational definition of liquidity contains three dimensions closely related to each other. Change in one dimension of liquidity may bring a change in another aspect of liquidity. High transaction cost leads to a difficulty in trading of securities because buyers and sellers are not willing for trading of securities at high price. Traditional view of asset pricing theory is the liquidity-based transaction cost in relation to return of the stock is negligible. Liu (2006) argued transaction cost liquidity has a strong impact on equity returns . Pastor and Stambaugh (2003) in line with Amihud and Mendelsen (1986) and Amihud (2002) empirically prove that high spread means a high transaction cost of trading and causes a source of illiquidity and investor demand illiquidity premium for illiquid stocks as compared to liquid stocks. The above discussion leads to the development of the hypothesis related to transaction cost liquidity.

- **H<sub>1</sub>:** There exist long term inters linkage between transaction cost liquidity and equity returns in oil and gas sector
- **H<sub>a1</sub>:** There is no interaction between transaction cost liquidity and equity returns in oil and gas sector in long run.
- **H<sub>2</sub>:** There exist short term inter linkage between transaction cost liquidity and equity returns in oil and gas sector
- **H<sub>a2</sub>:** There is no interaction between market transaction cost liquidity and equity returns in oil and gas sector in short run.

According to Liu (2006), shares traded in quantity (depth) may fall due to high transaction cost. This shows an association between trading volume and transaction cost. Lesmond et al. (1999) empirically proves that trading of assets occur only if return is greater than transaction cost. Liu (2006) argued liquid market is able to trade the assets in large volume with less spread as compared to illiquid markets. Kerry (2008) demonstrates that large number of buyers and sellers are available in liquid market therefore the market depth of liquid market is more as compared to illiquid market. In deep liquid market return is less because investor does not demand illiquid premium on liquid stocks. This derives the hypotheses related to market depth liquidity.

- **H<sub>3</sub>:** There exist long term inter linkage between market depth liquidity and equity returns in oil and gas sector
- **H<sub>a3</sub>:** There is no interaction between market liquidity and equity returns in oil and gas sector in long run
- **H<sub>4</sub>:** There exist short term inter linkage between market depth liquidity and equity returns in oil and gas sector
- **H<sub>a4</sub>:** There is no interaction between market depth liquidity and equity returns in oil and gas sector in short run.

In order to attract investors, prices of the securities (price impact) may be decreased that may increase the return on securities. Low transaction costs motivate the investors for

trading of more securities. Hence the number of securities traded may increase and cause disturbance in balance of demand and supply of securities. Liu (2006) argue the upward movement of the prices results to form a new equilibrium in the market that may lead to less stock returns. Minovic (2012) empirically proves that price change in response to increase in volume occur in illiquid market as compared to liquid market. The following hypotheses have been drawn from this discussion.

- **H<sub>5</sub>:** There exist long term inter linkage between price impact liquidity and equity returns in oil and gas sector.
- **H<sub>a5</sub>:** There is no interaction between price impact liquidity and equity returns in oil and gas sector in long run.
- **H<sub>6</sub>:** There exist short term inter linkage between price-impact liquidity and equity returns in oil and gas sector
- **H<sub>a6</sub>:** There is no interaction between price-impact liquidity and equity returns in oil and gas sector in short run.

The stock with three characteristics low transaction cost, less price impact and high market depth indicate liquidity. Alternatively high cost of trading of shares, low market depth and high price impact signals illiquidity of stock in the market.

#### 4. Data and Methodology

This study investigates long term and short term relationship among liquidity indicators including Roll estimator of effective spread, Amihud (2002), turnover ratio, turnover rate and trading Volume and equity returns of Oil and Gas sector for the time period starting from July2009- June 2015. Monthly data of prices, volume and turnover of stocks has been taken from business recorder. In line with Tripathi and Kumar (2015) Pedroni cointegration, Granger causality and vector error correction model have been employed in the study to describe long and short term inter-linkage between multidimensional liquidity and equity returns in Pakistan stock exchange. The operational definition of independent and dependent variables are illustrated below

##### 4.1 Variables

###### 4.1.1 Roll Estimator of Effective Spread

The modified version of Roll estimator of effective spread proposed by Goyenko et al (2009) has been used in the research for measuring the transaction cost feature of liquidity.

$$Roll = \frac{2}{0} \sqrt{-Cov(\Delta P_t, \Delta P_t - 1)} \quad \begin{array}{l} \text{When } Cov(\Delta P_t, \Delta P_{t-1}) < 0 \\ \text{When } Cov(\Delta P_t, \Delta P_{t-1}) \geq 0 \end{array}$$

Roll estimator is a mechanism to measure the transaction cost indirectly. It is the negative autocorrelation between prices caused due to bounce in Bid and ask prices. It shows the behavior of prices in financial market. High values of Roll spread indicate high transaction cost and illiquidity in the market.

###### 4.1.2 Amihud Measure

Amihud (2002) measure the price impact liquidity that can be explained by using following formula.

$$RV_{i(dt)} = |ER_{i(dt)}| / PV_{i(dt)}$$



It is the ratio of absolute equity return of oil and gas stock  $i$  on the day during month  $(d, t)$  to the product of price and volume of oil and gas stock  $i$  on the day during month  $(d, t)$ . High value of Amihud Measure indicates market is illiquid and low volume of shares is trading in the market.

#### 4.1.3 Conventional Liquidity Ratio

Another proxy to measure the price impact aspect of liquidity is conventional liquidity ratio. It was developed by Cooper, Groth and Avera (1985). The analytical expression of this ratio is

$$LR_{it} = PV_{it} / |\% PC|$$

$P_{it} V_{it}$  are the prices and volume of equity  $i$  during monthly time period  $t$  and  $PC_{it}$  is the absolute percentage change in prices of equity  $i$  during the same month  $t$ .  $PC_{it} = P_{it} - P_{it-1}$ . High value of conventional liquidity ratio indicates liquidity in the market.

#### 4.1.4 Trading Volume

Blume, Easley and O'Hara (1994) develop trading volume as a proxy to determine the depth of liquidity in the market. It can be expressed as

$$TV = ST_{i(d,t)}$$

$ST_{i(d,t)}$  is the quantity of share  $i$  traded on the day of month  $(d, t)$ . High trading volume shows liquidity in the market.

#### 4.1.5 Turnover Rate

The proxy used to measure the market depth dimension of liquidity is turnover rate. It is proposed by Datar, Naik and Radcliffe (1998)

$$TR_{it} = SH_{it} / NSH_{it}$$

It is the ratio of shares traded of oil and gas stock  $i$  during monthly time period  $t$  to the shares outstanding of the same stock  $i$  during the same month  $t$ . High value of turnover rate indicates liquidity in the market.

#### 4.1.6 Equity Returns

Equity returns of all the companies listed in Oil and Gas sector in Pakistan Stock Exchange have been calculated by using the formula

$$ER_{it} = \ln(P_{it} / P_{it-1})$$

$ER_{it}$  = Equity returns of stock  $i$  of oil and gas sector during monthly time period  $t$

$P_{it}$  = Closing Price of stock  $i$  of oil and gas sector at month  $t$

$P_{it-1}$  = Closing Price of stock  $i$  of oil and gas sector at the end of month  $t-1$ .

Empirically various techniques are available to test the long term interaction between two variables. The research paper employs Pedroni Panel Cointegration, Granger Causality test & VECM to measure the relationship between liquidity indicators and equity returns. The methodological framework of the study is composed of descriptive statistics, correlation, stationarity tests through panel unit root, long term inter linkage by Panel Cointegration proposed by Pedroni (2002).

Short term inter linkage by VECM, unidirectional or bidirectional relationship by granger causality

#### 4.1.7 Stationarity Tests in Panel data

Stationarity of data has been checked through different panel unit root tests proposed in HIS (2013), LLC (Levin, Lin and Chu) Test, IPS (Im, Pesaran and Shin) test, ADF and PP test of Fisher

#### 4.1.8 Pedroni's Panel Cointegration Test

In order to explore the existence of long term cointegration or equilibrium relationship between liquidity and equity returns in oil and gas sector of Pakistan Stock Exchange, the study employs Pedroni's Panel cointegration. Pedroni's Cointegration is based upon Granger & Engle (1987) concept. Spurious regression has been performed on I(1) variables and residuals are examined. The residuals I(0) show cointegration among variables and if the residuals are I(1), would indicate the absence of cointegration among variables. The concept of Granger & Engle (1987) has been extended by Pedroni(1999, 2004). The equation of regression proposed by Pedroni is presented as

$$Y_{it} = \alpha_i + \delta_{it} + \beta_{1i}X_{1i,t} + \beta_{2i}X_{2i,t} + \dots + \beta_{Mi}X_{Mi,t} + \varepsilon_{it}$$

Where  $i = 1, \dots, N$ ;  $t = 1, \dots, T$  and  $m = 1, \dots, M$ . N indicates number of companies listed in oil and gas sector of Pakistan Stock Exchange. T represents number of observations over time in panel data. M indicates number of variables for regression. It is assumed that variables X and Y integrated at I(1).

The regression for Non parametric statistics is given below

$$\hat{\varepsilon}_{it} = \rho_i \hat{\varepsilon}_{it-1} + u_{it}$$

The regression equation for parametric statistics is shown as

$$\hat{\varepsilon}_{it} = \rho_i \hat{\varepsilon}_{it-1} + \sum_{j=1}^t \psi_{tj} \Delta \hat{\varepsilon}_{it-j} + u_{it}$$

There are two types of test statistics in Pedroni's work. First one is panel statistics and the other one is group statistics. Panel statistics include residuals are pooled across the within dimensions of the panel data where as in group statistics pooling of residuals occur across the between dimensions of the panel data. The power of test varies with the value of N. Pedroni demonstrates that if group rho statistic is significant it will indicate that variables have strong cointegrating relationship among them.

#### 4.1.9 Granger Causality

The concept of Granger (1969) has been used in the research to examine the unidirectional or bi-directional relationship between liquidity indicators and equity returns.

The two models are tested by using granger causality in the research. First model is given below

$$Y = \sum_{j=1}^k a_j Y_{t-j} + \sum_{j=1}^k b_j \Delta X_{t-j} + \mu_t$$

The mechanism of second model is shown below

$$X = \sum_{j=1}^k a_j X_{t-j} + \sum_{j=1}^k b_j \Delta Y_{t-j} + \mu_t$$

F statistic is used to test the above two equations. The statistically significant F- statistic would indicate that lagged X variable granger causes the variable Y in first equation. Similarly if the F-statistic of the lagged variable of Y is significant it would indicate that Y granger causes X.

The current research paper tests five models based upon Liu (2006)

Model 1: (EQ) <sub>it</sub> = $\alpha_i + \beta_1$ (CLR) + $\mu_{it}$ .....	1 (Price Impact)
Model 2: (EQ) <sub>it</sub> = $\alpha_i + \beta_1$ (AR) + $\mu_{it}$ .....	2 (Price Impact)
Model 3: (EQ) <sub>it</sub> = $\alpha_i + \beta_2$ (TR) + $\mu_{it}$ .....	3 (Market Depth)
Model 4: (EQ) <sub>it</sub> = $\alpha_i + \beta_3$ (V) + $\mu_{it}$ .....	4 (Market Depth)
Model 5: (EQ) <sub>it</sub> = $\alpha_i + \beta_4$ (RE) + $\mu_{it}$ .....	5 (Transaction Cost)

Where

EQ= Equity return

CLR= Conventional Liquidity Ratio (Price Impact- liquidity indicator)

AR= Amihud Ratio (Price Impact- liquidity indicator)

TR = Turnover Rate (Market Depth- liquidity indicator)

V= Volume (Market Depth- liquidity indicator)

RE= Roll Estimator (Transaction cost- liquidity indicator)

The bi-variate models have been tested to measure the long term and short term inter-linkage between liquidity indicators and equity returns of oil and gas sector during the data period 2009-2015 in Pakistan Stock Exchange. Pedroni cointegration test is employed to check long term relationship. Short term relationship has been examined through VECM. Moreover unidirectional or bidirectional relationship has been explained through Granger causality.

Panel VECM in line with Canning and Pedroni (2008) has been employed on the evidence of cointegration among variables. The specified equation is given below.

$$\Delta y_{it} = \pi_{it} + \lambda_{1i} e_{it-1} + \sum_{j=1}^K \lambda_{2ij} \Delta y_{it-j} + \sum_{j=1}^K \lambda_{3ij} \Delta x_{it-j} + \sum_{j=1}^K \lambda_{4ij} \Delta z_{it-j} + \varepsilon_{it}$$

The disequilibrium term of the equation indicates that how much variables are far from maintaining the equilibrium relationship. The mechanism of error correction depict that disequilibrium causes the liquidity indicators to adjust towards equilibrium to maintain long term intact. The coefficient of error term must be negative to hold the long run relationship between liquidity indicators and equity returns.

#### 4.2 Results and Discussion

Descriptive statistics has been analyzed in table 1 to see the general behavior of data. Average monthly return of Karachi stock exchange is 1.0% and maximum return during data period (2009-2015) is 34% indicating high volatility in this emerging market. Average volume of shares of oil and gas sector traded during sample period is 1.59 million. The maximum volume of this sector traded in this period is 11.6 million. Low average value of Amihud ratio and high average value of conventional liquidity ratio shows shares of oil and gas sector are liquid in nature. Maximum turnover rate of oil and gas sector is 4.2%. Roll estimator, a transaction cost indicator shows average value 1.27 indicating transaction cost involve during trading of shares of oil and gas sector. Kurtosis

value is above three indicating leptokurtic distribution and the probability of extreme values exist during 2009-2015.

**Table1: Descriptive Statistics**

Variables	AR	CLR	TR	V	RE	Return
Mean	-0.00312	8.03333	0.00238	1.59910	1.27956	0.01022
Median	0.00737	1.13841	0.00022	0.90675	1.10970	0.01372
Maximum	0.65832	13.19332	0.04215	11.61821	7.54717	0.34978
Minimum	-0.00001	-0.01401	0.00002	0.12361	0	-0.25831
Std. Dev.	0.01876	0.86543	0.00655	1.90151	1.00698	0.09283
Skewness	-4.20326	3.98718	3.88443	3.03241	3.10607	0.223072
Kurtosis	33.12566	18.87054	19.83674	14.46559	18.92084	5.05968
Observations	756	756	756	756	756	756

A weak correlation has been observed among liquidity indicators and stock returns in table 2. Equity returns are negatively correlated to Amihud ratio and positive correlated to turnover rate. A positive association has been seen between Conventional liquidity ratio and equity returns. A possible explanation for this positive association can be derived from liquidity premium theory that investors demand high return for those securities having high price impact. Positive relationship is between volume and return show trading of shares in large volume is accompanied by an increase in price change Osborne (1959). The relationship between Roll estimator and equity return is negative because an increase in transaction cost leads to decrease the return of shares.

**Table 2: Correlation**

	Return	AR	CLR	V	TR	RE
Return	1	-0.0791	0.1416	0.3723	0.0662	-0.0044
AR	-0.0791	1	-0.4253	0.1229	-0.0349	0.1933
CLR	0.1416	-0.4253	1	0.0661	-0.0699	0.0555
V	0.3723	0.1229	0.0661	1	-0.0571	0.3120
TR	0.0662	-0.0349	-0.0699	-0.0571	1	-0.0400
RE	-0.0044	0.1933	0.0555	0.3120	-0.0400	1

Table 3 and table 4 reveal about the stationary of panel data during 2009-2015. Four tests; LLC, IPS, ADF and PP proposed by fisher have been applied to examine either the data is stationary or not. Results report that all panel series are stationary at first difference but non stationary at level. Hence first order integrated series can be further analyzed because there is no risk of spurious relationship.

**Table 3: Panel Unit Root Test (at Level)**

Panel Variables	Levin, Lin & Chu t-Statistic		Im, Pesaran And Shin W-Statistic		ADF - Fisher Chi-Square		PP - Fisher Chi-Square	
	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
<b>Stock Prices</b>	1.1953	0.8840	-0.7989	0.2122	15.8688	0.6017	26.4483	0.0899
<b>Volume</b>	-0.1979	0.4215	-3.0150	0.0930	34.1147	0.0820	42.1187	0.0800
<b>Turn over</b>	0.6700	0.9915	-3.4328	0.9915	-2.8625	0.9915	-2.5673	0.9915
<b>Amihud Ratio</b>	-2.0045	0.6615	-2.3124	0.6515	1.5124	0.6505	1.3324	0.6523
<b>Conventional liquidity Ratio</b>	-2.8272	0.3215	-2.4323	0.3325	-1.4393	0.3320	-0.4329	0.3320
<b>Roll Estimator</b>	-7.2166	0.9915	-6.0688	0.9915	-5.0698	0.9915	-2.0698	0.9915

**Table 4: Panel Unit Root Test (at First Difference)**

Panel Variables	Levin, Lin & Chu t-statistic		Im, Pesaran and Shin W-statistic		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
<b>Stock Prices</b>	-1.590	0.044	-9.309	0.000	125.228	0.000	627.883	0.000
<b>Volume</b>	-12.357	0.000	-12.010	0.000	171.383	0.000	308.658	0.000
<b>Turnover Rate</b>	-4.741	0.000	-12.295	0.000	184.429	0.000	320.038	0.000
<b>Amihud Ratio</b>	-14.003	0.000	-15.213	0.000	231.350	0.000	282.605	0.000
<b>Conventional Liquidity Ratio</b>	-14.822	0.000	-12.423	0.000	179.248	0.000	287.383	0.000
<b>Roll Estimator</b>	-0.213	0.000	-9.069	0.000	117.620	0.000	301.468	0.000

Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ) applied in the study to know the appropriate lag order of panel series. The selected lag length for each variable is 1 for testing the Panel Cointegration.

**Table 5: Lag Order Selection Criteria**

<b>Lag</b>	<b>LogL</b>	<b>LR</b>	<b>FPE</b>	<b>AIC</b>	<b>SC</b>	<b>HQ</b>
0	-18794.1	NA	301	54.9	55.0	54.9
1	-18619.4	345.8	201	54.5	54.8*	54.6*
2	-18564.2	108.1	190	54.5	55.0	54.7
3	-18511.3	102.9	181	54.4	55.2	54.7
4	-18489.1	42.7	188	54.5	55.4	54.8
5	-18460.3	55.0	192	54.5	55.7	54.9
6	-18401.9	110.3	180	54.4	55.9	55.0
7	-18376	48.5	185	54.4	56.1	55.1
8	-18359.9	29.8	197	54.5	56.4	55.2

Long term relationship between liquidity indicators; Amihud Ratio, Volume, Roll Estimator, Conventional Liquidity Ratio, Turnover rate and stock return have been tested through Pedroni Panel Cointegration. As the variables of the research are cointegrated in the same order therefore Pedroni Panel Cointegration proposed by Pedroni ;( 1999, 2004) is employed. Results reveal that liquidity indicators and stock returns of oil and gas sector have co-integration in the long run during 2009-2015 and reject the null hypothesis of no cointegration at 5% significance level because tables 6,7,8,9 and10 illustrate that  $p < 0.05$  for all the panel cointegration test except Panel v- statistics

Table 6 illustrates the long term interaction between Amihud ratio and equity returns of oil and gas sector in Pakistan stock exchange. It means price moves in response to volume is less and the buying and selling of asset can be done without affecting the price adversely Liu (2006). Therefore stocks of oil and gas sector have less price impact in long run during the sample period. Conventional liquidity ratio reveals unit change in stock price. The cointegration result of conventional liquidity ratio and equity returns are reported in table 7. The inter-linkage between conventional liquidity ratio and equity returns indicates that less price impact per unit has been observed in long run. The result of the study is in contrast with Grunding and Hardig (2012) who have found high price impact on equity returns in Stockholm stock exchange.

Table 8 and 9 illustrate interaction between market depth liquidity and equity returns of oil and gas sector in long run. Trading volume provides historical information about past returns and quantity of shares traded per time. More over turnover is the indicator of that portion of issued stocks which trade daily in a year. High turnover and large volume show that oil and gas equity securities are liquid in nature and future returns of this sector can strongly be predicted from these indicators. The result of the study is in line with Hartian and Sitorus (2015) who report market depth liquidity exist in emerging as well as developed market. Moreover, Dinh (2017) has also indicated price impact and market depth liquidity in Oslo stock markets.

Pedroni panel cointegration results in table 10 also narrate long term inter -linkage between transaction cost liquidity and equity returns in oil and gas sector. Illiquid stocks have high transaction cost and investor demands illiquid premium in his return. Kerry (2008) describes spread of liquid stock does not increase incrementally with the increase in number of orders in liquid market. Oil and gas stocks have less spread therefore the securities of this sector are liquid in nature. The result of the study is in contrast with Trang (2013) who found no relationship between transaction cost liquidity and equity return in developed market.

The pedroni cointegration results show that long term interaction exist among all aspects of liquidity proposed by Liu (2006) and equity returns in Pakistan stock exchange. Therefore emerging market of Pakistan is able to receive more orders because uncertainty about price impact, market depth and transaction cost is less in long run. The results of the study contrast with Leirvik et al. (2017) who have found no association between liquidity and return in Norwegian stock market.

**Table 6: Pedroni Panel Cointegration between Amihud Ratio and Equity Return**

Pedroni Panel Statistic	Statistic	Prob.	Weighted	
			Statistic	Prob.
<b>Panel v-Statistic</b>	-1.8734	0.9695	-1.8734	0.9695
<b>Panel rho-Statistic</b>	-43.1914***	0.0000	-43.1914***	0.0000
<b>Panel PP-Statistic</b>	-27.3901***	0.0000	-27.3901***	0.0000
<b>Panel ADF-Statistic</b>	-16.8996***	0.0000	-16.8996***	0.0000
<b>Group rho-Statistic</b>	-38.7499***	0.0000		
<b>Group PP-Statistic</b>	-31.4056***	0.0000		
<b>Group ADF-Statistic</b>	-18.9529***	0.0000		

Significance level is 0.05.

**Table 7: Pedroni Panel Cointegration between Conventional Liquidity Ratio and Equity Return**

Pedroni Panel Statistic	Statistic	Prob.	Weighted	
			Statistic	Prob.
<b>Panel v-Statistic</b>	-2.2653	0.9883	-2.26537	0.9883
<b>Panel rho-Statistic</b>	-44.4648***	0.0000	-44.4648***	0.0000
<b>Panel PP-Statistic</b>	-27.1144***	0.0000	-27.1144***	0.0000
<b>Panel ADF-Statistic</b>	-17.4459***	0.0000	-17.4459***	0.0000
<b>Group rho-Statistic</b>	-39.937***	0.0000		
<b>Group PP-Statistic</b>	-31.0784***	0.0000		
<b>Group ADF-Statistic</b>	-19.6013***	0.0000		

Significance level is 0.05.

**Table 8: Pedroni Panel Cointegration between Volume and Equity Return**

Pedroni Panel Statistic	Statistic	Prob.	Weighted	
			Statistic	Prob.
Panel v-Statistic	0.0188	0.4925	0.0188	0.4925
Panel rho-Statistic	-44.4583***	0.0000	-44.4583***	0.0000
Panel PP-Statistic	-27.3226***	0.0000	-27.3226***	0.0000
Panel ADF-Statistic	-16.6728***	0.0000	-16.6728***	0.0000
Group rho-Statistic	-39.9309***	0.0000		
Group PP-Statistic	-31.3255***	0.0000		
Group ADF-Statistic	-18.6837***	0.0000		

Significance level is 0.05

**Table 9: Pedroni Panel Cointegration between Turnover Rate and Equity Return**

Pedroni Panel Statistic	Statistic	Prob.	Weighted	
			Statistic	Prob.
Panel v-Statistic	-1.3442	0.9106	-1.3442	0.9106
Panel rho-Statistic	-43.5725***	0.0000	-43.5725***	0.0000
Panel PP-Statistic	-26.8966***	0.0000	-26.8966***	0.0000
Panel ADF-Statistic	-16.7767***	0.0000	-16.7767***	0.0000
Group rho-Statistic	-39.1051***	0.0000		
Group PP-Statistic	-30.8198***	0.0000		
Group ADF-Statistic	-18.8070***	0.0000		

Significance level is 0.05

**Table 10: Pedroni Panel Cointegration between Roll Estimator and Equity Return**

Pedroni Panel Statistic	Statistic	Prob.	Weighted	
			Statistic	Prob.
Panel v-Statistic	-2.1297	0.9834	-2.12973	0.9834
Panel rho-Statistic	-44.5496***	0.0000	-44.5496***	0.0000
Panel PP-Statistic	-27.0189***	0.0000	-27.0189***	0.0000
Panel ADF-Statistic	-16.9884***	0.0000	-16.9884***	0.0000
Group rho-Statistic	-40.016***	0.0000		
Group PP-Statistic	-30.965***	0.0000		
Group ADF-Statistic	-19.058***	0.0000		

Significance level is 0.05

When variables are associated in long run it means there should exist causal relationship in at least one direction. Therefore, the concept of Granger (1969) has been applied to



explain the unidirectional or bi-directional causality among liquidity indicators and equity returns. Table 11 reveals that F-Statistic is statistically significant reflecting bi-directional causality among all the liquidity indicators AR-Return, TR-Return, V-Return, RE-Return and CLR - return. The bi-directional causality shows that return also influences liquidity by creating return dependent investing wave in capital market of Pakistan during the sample period. The study has found results similar to the studies conducted by (Chen et al., 2001; Lee and Rui, 2002; and Kumar et al., 2009.) and report that equity returns are the source of transforming uninterrupted information that strongly predict liquidity of stock returns in Pakistan stock market just like in Japanese and U.K stock markets.

**Table 11: Results of Granger Causality**

Null Hypothesis	Obs	F-Statistic	Prob.
AR does not Granger Cause RETURN	738	16.42 <sup>***</sup>	0.0000
RETURN does not Granger Cause AR		5.67 <sup>***</sup>	0.0036
TR does not Granger Cause RETURN	738	37.12 <sup>***</sup>	0.0000
RETURN does not Granger Cause TR		33.11 <sup>***</sup>	0.0000
V does not Granger Cause RETURN	738	16.44 <sup>***</sup>	0.0000
RETURN does not Granger Cause V		11.64 <sup>***</sup>	0.0000
RE does not Granger Cause RETURN	738	4.60 <sup>***</sup>	0.0103
RETURN does not Granger Cause RE		16.55 <sup>***</sup>	0.0000
CLR does not Granger Cause RETURN	738	10.76 <sup>***</sup>	0.0000
RETURN does not Granger Cause CLR		36.34 <sup>***</sup>	0.0000

Significance level is 0.05

t-statistics are given within parentheses. All the lagged coefficients of liquidity indicators except Conventional Liquidity ratio are statistically significant at 5% level of significance demonstrating that liquidity indicators have short run relationship with equity return. The statistically significant coefficients of turnover rate (-0.005) and volume (-0.0045) at 5% significance level indicate relationship between volume and turnover rate with return is negative. It means that liquid stocks have low return and these results supports the market depth liquidity hypothesis of Liu (2006). The results of the study are consistent with the empirical evidence provided by Mustafa and Nishat (2008) that Pakistani stock market has market depth liquidity. The statistical significant coefficient (0.0055) of Amihud Ratio (2002) at 5% significance level indicates that price impact exists and returns of illiquid stocks are higher in comparison to liquid stocks which are in line with high risk and high return argument. These results have support from Liu (2006) and indicate short run relationship of liquidity with equity returns in this financial market.

Roll estimator is statistically significant at 5% significance level with opposite sign contradict with liquidity theory proposed by Liu (2006). The positive coefficient +0.029 of Roll estimator indicates that transaction cost lowers the volume but has small effect on price in short run (Voyanos, 1998). The result of the study contrasts with Trang (2013) who has found no relationship between transaction cost liquidity and equity returns in

developed stock market. A study conducted on six companies of oil and gas sector in Tehran stock exchange by Moradi (2015) also provides an empirical evidence for the existence of liquidity-return relationship in this sector using Amihud ratio. In addition, Sorayaei et al. (2014) also analyze inter-linkage between liquidity and stock returns in investment sector of Tehran stock exchange

Moreover ECT ( $e_{t-1}$ ) is negative (-1.34, -1.39, -1.35, -1.25, -0.74) and statistically significant in all cases indicating that disequilibrium is adjusted rapidly. However, ECT is greater than one in most of the cases which is indicator of over adjustment.

The robustness of the results has been tested by using multiple proxies to measure the various dimensions liquidity. The study analyzes the consistency of result for each dimension of liquidity in short and long run. For examining price impact liquidity, Conventional liquidity ratio is used and robustness has been confirmed by using Amihud ratio. Similarly impact of market depth on returns has been studied by using volume and then robustness of results has tested by using turnover ratio. It is worth mentioning that the results are found consistent in general for each dimension of liquidity. However, Pooled mean group may also be used in future for evaluation of link between liquidity and equity returns.

The current study concludes that significant long run interaction exist between liquidity and equity returns. These results are consistent for price impact, Effective spread and market depth. These results are in line with previous studies conducted by (Mustafa and Nishat. 2008; Khan and Rizwan. 2008). The studies (Trang.2013;Dinh.2017) done in stock markets in the context of liquidity also reveal that liquidity has an impact on investor's return and investors consider liquidity as one of the determinants of equity selection for making portfolios. Similarly, short run relationship between each dimension of liquidity and equity return is also present. In case of disequilibrium the rapid adjustment is also observed.

The results of the study enable the domestic and international investors and portfolio managers to allocate their financial resources effectively. It also helps the Portfolio managers to consider liquidity and return relationship of assets in short run and long run for portfolios restructuring. Policy makers and regulators are recommended to give attention to liquidity while designing policies for oil and gas sector because market players usually prefer stable financial market that is able to receive orders in large volume with a little bit price impact.

**Table 12: Results of Vector Error Correction Model**

<b>Liquidity Indicators</b>	<b>Constant</b>	<b>Error Correction term(<math>e_{t-1}</math>)</b>	<b>Lagged Coefficients of Liquidity Indicators</b>
<b>Amihud Ratio</b>	-0.0023	-1.3499 <sup>***</sup>	0.0055 <sup>***</sup>
	[-1.0467]	[-20.7230]	[-3.2311]
<b>Conventional liquidity Ratio</b>	-0.0023	-1.3952 <sup>***</sup>	0.0024
	[-1.0319]	[-21.2329]	[-1.5065]
<b>Volume</b>	-0.0029	-1.3562 <sup>***</sup>	-0.0045 <sup>***</sup>
	[-1.2921]	[-18.6424]	[-3.7222]
<b>Turnover Ratio</b>	-0.0024	-1.2585 <sup>***</sup>	-0.0054 <sup>***</sup>
	[-1.0907]	[-20.6749]	[-7.8976]
<b>Roll Estimator</b>	-0.00291	-0.74169 <sup>***</sup>	0.02973 <sup>***</sup>
	[-1.1276]	[-13.7253]	[9.6215]

Significance level is 0.05

## 5. Conclusion

The inter-linkage between equity returns and five liquidity indicators Amihud Ratio, Conventional Liquidity Ratio, Roll Estimator, turnover rate and volume examined in the study through Pedroni Panel cointegration and VECM. Panel Granger Causality has been employed on monthly observations of oil and gas sector to examine the unidirectional or bidirectional causality among liquidity factors and equity returns during the sample period (2009-2015).

Multi-dimensional concept of liquidity proposed by Liu (2006) has been examined in the study. Liu (2006) proposed that market liquidity cannot be judged by using single indicator of liquidity. Market liquidity has various dimensions. The contribution of the study to literature is that it provided empirical evidence about the multiple aspects of liquidity by using various liquidity proxies in contrast to previous studies (Minovic (2012) , Grunditz and Hardig (2012) , Chikore et al. (2014) and Hartian and Sitorus (2015) who focused on one or two aspects of liquidity. Moreover the study is also beneficial for international reader because short term and long term interaction between liquidity and equity returns have not been sufficiently investigated in other markets as well. The study explored price impact liquidity, transaction cost liquidity and market depth liquidity in Pakistan stock exchange in contrast to the earlier studies conducted in Pakistan by Mustafa and Nishat (2008) and Akram (2014) . Two aspects of liquidity are related to price impact and transaction costs whereas the third aspect; number of shares traded shows the market depth of liquidity in the market. The proxy used for measuring the transaction cost is Roll Estimator. Turnover rate and volume revealed market depth of stock in the market. Price impact of liquidity is measured through Amihud Ratio and Conventional liquidity ratio.

Pedroni Cointegration and VECM depict that both long term and short term association exist between liquidity indicators and equity returns in Pakistan stock exchange. Moreover Panel Granger Causality results reveal that bidirectional relationship exists between liquidity indicators and equity returns. The above results of the research support

the notion that various dimensions of liquidity should be considered while making investment decisions. It is further added that results are consistent for all dimensions and support the multidimensional liquidity proposed by Liu (2006). The results of the study acknowledge that liquidity is vital for asset pricing. Average liquidity is priced and these results are consistent with Amihud and Mendelson (1986) and Chordia et al. (2001). It is further added that Liquidity also predicts future returns and liquidity shocks are positively correlated with return shocks which is in line with Amihud (2002).

It is recommended to investigate the liquidity and return relationship on other important sectors listed in Pakistan stock exchange to get better insight about the liquidity behavior of stocks in various sectors listed at Pakistan stock exchange. Moreover, a combined liquidity measure may be developed for future research by integrating various dimensions through principal component analysis..

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