Interest Rate Sensitivity of Bank Stock Returns: Evidence from Pakistan Stock Exchange (PSX)

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CERTIFICATE

This is to certify that this thesis entitled **"Interest Rate Sensitivity of Bank Stock Returns: Evidence from Pakistan Stock Exchange"** submitted by **Mr. Asim Mustafa** is accepted in its present form by the Department of Business Studies, Pakistan Institute of Development Economics (PIDE) Islamabad as satisfying the requirements for partial fulfillment of the Degree of Master of Philosophy in Economics and Finance.

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Undertaking

I declare that the research work presented in this thesis titled “An investigative study of Interest rate sensitivity of Bank stock returns using GARCH type models: Evidence from Pakistan Stock Exchange (PSX)” is my own work. I confirm that no portion of this research work has been plagiarized and any material used is properly cited.

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Abstract

This study investigates sensitivity of banking sector stock returns to interest rate. The study employs daily stock returns of seventeen commercial banks listed at Pakistan Stock Exchange, covering ten years period from 2010-2019. For data analysis Autoregressive Conditional Heteroscedasticity (ARCH) based statistical models are applied including GARCH-M, EGARCH and DCC-GARCH. The sample of banks considered for the study is divided into three categories i.e. Large banks (LGB), Second-tier banks (STB) and Third-tier banks (TTB). The three portfolios allows to investigate level of sensitivity of banks to interest rate, depending upon their size and the maturity gap between their assets and liabilities. Findings of this study suggest that bank stock returns are sensitive to changes in interest rate, the direction of effect is positive and the magnitude of interest rate sensitivity is portfolio-specific. Besides, it is also found that the market wide movement do affect stock returns. The thesis provides an insight into the nature of relationship and sensitivity level that bank stock returns exhibit vis-à-vis monetary policy as per their respective balance sheet profile.

Keywords: Mean spillover, Volatility spillover, Monetary Policy, Leverage effect, Dynamic Conditional Correlation

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List of Abbreviations

ARMA	Auto Regressive Moving Average
ARCH	Autoregressive Conditional Heteroscedasticity
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
EGARCH	Exponential Generalized Autoregressive Conditional Heteroscedasticity
DCC	Dynamic Conditional Correlation
ADCC	Asymmetric Dynamic Conditional Correlation
EMH	Efficient Market Hypothesis
PSX	Pakistan Stock Exchange
NII	Net Interest Income
MV	Multivariate

Figure A	Stock return series at level of MCB Bank
Figure B	Stationary return series of MCB Bank

1.0 Introduction

Interest rate risk emanates from fluctuations in market interest rate that inturn depends on Central bank's policy rate. Central banks around the world manage inflationary pressures in the economy with tightening of interest rates as a preferred monetary tool. Asynchronous movement of interest rate may cause capital loss on investment made by a bank. To explain this, we may refer to basic Finance theory which states that increase in interest rate (which is used as discount rate in asset valuation) pulls down price of a financial asset, since the present value of future cashflow reduces after getting discounted by a larger factor. This means that income associated with the financial asset would decrease consequent to increase in interest (discount) rate. Adding further to this, Gali & Gambetti (2015) dissected the stock price into two components – fundamental and bubble related. They explained that the bubble component in the stock price responds negatively to an increase in interest rate and gets reduced to bring down the stock price. However, if the bubble is large, it will add to the price of a stock against a tight monetary policy.

Since financial assets and liabilities essentially define balance sheet of any financial institution particularly banks, therefore the common view expects strong correlation between profitability of banks and movement in the interest rates over time.

Interest rate volatility and its impact on equities has remained an area of concern for investors, banks, regulators and researchers alike. The question, whether interest rate movements affect equity markets especially banking stock valuation can be regarded as an unsettled dispute. Those who invest in both stocks and bonds would like to know how the two investments behave in relation to each other with changes in monetary policy and resultant investment environment.

Although number of research papers provides evidence for significant and negative relationship between interest rate and stock returns of banks, there are studies that question possible non-linear relationship and may not render interest rates solely responsible for movement in stock returns. Thus the findings differ in terms of magnitude and direction of sensitivity of bank stock returns to the interest rate. Banking stocks are impacted more due to market movements than interest rates (Chance and Lane, 1980). Another puzzling observation is the fact that interest rate risk is considered as a systematic risk and it is priced for overall equity market and not only for banking stocks. It is also empirically concluded that anticipated changes interest rates are already built in the stock return while only the unanticipated changes in the economic factors are not accounted for and they may affect the stock returns. This explains the importance of study of relationship between monetary policy and stock return.

A fundamental reason highlighted in various studies that contributes to the sensitivity of a financial institution to fluctuation in interest rates is the mismatch between the assets and liabilities it is holding on books. Typically bulk of assets on the books is long term while the deposit is generally short term in nature. This maturity gap exposes a bank to interest rate risk. Besides it is also established empirically that interest rate sensitivity is more pronounced in volatile time period as compared to relative stability.

Despite the aforementioned mismatch between the assets and liabilities, banks are able to hedge themselves against untoward movement in interest rates. By offering well perceived value of their business, they are able to mobilize deposit at an interest rate lower than the market, while they usually earn an interest income over and above the market rate when they invest and lend money to the government, public and private borrowers. Thus banks strategically earn a positive net spread in their interest income and hedge their bottom line from any possible deterioration.

The nature of relationship between interest rate and stock returns is also covered in the study. An asymmetric relationship may render estimation through regular OLS inaccurate and in such case alternate modeling techniques like ARCH family of models are generally favored by researchers and professionals.

1.1 Problem Statement

Understanding the relationship and possible transmission of return and volatility from a macroeconomic factor like interest rate, inflation or exchange rate to stock returns has remained pivotal in hedging of an investment portfolio against any untoward market movement.

In particular, changes in monetary policy is regarded as key element in determining performance of financial institutions especially commercial banks who are affected on both their asset and liability side of balance sheet with change in the interest rate.

This study addresses the research problem that whether stock returns of commercial banks in Pakistan are exposed to transmission of return and volatility from interest rate and whether their sensitivity level in this regard differs from one bank to another based on their size of business.

Another research problem which is investigated in the thesis is spillover of return and volatility from market to bank stock returns. This is based on a research premise that stock returns are affected by interest rate through market wide movement (Chance and Lane, 1980).

1.2 Research Questions

This study is based on the following research questions:

a) Whether spillover from mean or volatility takes place from interest rate to bank stock returns of commercial banks listed on Pakistan Stock Exchange (PSX)?

b) Whether spillover from mean and volatility takes place from market wide movement to bank stock returns of commercial banks listed on PSX?

c) Whether the effect of interest rate and market movement is identical for all the commercial banks or depend on their respective sizes?

d) Does the correlation between interest rate and bank stock returns show an asymmetric behavior?

e) Is the correlation between interest rate and bank stock returns is time varying?

1.3 Gap Analysis

Investigation of effect of interest rate on stock returns of various industries and financial institutions in particular has been a focus area of researchers. Various studies have covered specific and multiple international jurisdictions to validate 'heat-wave' and 'meteor-shower' type spillover transmissions. However, these studies have either not investigated banks in particular or have not used multiple ARCH type models for their estimations. Due to presence of leptokurtosis and non-normality, OLS modelling may not generate reliable results (Elyasiani, 2004). This study has applied a combination of ARCH type models i.e. GARCH in Mean, EGARCH and DCC-GARCH to model conditional variance and time-varying correlation respectively.

Besides, return and volatility spillover from dual sources of interest rate and market is a peculiarity of this study. In the context of Pakistan Stock Exchange (PSX), the research gap is more prominent as no particular study could be found on investigation of spillover of return and volatility from interest rate to stock returns of commercial banks. Since sensitivity of banks to interest rate is dependent upon their size and maturity gap between their assets and liabilities (Mitchell, 1989), therefore a specific research was required to categorize banks into groups as per their balance sheet size. This thesis addresses the matter of variable sensitivity by grouping banks into three distinct portfolios before subjecting them to estimation models.

The study contributes to the body of knowledge by carrying out investigative study on spillover transmission by applying multiple GARCH models on a considerably large sample of banks listed on PSX and determining their respective sensitivity level corresponding o their respective size.

1.4 Research Objectives

The objectives of this research are narrated below:

1. To investigate possible mean and volatility spillover of interest rate to stock returns of commercial banks listed on Pakistan Stock Exchange.
2. To find out whether the relationship between interest rate and bank stock returns exhibits asymmetry and measurable through GARCH type econometric models.
3. To investigate presence of time varying correlation between interest rate and the bank stock returns.

1.5 Significance of the Study

Interest rate volatility has been a matter of concern for an under developed country like Pakistan. Monetary policy is used invariably to control inflation as a preferred macro-economic tool. Banks comprise one of the most significant segments of economy that channelize funds where they are needed and serve as a bridge between savers and borrowers. The financial assets and liabilities banks carry on their books are exposed to interest rate risk. An asynchronous movement in the interest rate is likely to affect the financial health of the banks that might turn into a systemic risk for the overall economy.

This study serves the purpose of investigating the relationship and its extent between interest rate volatility and bank stock returns from an economic point of view. In case of significant relationship, appropriate measures and their possible implementation can be looked into.

Besides, the study also envisages the time varying correlation between interest rate shocks and stock returns of banks, thus pointing out for an appropriate portfolio strategy. The desired portfolio of bank stocks would be the one that will make the investment risk assumable through uncorrelated diversification.

1.6 Plan of the Study

The study is divided into four portions. First portion covers the scope of study under Introduction, highlights the research questions, research gap and significance of study. Second portion covers the literature review and gives an insight into the theoretical background. Third portion discusses the underlying econometric models and identifies the model specifications to be used for estimations. Fourth part discusses the results of estimations and analyses there upon. The study is completed by adding conclusion and recommendation.

2.0 Literature Review

Literature review envisages the historical developments along-with theoretical background of the study. It presents various evidences based on the empirical work of different researchers on the topic of possible relationship between interest rate and bank stock returns. The review also covers study of relevant econometric models that have been instrumental in estimating the aforesaid relationship from scope and significance point of view.

2.1 Theoretical Background

Various theories that are relevant to this thesis are discussed here. First of all is the Efficient Market Hypothesis (EMH). This theory states that asset price reflects all available information. This means that theoretically, it is not possible to generate 'excess return' through risk adjustment consistently. Therefore stocks always trade on exchange at their fair market value and it is not possible to out-perform the 'market'. Higher return is possible only if an investor is willing to take incremental risk. Efficient Market Hypothesis is considered a corner stone of the modern finance theory, however it has also attracted criticism. The critics of this theory have pointed out free fall of equities more than their fair price in the events of melt downs.

Another important theory is Modern Portfolio theory (MPT) of Markowitz that highlights the importance of correlation to portfolio management. MPT is regarded as the cornerstone of modern portfolio management. Briefly theory can be described as typical investor behavior where they would like to maximize their return for a given amount of risk of a portfolio, and minimize risk of a portfolio at a given amount of return. The theory explains the importance of diversification in order to lower the risk of investment. By building a portfolio of multiple assets instead of holding a single asset with identical return, an investor can effectively lower the risk of his holdings. However, it is important that the assets in a portfolio should move in opposite direction, otherwise risk will not be lowered. For instance, one can invest in a particular foreign currency, say Euro and physical gold. Now compared to holding one of the two assets, the risk will be lowered if Euro and gold move in opposite direction with the movement in market. In other words these two assets should not have positive correlation. The investors show rational behavior and pick a portfolio of assets with low correlation to diversify the risk at a given return level.

Capital Asset Pricing model (CAPM) requires a special mention here. The model tells that there are two kinds of risk attached to a portfolio; the total risk and the systematic risk. The total risk is measured by the correlation coefficient and variances of the assets in the portfolio, while the systematic risk is stated by the value of beta of the portfolio. CAPM states that only the non-systematic part of the total risk is diversifiable. To diversify the risk, those assets are added in the portfolio who exhibit low correlation with each other. However the assets should have the same level of return.

Discounted cashflow (DCF) model holds a prominent position when effect of interest rate on stock returns is studied. As per DCF, stock price is determined by the present value of the future discounted cashflows. Hence any alteration in the monetary policy impacts the discount factor and the resultant stock price. To explain, an expansionary monetary policy, credit becomes cheaper and stimulates economic growth, resulting in higher corporate profitability and stock prices. On the contrary, in case of a tight monetary policy when the interest rates undergo a spike, contractionary pressure builds in the economy as credit becomes expensive and corporate earnings are negatively impacted. Consequently, lower profits reduce the value of stocks.

In case of bank stocks, the proposition may differ as banks generally experience higher profitability in the times of rising interest rate scenario. This happens primarily due to their ability to protect their interest margin i.e. the difference between interest earnings on financial assets and interest expense on their deposit accounts. To understand the discount factor as discussed above and its role in determining the stock value, numerical representation clarifies well:

$S_t = \left[\sum_{j=1}^{k} \left(\frac{1}{1+R}\right) D_{t+j}\right]$, where the stock price S_t is the present value of expected future dividend D_{t+j} and the discount rate is represented by R.

2.2 Sensitivity of Bank Stocks to Interest Rate and Market

There are numerous studies that investigate the effect of interest rate movement on stock returns in terms of return and volatility at both individual and portfolio level, i.e. covering various industries including financial industry, varying periods of financial turmoil and ease, different geographical jurisdictions and considering different proxies for the short term and long term interest rates.

Consequent to liberalization measures in the financial markets around the world, banks faced market shocks related to volatility in interest rates and exchange rates. Due to inter-connectivity of financial markets especially in the developed world, the transmission of volatility from one market to another was found to be an imminent phenomenon. Financial crisis faced in relatively recent times like in 2008, the spillover across global markets (referred as ‘meteor shower’) was rapid and significant. The interconnectedness and interdependence of markets due to globalization is often referred as a boon for business growth but it has resulted at times in triggering a crisis that was not home grown. The severity could be judged from the fact that the financial meltdown triggered by sub-prime mortgage led to failure of some banks in global markets including United States.

Since 1980s, there has been a substantial increase in offshore equity investment. Being cross border, such investments are also exposed to volatility in the exchange rate in addition to interest rates (Kanas, 2000). Return and volatility spillover from one financial market to another drew lot of interest of researchers and portfolio managers. Hamao et al. (1990) studied first and second moment interdependencies in the three markets of New York, Tokyo and London using univariate GARCH (model is discussed later in the review). They found out that after the market crash in 1987, there was significant volatility spillover from New York to London, New York to Tokyo and London to Tokyo. Interestingly, no such spillover was found during the period before the market crash. In a later study, Lin et al. (1991) found that the mean and volatility spillover between markets is reciprocal.

Due to difference in time zones, the mean and volatility estimation of a financial market depends upon its own past information and as per the information generated by the last two markets to close (Koutmos and Booth, 1995).

In response to the interconnectedness of global financial markets, central banks particularly in the first world adopted policies in regulatory coordination with each other. This exposed the banks to external shocks transmitted from foreign economies. The ‘domino effect’ is more significant and notable in times of crisis and the world has witnessed the contagion effect well during Asian crisis of 1997 and market crash in 1987. Banks which are not able to pass on the economic shock to their clients are exposed to more volatility in their stock returns (Elyasiani and Mansur, 1998).

An interesting observation we come across in the literature is regarding the difference in reaction of macroeconomic variables like inflation and output to monetary policy as compared to financial markets. The former has a time lag in their reaction while the latter respond swiftly and adjust accordingly. This is the reason that financial assets are given more importance in understanding the effects of monetary policy as they tend to show a higher level of sensitivity (Grogoriou et al., 2009).

The sensitivity of stock returns to external shocks has remained an area of concern for investors, regulators, portfolio managers and researchers alike. Particularly effect of monetary policy has received more attention with respect to financial industry considering their typical asset and liability structure. The sensitivity of bank stocks return due to the changes in interest rate can be explained both theoretically and by using different models (Tunc et al, 2011). The debate on sensitivity of bank stock returns to monetary policy has remained inconclusive due to multiple reasons discussed later in the review. Besides, the direction of relationship is found to be positive as well as negative in the literature, primarily due to peculiar structure of respective markets and the time period considered in research i.e. crisis or smooth-sail period.

An additional debatable area found in research relates to anticipated and unanticipated effect of interest rate on stocks return. Effect of anticipated policy action on the stocks return is incorporated by investors in their investment decision (Bernanke and Kuttner 2005). The unanticipated changes however affect the stock returns. In an efficient market, anticipated changes in the interest rates are embedded in the stock price, while only the unanticipated changes in the economic factors could influence stock returns (Bae, 1990). Therefore it is important for investors to get an insight in to the relationship between the monetary policy and equity returns. Reaction of fixed return instruments, like corporate bonds to the unanticipated change in the policy rate is significant whereas bonds are non-responsive to the change in interest rate that is anticipated by market and does not have surprise in it (Kuttner, 2000).

As discussed above, the dissimilarities in various studies and the varying conclusions regarding the effect of interest rate on stocks return are due to multiple reasons. These include the differences in the estimation methods (Akella & Chen 1980), the period taken into account i.e. whether turmoil or smooth sailing time, frequency of data and cross sectional variation in the level of risk exposure taken by banks in the sample (Joseph & Vezos 2014).

Various studies on the subject provide mixed results on the direction of relationship between interest rates and the stock returns. Some studies have provided evidence for significant and negative relationship between interest rate and stocks return of banks (Flannery & James 1984;

Gali and Gambetti 2015, Mitchell 1989, Bae 1990, Fraser & Madura 2002). Whereas, in a well cited study of Bernanke and Gertler (1999) that covers the US stock market, statistical evidence has been provided confirming a positive relationship between stock market and interest rates. As Fama (1976) quotes, if changes in the term structure of the interest rates shows inflationary expectations, then stock returns and interest rate should be inversely related. Some studies also discuss the two way causality effect i.e. effect of stock market on the interest rates. For instance, if the markets are not performing well, there is an expectation that the central bank will provide an interest rate stimulus which leads to an uncertain monetary policy (Valera and Hassan, 2016).

A relevant observation is made by Grogoriou et al, 2009 that the response of stock market to interest rates is empirically observed to be opposite in times of financial ease versus in times of credit crunch. During the time when credit is ample, the relationship between interest rate and stock returns is negative. While in the time of credit shrinkage, the relationship becomes opposite and both interest rate and stock returns move in the same direction. If policy makers desire, they can use interest rate cut to stimulate growth in the stock market. However, as mentioned above, the strategy does not necessarily work, especially in times of credit crunch.

Whereas some studies have also raised an important question that interest rate is not solely responsible for the movement in stocks return and the sensitivity in banking stocks return is affected more due to the market movement than the interest rates (Chance & Lane, 1980). Kasman et al (2011) report that bank stocks return exhibits stronger sensitivity to market return as compared to volatility in interest rate and exchange rate. A study by Beirne et al (2009) has covered the financial markets of US, Japan and few European countries by taking into account commercial banks, insurance and other financial services providers. The results of the study suggest that volatility spillover from market is stronger than spillover from interest and exchange rate. These studies thus raised a puzzling observation that shocks like interest rate and exchange rate are *systematic* in nature and therefore priced for overall market and not only for bank stocks. Hence, some researchers have remarked that interest rates may affect stock returns through the market (Dinenis and Staikouras, 1998).

Another element that qualifies for a mention is the time varying nature of the relationship between interest rate and the stock returns. This is evidenced by considerable difference in the value of the parameters, while using proxies for the return and volatility to find effect on bank stocks over time (Chen and Chan, 1989).

We know that bank earnings depend upon conducive economic conditions involving demand for loans and level of interest payment on deposits. Mitchell (1989) has explained the sensitivity of bank stock returns to the changes in interest rate and has reported that banks show varying level of sensitivity to changes in interest rate, depending upon their size and maturity gap between their assets and liabilities. Large banks exhibit more flexibility in their asset/liability mix in response to interest rate (Bae, 1990). The difference in the duration (maturity) of assets and liabilities of a bank can be explained by the fact that an increase in interest rate may reduce the value of bank's earning assets, while there will be an increase in the return bank pays to its depositors (in sync with the interest rate hike), hence creating pressure on the bank's bottom line profitability, which will also depress the stock value.

The study further suggests that banks can significantly reduce their interest rate risk exposure by matching the maturities of assets and liabilities and reducing the duration gap between them. At the same time the study argued that large banks enjoy the ability of passing on the risk to its customers. Banks employ other strategies to mitigate interest rate risk by securitization of loans, reducing mismatch in assets and liabilities, increased off balance sheet activities and derivatives (Elyasiani & Mansur 1998).

Fraser and Madura (2002) have measured sensitivity to interest rates by dividing sample of banks into four distinct classes and using some *characteristic ratios* that serve as an effective measure to check sensitivity of a bank. These characteristic ratios included Equity ratio, Loan to Assets, Non-interest Income to Total Revenue and Demand deposits to Assets. It was empirically proven that sensitivity of stock returns is affected to a significant extent by financial characteristics of a bank. For instance, banks with higher equity ratio would be less sensitive to interest rate changes due to lower debt level. It has also been established that bank stock returns exhibit higher sensitivity to long term interest rate as compared to short term one. Besides interest rate sensitivity is more pronounced in volatile time period as compared to relative stability (Verma 2016, Dinenis & Staikouras 2010).

It is empirically established that banks experience higher profitability during periods of low interest rates, while their entity risk is lowered (Altavilla et al 2018). This study explains, an accommodative monetary policy that supports low interest rate reduces the credit default risk of bank clients and therefore positively impacts the provision requirement for non-performing loans for banks. The study however acknowledges that protracted low rates could depress Net Interest

Income (NII) of banks which is the difference between bank's interest income on assets and interest expense paid on deposits. Further, it is also found empirically that if interest rate forwards show an increase in future, stock returns will exhibit a declining trend (Booth and Dennis 1985).

A new phrase of '*franchise value'* was coined by Drechsler et al (2018) in their study of sensitivity of bank stock returns to interest rate changes. The study discusses a common strategy of commercial banks where they invest heavily in establishing wide and strategic branch network (franchise) in order to get access to public deposit. By establishing their franchise, banks acquire the ability to offer lower than market rate of return to their depositors, thus leveraging on their strong market presence. In this way banks are able to manage their sensitivity to interest rate movement and hedge their Net Interest Income. This study refers bank deposit as a swap transaction where banks swap their fixed operational cost with floating cost of deposit.

Tissaromatis (2003) proposed the idea of 'Duration of Stock' to measure the sensitivity of equities against interest rate movement. This term 'Duration' was introduced by Macaulay for bonds in 1938 which studied the effect of changes on yield over price of a bond. The same has been proposed by Tissaromatis in the study by defining duration as ratio of percentage change in price of stock to 1% change in expected equity return. The formula actually used was reciprocal of dividend yield. Thus sensitivity of stock returns to interest rate is a function of duration (length) of dividends, relation between interest rate and inflation and future growth in dividends. Some researchers however render the Duration concept not applicable to equities due to non-constant cashflow vis-à-vis fixed income securities (Reilly et al 2007).

In a study regarding impact of interest rate and exchange rate movement on US bank stocks returns, the author Priti Verma (2016) remarked that asymmetry exists in the relationship between bank stock returns and volatility transmission from interest rate and exchange rate. She took three sets of banks: Money Centre, Large and Medium size and concluded that the stock returns of all three classes showed more sensitivity to 'bad news' as compared to 'good news' with respect to changes in interest rate and exchange rate, thus reflecting an asymmetric behavior. This asymmetric response to market shocks first observed by Black (1976) is also referred as the 'leverage effect'.

Due to presence of leverage effect, volatility clustering and non-normality of financial time series (leptokurtic essentially), the literature recommends specific models for estimation in lieu of standard OLS based regression. Volatility clustering is explained as a phenomenon where large changes in prices are followed by similar large changes, while small changes in prices are followed by similar small changes. In the backdrop of risk - return paradox, the literature emphasizes that an accurate way of measuring market volatility leads way to determine asset price not only in the current market but predicting the future price as well.

As an alternate technique Engle (1982) introduced the concept of Autoregressive Conditional Heteroscedasticity (ARCH) that captures time varying dynamic variance through lagged disturbances. Time series models that assume constant variance are not suitable to measure stock return movements. ARCH type models allow conditional variance to change over time as a function of lagged disturbances, while keeping the unconditional variance constant (Najjar, 2016). ARCH models however had problem of number of parameters which was countered by Bollerselev (1986) by introducing Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model to reduce number of parameters to two and to allow for a longer memory. GARCH model takes into account lagged squared residuals as well as lagged variances. In this way, the model not only considers recent variances but also past shocks, hence accommodating well for volatility clustering. Both ARCH and GARCH models can capture volatility clustering and leptokurtosis. For this reason, these models are considered best in estimating volatility of financial markets (Najjar, 2016).

ARCH and GARCH models however are not able to capture the leverage effect i.e. asymmetric effect of bad news on volatility. To counter this, Nelson (1991) introduced an extended model, called Exponential Generalized Conditional Heteroscedasticity Model (EGARCH) to estimate asymmetric behavior of the conditional variance using log of the variance (Gokcan, 2000; Freedi et al, 2012).

An important extended model introduced by Engle et al. (1987) is GARCH in Mean or GARCH-M that allows conditional variance to be determinant of the mean. This would make the premium on stock as compensation to volatility (risk) time dependent. A substitute model that also measures the asymmetric behavior of volatility subject to good or bad news is called GJR GARCH, as proposed by Golsten et al. (1993). Some other popular GARCH models are Asymmetric Power GARCH by Ding et al (1993) and Threshold GARCH by Zokoian (1994). Subsequent empirical studies by Bekaert and Harvey (1997) and Taylor (1994) and Yosef et al. (2008) confirm the usefulness of GARCH type models in measuring volatility and asymmetric behavior. The best model these studies propose is GARCH (1, 1) denoting first lag of autoregressive element and the moving average. For forecasting stock market volatility, GARCH-M is found out to be the best (Rashid and Ahmad, 2008). Despite their utility, the results sometimes are not able to capture the stock returns due to peculiar nature of market behavior in different countries due to variation in macroeconomic variables. The same study of Rashid and Ahmad confirms that the relationship between stock returns and volatility transmitted form interest rate may be asymmetric and standard OLS estimation may not generate valid results. Instead the study advocates use of ARCH family of models.

GARCH models provide depth and variation to capture time varying correlation in addition to time varying variance. After globalization, financial markets have developed interconnectedness and they tend to exhibit correlation, especially in times of global crisis. Such co-movement of the financial markets is investigated through the type of GARCH models called Dynamic Conditional Correlation (DCC) and a variant Asymmetric Dynamic Conditional Correlation (ADCC). Gjika and Horvath (2013) carried out a research using ADCC to find out co-movement of stock markets three European countries. Since they considered the period of financial crisis, therefore considering more significant impact of the bad news, ADCC was the model of choice. They established in this study that the correlations between the markets increase with joint negative shock as compared to joint positive shock, besides the correlations increased over time, confirming the time varying nature of correlation.

2.3 Hypotheses of the Study

Hypothesis – I: There exists a return spillover from interest rate to bank stock returns of commercial banks listed on PSX

Hypothesis – II: There exists a volatility spillover from interest rate to bank stock returns of commercial banks listed on PSX

Hypothesis – III: There exists a return spillover from market to bank stock returns of commercial banks listed on PSX

Hypothesis – IV: There exists a volatility spillover from market to bank stock returns of commercial banks listed on PSX

Hypothesis – V: Sensitivity of banks to interest rate changes depends upon their respective size

Hypothesis – VI: The correlation between interest rate and bank stock returns is asymmetric in nature

Hypothesis – VII: There exists a time-varying correlation between interest rate and bank stock returns

Hypothesis – VIII: There exists an asymmetric time-varying correlation between interest rate and bank stock returns

3.0 Data Description, Research Methodology and Model Specifications

3.1 Data Description

Daily stock returns of 17 commercial banks listed on Pakistan Stock Exchange (PSX) have been taken into account for this study. Ten years period from 2010 – 2019 has been considered. Daily data series has been considered in view of the expected fast impact of interest rate on stock returns, which may not be visible in the longer tenor.

For interest rate, we have used daily quote of bid-price for Karachi Interbank Offered Rate (KIBOR) applicable for 3-months period as proxy for short term interest rate. KSE-100 index prices are used for the required market return. All this data is taken from a website www.khistocks.com owned by the financial newspaper Business Recorder.

Commercial banks are divided into three distinct groups in terms of their size. This is in accordance with the literature that indicates sensitivity of banks to interest as factor of their respective balance sheet size and asset / liability mix. Large banks differ significantly with the mid-tier and smaller banks in terms of the maturity profile of their assets and liabilities.

First portfolio comprises of five largest banks, referred as LG Banks (LGB) having minimum total asset size of PKR 1.4 trillion. Next is the group of mid-size banks referred as Second-tier banks (STB). Seven banks have been selected in this STB group. Last group has four smaller banks, referred as Third-tier banks (TTB). The three groups are mentioned in the Table - I below:

Table – 3.1: Three portfolios of commercial banks listed on Pakistan Stock Exchange; classified as per their size into Portfolios of Large Banks (LGB), Second-tier Banks (STB) and Third-tier Bank (TTB)

Large Banks (LGB)	**Second-tier Banks (STB)**	**Third-tier Banks (TTB)**
National Bank of Pakistan (NBP)	Askari Bank Ltd (AKBL)	Bank of Khyber (BOK)
Habib Bank Ltd (HBL)	Bank Alfalah Ltd (BAFL)	JS Bank Ltd (JSBL)
United Bank Ltd (UBL)	Bank AlHabib Ltd (BAHL)	Summit Bank Ltd (SBL)
Muslim Commercial Bank (MCB)	Bank of Punjab (BOP)	Soneri Bank Ltd (SNBL)
Allied Bank Ltd (ABL)	Meezan Bank Ltd (MEBL)	
	Habib Metropolitan Bank (HMB)	
	Standard Chartered Pakistan Bank Ltd (SCBPL)	
	Fayal Bank Ltd (FABL)	

3.2 Research Methodology

Most studies reveal that the effect of interest rate on stock returns is time varying and hence variance is not constant. Therefore, in order to study mean and volatility spillover of short term interest rate on the three selected portfolios of banking stocks, a combination of Autoregressive Conditional Heteroscedasticity (ARCH) and multivariate Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model, proposed by Bollerslev (1986) is used. GARCH model involves joint estimation of conditional mean and conditional variance equation.

The estimation assumes time dependent conditional variance, following the studies of Song (1994), Elyasiani and Mansur (1998) and Tai (2000). The process followed is discussed below:

a) First, GARCH (p, q) model is used to determine possible return and volatility spillover from interest rate to bank stock returns. The variant of model used here is GARCH-in-Mean (GARCH-M) which was used by Elyasiani and Mansur (1998) to estimate the compensation (risk premium) due to higher volatility. The same model will also be used to investigate spillover of mean and volatility from market to bank stock returns. For the effect of market, a stock market index serves the purpose;

b) Second, to verify whether the relationship between bank stock returns and interest rate is asymmetric or carries possible 'leverage effect' i.e. when negative innovations are more impactful as compared to positive innovations. To capture asymmetry, an extension of GARCH, Nelson's (1991) Exponential Generalized Autoregressive Conditional Heteroscedasticity, EGARCH model is used;

c) Thirdly, time varying correlation is measured through Dynamic Conditional Correlation DCC-GARCH and Asymmetric DCC (ADCC-GARCH) models.

This research envisages multiple time series since the hypotheses being tested include whether the first and second moments of bank stock returns are affected by changes in short term interest rates and market wide movement.

To begin with, the series at level of bank stock returns is required to be made stationary i.e. the mean, variance and autocorrelation should be constant and the series would show mean reversion behavior. To make the series stationary, log difference is taken of the successive returns, given as

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

Where R stands for daily stock return in time t;

P_t and P_{t-1} are closing values of stocks at time t and t-1.

Natural log ln is considered here.

Bank stock returns generally exhibit positive skewness and leptokurtosis, which means that the distribution of stock returns is not normal. Box Pierce test statistics confirm absence of homoscedasticity and presence of autocorrelation. Thus ARCH / GARCH type modeling can be used for estimation of time series.

3.2.1 Econometric Models

Some studies proposed the idea that bank stock return sensitivity to interest rate is time varying. Therefore the variance of return should not be considered as constant (Choi et al, 1992, Wetmore and Brick 1994, Mansur and Elyasiani, 2004). Song (1994) was the first one to demonstrate that ARCH type methodologies are suitable for bank stock returns analysis. This approach allows simultaneous modeling of bank stock returns, bank stock volatility and interest rate volatility in the same set of equations.

Engle (1982) proposed Autoregressive Conditional Heteroscedastic (ARCH) effect, where conditional variance is estimated as a quadratic function of lagged value of innovations. But ARCH required large number of parameters to capture the volatility process. To overcome this issue, Bollerslev (1986) proposed Generalized ARCH (GARCH) which reduces infinite parameters to two by imposing non-linear restrictions.

3.2.1.1 GARCH-M Model

GARCH-in-Mean (GARCH-M) model allows the conditional mean to depend on its own conditional variance. This means that if an investor agrees to take higher risk (variance), he will expect corresponding higher return.

Mansur and Elyasiani (1998) used GARCH-M to investigate effect of interest rate and its volatility on bank stock returns and found that changes in interest rate affect both mean and variance of bank stocks. GARCH-M is found to be a better model in GARCH family due to additional regressor, i.e. conditional standard deviation (Rashid and Ahmad, 2018).

Two equations are calculated simultaneously; one is return equation and the other is volatility equation. Therefore ARMA-GARCH-M (p, q) model is defined by the following set of equations:

$$y_t = \emptyset x_t + \gamma h_t + \varepsilon_t \qquad \ldots\ldots\ldots\ldots \quad (1)$$

$$h_t = \alpha_o + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \beta_i \, h_{t-i} \qquad \varepsilon_{j,t} \mid \theta_{t-1} \sim \mathrm{N}\,(0, h_t) \quad \ldots\ldots\ldots\ldots \quad (2)$$

Equation 1 defines the conditional mean, where y is the excess return or risk premium, x_t is the explanatory variable, ε_t represents random error, h_t stands for the conditional variance of the error termε_t. Parameters ϕ, α_0, α_i, γ and β_i are vectors with appropriate direction.

Equation 2 defines conditional variance where the variance h_t is linearly dependent on the past behavior of the squared errors and a moving average of the past conditional variances.

A major assumption of GARCH models is their symmetry, which means that the absolute value of innovation matters and not its sign, since the residual term is squared. This means, a positive shock may bring the same effect in volatility as a negative shock. But it is observed in real life that negative shocks (bad news) create more impact on volatility than the positive shock (good news).

GARCH models capture volatility clustering and leptokurtosis but they are unable to capture asymmetries since their distribution is symmetric. To capture asymmetry, non-linear extensions of GARCH serve the purpose like Exponential GARCH (EGARCH), Threshold GARCH or GJR and Asymmetric Power ARCH.

3.2.1.2 Exponential GARCH (EGARCH) Model

EGARCH model proposed by Nelson (1991) estimates the effect of interest rate changes on mean and conditional variance of bank stock returns. This model provides an insight into the non-linear relationship between the interest rate and bank stock returns. Bae and Karoyli (1994) reported that negative changes have larger impact on volatility than positive ones; i.e. the leverage effect is more pronounced.

EGARCH is the log form of the conditional variance that confirms that variance is non-negative. The model allows simultaneous study of transmission of positive or negative interest rate changes on stock returns. Thus EGARCH serves the following two objectives:

a) Examine impact of interest rate and its volatility on bank stock returns

b) Investigate whether interest rate has asymmetric effect on bank stock returns, i.e. the variance will react differently to good or bad news

EGARCH is generally specified by the conditional variance h_t as an asymmetric function of lagged disturbances ε_{t-i} as given below:

$$\ln(h_t) = \omega + \sum_{i=1}^{q} \alpha_i \ \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \gamma_j \ \ln(h_{t-j}) \qquad \ldots\ldots\ldots\ldots \qquad (3)$$

where $\varepsilon_t = \sigma_t z_t$ i.e. standardized residual

The sign of the parameter γ should be negative to confirm asymmetric behavior of volatility. Since above equation is based on log variance so it does not require any restrictions on parameters. Maximum Likelihood Estimate (MLE) of EGARCH is considered in estimation.

3.2.1.3 Time varying Conditional Correlations - DCC and ADCC GARCH

Dynamic Conditional Correlation model (DCC) introduced by Engle (2002) belongs to the class of multivariate GARCH model which is used to parameterize the time-varying conditional correlations directly. Other GARCH models assume correlation to be constant. DCC-GARCH is able to measure the effect of past shocks on conditional volatility and correlation, however it is not able to figure out effect of good or bad news (Cho and Pirhizgari, 2008). The extension Asymmetric Dynamic Conditional Correlation (ADCC), developed by Cappiello et al. (2006) is used to capture possible asymmetry in the series. Correlation between the returns of assets in a portfolio becomes the basis of developing a hedge against an untoward movement (Engle, 2002).

DCC and ADCC relates to a phenomenon referred as ‘time dependence’. This phenomenon is said to exist when the correlation between two variables increases as we move ahead in the tail. This could be witnessed in one or both distributions. DCC-GARCH gives higher tail dependence for both upper and tails of the multi period joint density while, ADCC gives higher tail dependence in the lower tail of the multi period density. DCC-GARCH is often referred as copulas that are used to describe inter-dependence of random variables and helpful in financial decisions with respect to volatility transmission. DCC-GARCH model estimates correlation coefficients of the standardized residuals and measures the heteroscedasticity directly (Chiang et al. 2015).

DCC-GARCH model provides a computational advantage that the number of parameters to be estimated in the correlation process is independent of the number of series to be correlated. This means that large correlation matrices can be estimated if required (Orskaug, 2009).

The DCC (p, q) model assumes that:

$$Q_t = \bar{R} + \sum_{i=1}^{p} \alpha_i \left(\vartheta_{t-1}\, \vartheta'_{t-1} - \bar{R}\right) + \sum_{j=1}^{q} \beta_j \left(Q_{t-1} - \bar{R}\right) \quad \text{……………..} \; (4)$$

Where Q_t depicts the correlation between returns at time t. $\bar{R}$ represents the matrix and ϑ states the conditional volatility.

The extension Asymmetric Dynamic Conditional Correlation (ADCC-GARCH) is defined through the following relationship;

σ_t = min (ε_t, 0), $\bar{N} = \frac{1}{T}\sum_{t=1}^{q}\sigma_t\, \sigma'_t$ …………….. (5)

Asymmetry can be introduced with terms that are zero except when both returns are negative such as; $\mu\sigma_{i,t}\sigma_{j,t}$ or generally averaging to zero i.e. G($\sigma_t\sigma'_t - \bar{N}$)

3.3 Data Diagnosis & Descriptive Statistics

To verify whether ARCH type models are suitable for estimation, it is important to verify certain properties of data including normality, skewness, kurtosis and white noise. Research tells us that the error term follow a normal distribution. These properties are tested through Lagrange Multiplier (LM) test. These properties of data with respect to the three groups of banks are discussed in the Tables below:

Table – 3.2: Descriptive Statistics of Large Banks (LGB)

	NBP	UBL	ABL	HBL	MCB
Mean	-0.000214	0.000426	0.000222	0.000103	-2.61E-05
Median	-0.000183	-4.05E-05	0.000000	-0.000440	-5.28E-05
Maximum	0.091721	0.078781	0.071826	0.083287	0.077811
Minimum	-0.364836	-0.116570	-0.150685	-0.146217	-0.122408
Std. Dev.	0.023083	0.018097	0.017825	0.018759	0.017760
Skewness	-4.166075	-0.169281	-0.564430	-0.536041	-0.322449
Kurtosis	61.15518	5.638266	9.738260	9.377318	7.177149
Jarque-Bera	356362.2	730.5010	4819.552	4317.868	1844.506
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	-0.529419	1.055197	0.551041	0.256289	-0.064781
Sum Sq. Dev.	1.319864	0.811196	0.787054	0.871687	0.781276
Observations	2478	2478	2478	2478	2478

Average mean return of five largest banks listed on PSX has remained in the range of minimum negative 0.021% (NBP) to 0.042% (UBL) over the period of ten years. Average change in return for the top five banks comes out to be 0.01%. Volatility in returns as reflected by standard deviation is constant for four large banks at 1.8%, while it is little higher at 2.3% for NBP. All these return series are negatively skewed to a mild level, with the exception of NBP where the data reflects high skewness. All these series are leptokurtic which is a typical feature for a financial time series. Non normality of distribution and excess kurtosis suggests that the appropriate framework to investigate return and risk of bank stocks is through ARCH type modeling (Elyasiani and Mansur, 2004).

Table – 3.3: Descriptive Statistics of Second-tier Banks (STB)

	AKBL	BAFL	BAHL	BOP	HMB	MEBL	SCBPL	FABL
Mean	-0.000155	0.000489	0.000341	-0.000214	5.95E-05	0.000730	0.000391	4.77E-05
Median	-0.001340	0.000000	0.000000	-0.002629	0.000000	0.000000	0.000000	-0.000696
Maximum	0.115775	0.095636	0.080244	0.177455	0.125331	0.105129	0.135341	0.103505
Minimum	-0.193599	-0.109470	-0.241852	-0.175633	-0.194349	-0.167054	-0.120336	-0.172966
Std. Dev.	0.021859	0.019423	0.017553	0.029388	0.020632	0.022347	0.026536	0.024362
Skewness	-0.103304	0.115212	-2.697586	0.351762	-0.814520	-0.274028	0.160035	-0.048453
Kurtosis	8.679332	5.270909	39.59541	6.810345	11.45520	7.069739	4.976202	6.915569
Jarque-Bera	3334.717	537.9450	141280.3	1550.162	7655.393	1741.119	413.8074	1583.966
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	-0.383725	1.212001	0.845858	-0.530680	0.147479	1.808351	0.969593	0.118227
Sum Sq. Dev.	1.183535	0.934459	0.763190	2.139259	1.054456	1.236953	1.744235	1.470167
Observations	2478	2478	2478	2478	2478	2478	2478	2478

With regards to Second-tier banks, we note that average change in the mean return over the ten years period ranged between negative 0.015% (AKBL) to 0.07% (MEBL). Askari Bank and Bank of Punjab are the only two banks in this tier with negative average change in mean return. Average change in return is 0.021%, which is nearly double the average change for top five banks. Volatility as shown by average Standard deviation comes out to be 2.27%, where Bank of

Punjab is showing highest volatility of 2.9% in its stock value, while Bank AlHabib has the lowest volatility of 1.75%. All the banks in this tier group show skewness in data in both right and left tail. Skewness is mostly in the mild range except Bank AlHabib and Habib Metropolitan which is on the higher side. Stock return series of all these commercial banks are leptokurtic which is in line with the typical structure of financial time series. Hence their distribution is non-normal.

Table – 3.4: Descriptive Statistics of Third-tier Banks (TTB)

	BOK	JSBL	SBL	SNBL
Mean	0.000375	1.33E-05	0.000397	-4.92E-05
Median	0.000000	0.000000	0.000000	0.000000
Maximum	0.204794	0.311128	0.520534	0.186412
Minimum	-0.216223	-0.170024	-0.231947	-0.161068
Std. Dev.	0.034496	0.038833	0.056070	0.027211
Skewness	0.200871	0.814106	0.714300	0.372042
Kurtosis	6.083770	8.107790	9.707331	7.811171
Jarque-Bera	998.5343	2967.466	4855.763	2447.131
Probability	0.000000	0.000000	0.000000	0.000000
Sum	0.929643	0.032917	0.983469	-0.121856
Sum Sq. Dev.	2.947634	3.735408	7.787343	1.834055
Observations	2478	2478	2478	2478

Average change in mean return in this tier of banks is 0.018% which is nearly in the same range as of second-tier banks. Summit Bank (SBL) has recorded the highest change in mean return i.e. 0.04% approx. Volatility in stock returns is considerably higher than the first two tiers of banks, recorded at 3.91%. Volatility appears to be in synchronization with the financial strength of the bank, as we observe it increasing as we move down the tier. All four banks in this tier exhibit skewness in the right tail. Stock returns data is highly skewed for JS Bank and Summit Bank. As expected, series are leptokurtic, thus confirming non-normality of data.

3.4 Model Specification

3.4.1 Return and Volatility Spillover – ARMA GARCH

3.4.1.1 Spillover from Interest rate to Bank stock returns

Two-stage GARCH (p, q)-in-Mean model is used to investigate mean and volatility spillover from interest rate to bank stock returns and from market to bank stock returns. GARCH-M uses a Heteroscedastic term in the mean equation to figure out effect of volatility on return. The underlying idea is the compensation of higher volatility through demand of premium on stock return.

The model works in two stages – in the first stage standardized error term and its square is determined from the regressor series (interest rate), which is then added in the mean and volatility equations of the series being regressed (stock returns).

In the first stage, return and conditional volatility equations for the Interest rate series are modeled as below:

$$r_{p,t} = \beta_0 + \beta_1 r_{p,t-1} + \beta_2 \vartheta_{p,t} + \beta_3 \varepsilon_{p,t-1} + \varepsilon_{p,t} \qquad \varepsilon_{p,t} \sim (0, \vartheta_{p,t}) \qquad \ldots\ldots\ldots\ldots\ldots \quad (6)$$

$$\vartheta_{p,t} = \gamma_0 + \gamma_1 \mu_{p,t-1}^2 + \gamma_2 \vartheta_{p,t-1} \qquad \ldots\ldots\ldots\ldots\ldots \quad (7)$$

Where $r_{p,t}$ denotes the return at time t, followed by an autoregressive term of the return i.e. $r_{p,t-1}$, $\vartheta_{p,t}$ represents the GARCH term which is added in the standard ARMA-GARCH model to remove serial correlation from the series, while $\varepsilon_{p,t}$ is the error term with iid distribution.

In the conditional variance equation, $\mu^2_{p,t-1}$ defines square of the standardized residual term (ARCH), while the effect of the lagged volatility $\vartheta_{p,t-1}$ is carried to the mean equation through GARCH term. This is important that the sum of coefficients for ARCH and GARCH term should be less than or equal to 1 for stability to hold.

Return and conditional volatility equations for the Stock return series are then modeled as:

$$r_{q,t} = \beta_0 + \beta_1 r_{q,t-1} + \beta_2 \vartheta_{q,t} + \beta_3 \varepsilon_{q,t-1} + \emptyset_q \varepsilon_{p,t} + \varepsilon_{q,t} \qquad \varepsilon_{q,t} \sim (0, \vartheta_{p,t}) \text{ ……… } \quad (8)$$

$$\vartheta_{q,t} = \gamma_0 + \gamma_1 \mu^2_{q,t-1} + \gamma_2 \gamma_{q,t-1} + \tau_q e^2_{p,t} \qquad \text{……….} \quad (9)$$

In the second stage, the standardized error term $\varepsilon_{p,t}$ which carries the return transmission effect of interest rate is used in the return equation of the bank stocks. Whereas, for the volatility transmission, square of the standardized error term $e^2_{p,t}$ = $\varepsilon^2_{p,t}$ / $\vartheta_{p,t}$ is included in the conditional volatility equation, where the denominator $\vartheta_{p,t}$indicates the GARCH term.

3.4.1.2 Spillover from Market to Bank stock returns

The two-stage approach used earlier will determine the model to capture mean and volatility spillover from Market to bank stock returns. First, market return will be modeled through ARMA-GARCH (1, 1) – M:

$$r_{m,t} = \beta_0 + \beta_1\, r_{m,t-1} + \beta_2\, \vartheta_{m,t} + \beta_3\, \varepsilon_{m,t-1} + \varepsilon_{m,t} \qquad \varepsilon_{m,t} \sim N\,(0, \vartheta_{m,t}) \quad \text{……… (10)}$$

$$\vartheta_{m,t} = \gamma_0 + \gamma_1 \mu^2_{m,t-1} + \gamma_2 \vartheta_{m,t-1} \quad \text{……… (11)}$$

Where $r_{m,t}$ represents daily closing value of stock index at time t, $\vartheta_{m,t}$ is the conditional variance and $\varepsilon_{m,t}$ is the residual. ARMA-GARCH structure is added in the model to address the issue of serial correlation in data.

In the second stage, the return and volatility transmission from the market is determined by finding the standardized residual term and using the same in the mean and conditional volatility equation of the Stock return series. The process is represented by the following set of equations:

$$r_{n,t} = \beta_0 + \beta_1 r_{n,t-1} + \beta_2 \vartheta_{n,t} + \beta_3 \varepsilon_{n,t-1} + \varphi_n . \varepsilon_{n,t} + \varepsilon_{n,t} \qquad \varepsilon_{n,t} \sim \text{N}(0, \vartheta_{n,t}) \qquad \text{........ (12)}$$

$$\vartheta_{n,t} = \gamma_0 + \gamma_1 \mu_{n,t-1}^2 + \gamma_2 \vartheta_{n,t-1} + \tau_n . e_{n,t}^2 \qquad \text{......... (13)}$$

To determine volatility transmission, square of the standardized residual $e_{n,t}^2$ is incorporate in the conditional volatility equation. This is defined by the relationship $e_{n,t}^2 = \varepsilon_{n,t}^2 / \vartheta_{n,t}$ where the denominator $\vartheta_{n,t}$is the GARCH term.

For volatility transmission, it is fundamental that the related series exhibits heteroscedasticity. Otherwise, standardized residual will not be available for regression of volatility spillover. The only regressor in such a case will be the one utilized for estimating mean spillover. In other words the term $e_{n,t}^2$ will not be available to incorporate in the volatility equation.

4.0 Results and Analysis

4.1 Stationarity of Series

Time series at level has trend, therefore they have to be made stationary i.e. the mean, variance and serial correlation of the series should be constant over time. Unit root test is applied to check whether the series is stationary. ARCH type models are appropriate when the series has serial correlation, which means volatility clustering is observed in the series, i.e. period of high volatility is followed by period of high volatility, while period of low volatility is followed by period of low volatility. Visual inspection shows mean reversion behavior of the time series. Unit root is removed through continuous compounding of returns and Augmented Dickey-Fuller (ADF) test shows significant statistics.

Detailed results of ADF are listed below:

Table – 3.5: Results of Augmented Dickey-Fuller Unit Root Test

H0: Series has a unit root
H1: Series is stationary

S.No.	Variable	P-value*		Decision
		At Level	1st Diff	
1	Interest rate	0.9352	0.0000	Series is stationary at 1st difference
2	Market (KSE 100)	0.7126	0.0000	Series is stationary at 1st difference
	Stock returns:			
	LGB Portfolio			
1	National Bank	0.2579	0.0001	Series is stationary at 1st difference
2	Habib Bank	0.4231	0.0001	Series is stationary at 1st difference
3	UBL	0.5139	0.0001	Series is stationary at 1st difference
4	MCB Bank	0.0605	0.0000	Series is stationary at 1st difference
5	Allied Bank	0.2823	0.0001	Series is stationary at 1st difference
	STB Portfolio			
1	Askari Bank	0.0513	0.0001	Series is stationary at 1st difference
2	Bank Alfalah	0.8055	0.0000	Series is stationary at 1st difference
3	Bank AlHabib	0.8088	0.0001	Series is stationary at 1st difference
4	Bank of Punjab	0.0082	0.0000	Series is stationary at 1st difference
5	Meezan Bank	0.9282	0.0000	Series is stationary at 1st difference
6	Habib Metro	0.4923	0.0001	Series is stationary at 1st difference
7	Standard Chartered	0.5498	0.0000	Series is stationary at 1st difference
8	Faysal Bank	0.3507	0.0001	Series is stationary at 1st difference
	TTB Portfolio			
1	Bank of Khyber	0.4827	0.0000	Series is stationary at 1st difference
2	JS Bank	0.3984	0.0000	Series is stationary at 1st difference
3	Summit Bank	0.5439	0.0000	Series is stationary at 1st difference
4	Soneri Bank	0.5343	0.0000	Series is stationary at 1st difference

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

Regarding visual inspection, the illustration in Fig (a) depicts series at level which appears trendy. But when the differencing is taken (return series) as depicted in Fig (b), the resultant series becomes stationary, showing mean reversion behavior.

Fig (a)

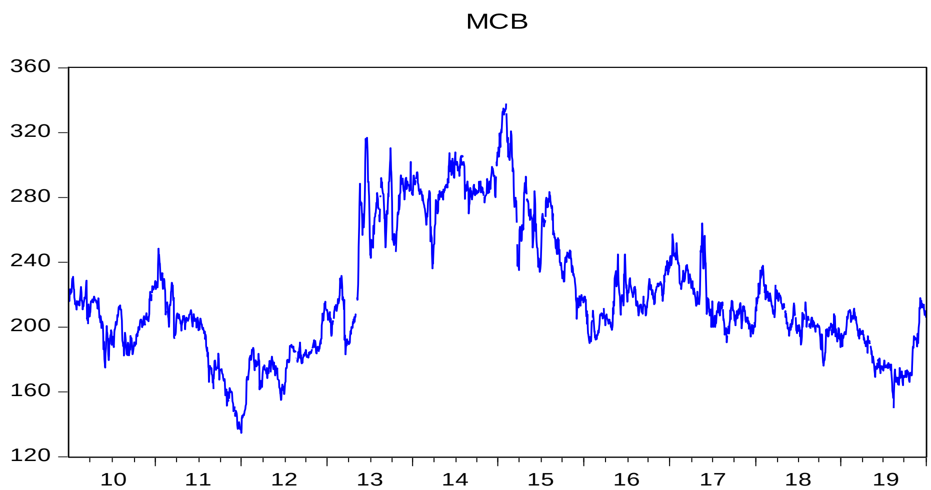
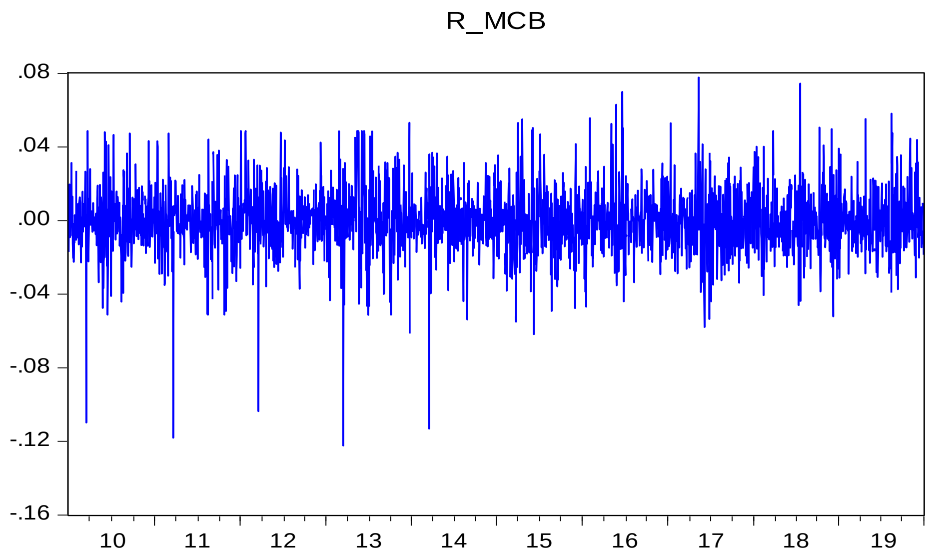


Fig (b)



In order to verify presence of serial correlation, two tests are applied on the below mentioned Autoregressive regression equation i.e. Q-Statistics and Breusch-Godfrey LM Test.

$R_t = \alpha + \beta.\text{INT} + \gamma.\text{MKT} + \delta.\ R_{t-1} + \varepsilon_t$

Where R_t represents the stock return at time t as a dependent variable, to be regressed by Interest rate (INT) and Market return (MKT) together with its own lag, R_{t-1}.

Both the above tests confirm presence of serial correlation in the autoregressive regression line as probability values come out to be significant at 5%. Thus in order to make the equation fit for hypothesis testing, it is important that the serial correlation effect is removed.

4.2 Sensitivity of Bank Stock returns to Interest Rate

Table – 4.1: Maximum Likelihood estimate for Mean and Volatility Spillover from Interest Rate to Stock returns of Large-size banks (LGB) applying ARMA–GARCH–M (1, 1)

	NBP	HBL	UBL	MCB	ABL
β0	-0.0003	-0.0018	-0.0002	-0.0011	0.0000
	(0.5493)	(0.1906)	(0.7862)	(0.4314)	(0.7999)
β1	-0.2238	0.0349	0.3476	0.235	0.5392
	(0.7127)	(0.9245)	(0.6896)	(0.8154)	(0.0860)
β2	n/a	5.151	1.252	3.5583	n/a
		(0.1894)	(0.6787)	(0.4450)	
β3	0.2561	0.0143	-0.3239	-0.2234	-0.6058
	(0.6736)	(0.9690)	(0.7098)	(0.8244)	(0.0543)
φ	0.0012	0.0006	0.0016	0.0015	0.0007
	(0.1374)	(0.1380)	(0.0001)	(0.0000)	(0.2831)
Volatility Parameters					
γo	n/a	0.0000	0.0000	0.0000	n/a
		(0.0000)	(0.0000)	(0.0000)	
γ1	n/a	0.0952	0.1457	0.1698	n/a
		(0.0000)	(0.0000)	(0.0000)	
γ2	n/a	0.7655	0.7581	0.6318	n/a
		(0.0000)	(0.0000)	(0.0000)	
τ	n/a	0.0000	0.0000	n/a	n/a
		(0.0000)	(0.2089)		

Beta0 is the coefficient for the constant; Beta1 represents coefficient for the ARCH term, Beta2 is the coefficient for the GARCH term, while Beta3 depicts coefficient for the standardized residual term. Mean spillover is represented by Phi, which is the regressor. Corresponding P-values are given in parenthesis.

Above results confirm that the LGB portfolio comprising of top five banks exhibit low sensitivity to changes in interest rate. As research confirms that sensitivity of banks to interest rate is largely dependent upon the nature and maturity profile of their assets and liabilities (Flannery and James, 1984). This means that higher the holding and longer the maturity of an asset or a liability position, higher will be the sensitivity of a bank to movement in interest rate.

Large size banks are string deposit franchises and have access to low cost deposits. A large portion of deposit comprises of current accounts that do not attract any interest expense for the bank. Hence we observe in the results that three of the five banks do not show significant value of coefficient Phi. The two banks, UBL and MCB though show a significant but weak effect. This is also possible due to mismatch between the assets and liabilities of these two banks which has added to their sensitivity to interest rate movement.

Since largely, banks in this portfolio are not affected by changes in interest rate, they are able to pass on adverse effect to their clients and stay hedged. This means they are able to lower their return offered on deposits immediately if the market interest rate drops. Likewise in case of tighter monetary regime, these banks possess the ability of raising rate of return on their assets as quickly as possible. Thus exhibiting strong negotiation ability with their clients on both assets and liabilities side. As Drechsler (2018) put it, large deposit franchise banks are able to protect their Net Interest Income (NII).

Besides, the above results also reflect that stock returns of these banks do not carry effect from past values (beta1) and past shock of residuals (beta3).

The interest rate series has not shown heteroscedasticity, therefore there is no volatility regressor available. Conditional volatility equation is shown as a support to the mean equation, otherwise its significance does not hold. Consequently, mean spillover is used as the only regressor for the stock return series. Stock return series of NBP and ABL are homoscedastic and therefore do not respond to GARCH model and there are no volatility parameters including GARCH coefficient.

Table – 4.2: Maximum Likelihood estimate for Mean and Volatility Spillover from Interest Rate to Stock returns of Second-tier Banks (STB) applying ARMA–GARCH–M (1, 1)

	AKBL	BAFL	BAHL*	BOP	HMB	MEBL	SCBPL	FABL
β0	0.0029	0.0001	0.0000	-0.0042	0.0016	-0.0006	0.0000	-0.0032
	(0.2261)	(0.9256)	(0.8488)	(0.0181)	(0.7703)	(0.6072)	(0.9542)	(0.0516)
β1	-3.0094	0.7169	0.6539	-2.7578	-0.0032	0.0867	0.1704	0.3818
	(0.3558)	(0.1244)	(0.5257)	(0.0189)	(0.9899)	(0.3037)	(0.0294)	(0.1107)
β2	-5.3248	0.0429	n/a	4.6049	-2.5028	1.4081	0.4217	5.4082
	(0.2450)	(0.9917)		(0.0202)	(0.7634)	(0.5963)	(0.8262)	(0.0658)
β3	3.0151	-0.763	-0.6764	2.7699	-0.0882	-0.368	-0.4779	-0.4554
	(0.3550)	(0.1007)	(0.5116)	(0.0184)	(0.7251)	(0.0000)	(0.0000)	(0.0557)
φ	0.0022	0.0015	0.0011	0.0034	-0.0004	0.0011	0.0011	-0.0003
	(0.0361)	(0.0231)	(0.0467)	(0.3301)	(0.6843)	(0.0297)	(0.1320)	(0.1191)
Volatility parameters								
γo	0.0000	0.0000	n/a	0.0000	0.0003	0.0002	0.0000	0.0003
	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
γ1	0.0593	0.0657	n/a	0.131	0.0458	0.2367	0.1092	0.2112
	(0.0000)	(0.0000)		(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)
γ2	0.9059	0.839	n/a	0.7821	0.4953	0.4109	0.8323	0.2489
	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
τ	0.0000	0.0000	n/a	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.0014)	(0.3275)		(0.0001)	(0.0007)	(0.0082)	(0.5011)	(0.0008)

*Beta0 is the coefficient for the constant; Beta1 represents coefficient for the ARCH term, Beta2 is the coefficient for the GARCH term, while Beta3 depicts coefficient for the standardized residual term. Mean spillover is represented by Phi, which is the only regressor. Corresponding P-values are given in parenthesis. *Stock return series for Bank AlHabib (BAHL) shows a homoscedastic structure, hence does not yield to ARCH type models.*

Banks comprising the STB portfolio are large franchises having country wide presence of branch network. They are savvy and efficient in terms of product mix and technology. Market considers these banks more responsive to macroeconomic challenges including monetary policy, as compared to banks in LGB portfolio.

Above Table shows varying behavior of banks in the STB portfolio. Two banks, Bank of Punjab (BOP) and Standard Chartered (SCBPL) have significant values for coefficient beta1, reflecting dependence of their stock returns on their past values. BOP is majority held by Government of Punjab and under performs in the respective tier of banks, despite having access to reasonable captive business from the provincial government. Dependence of stock returns on past values is an evidence of investor’s viewpoint with respect to performance of this government owned bank. For SCBPL, we can attribute significant beta1 to low level of free float i.e. 5.0%, which may subdue liquidity and return of the stock. BOP also registers positive and significant effect of GARCH coefficient beta2, which means that returns can be determined from forecasted volatility.

Besides, coefficient of standardized residual error term is showing significant effect for three out of eight banks in the portfolio. This exhibits sensitivity of stock returns to past shocks. Two banks remain the same, BOP and SCBPL, while an additional bank that makes to the list is Meezan (MEBL). Meezan being a bank offering Shariah-compliant products have peculiar nature of asset side where re-pricing is not possible in case interest rate takes a hike. Maturity profile and nature of asset holds importance to determine sensitivity of a financial institution to interest rate changes (Mitchell, 1989). The direction of correlation to past shocks is inverse with the exception of BOP.

Regarding return spillover from interest rate, four banks i.e. Askari Bank (AKBL), Bank Alfalah (BAFL), Bank AlHabib (BAHL) and Meezan Bank (MEBL) exhibit sensitivity. Since the direction of relationship is positive, we can infer that these banks are able to align themselves quickly with any change in monetary policy and use the change to their advantage. As discussed earlier, banks are able to hedge themselves by passing on the adverse effect to their clients, thus utilizing their franchise power (Dreschsler et al. 2018).

On the contrary, banks like BOP and HMB that are not showing sensitivity to interest rate, typically have a deposit mix where either the proportion of cost-free deposit is considerably high or they are able to quickly alter the offered return. Quick adaptation is possible in situation where a bank is holding more short term deposits than longer term ones (Elyasiani and Mansur, 1998; Bae 1990). For instance, BOP is owned by Provincial Government and has access to certain big-ticket government deposits which are captive and do not carry considerable cost for the Bank. Such deposits reduce the sensitivity to change in interest rate for a bank.

Table – 4.3: Maximum Likelihood estimate for Mean and Volatility Spillover from Interest Rate to Stock returns of Third-tier banks (TTB) applying ARMA–GARCH–M (1, 1)

	BOK	JSBL	SBL	SNBL
β0	-0.0008	-0.0014	-0.0022	-0.0015
	(0.6261)	(0.3926)	(0.2443)	(0.1614)
β1	-0.0323	0.2302	0.0376	0.0085
	(0.6177)	(0.0252)	(0.6013)	(0.9349)
β2	0.8316	0.7945	0.9883	1.8935
	(0.5911)	(0.5100)	(0.1966)	(0.2699)
β3	-0.3498	-0.4809	-0.3909	-0.2416
	(0.0000)	(0.0000)	(0.0000)	(0.0241)
φ	-0.0002	-0.0008	0.0000	-0.0003
	(0.8094)	(0.4008)	(0.9941)	(0.6549)
Volatility parameters				
γo	0.0001	0.0002	0.0001	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
γ1	0.1232	0.1719	0.095	0.093
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
γ2	0.7472	0.6787	0.873	0.8579
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
τ	0.0000	0.0000	0.0000	0.0000
	(0.1638)	(0.0000)	(0.0012)	(0.0000)

Beta0 is the coefficient for the constant; Beta1 represents coefficient for the ARCH term, Beta2 is the coefficient for the GARCH term, while Beta3 depicts coefficient for the standardized residual term. Mean spillover is represented by Phi, which is the only regressor. Corresponding P-values are given in parenthesis.

Portfolio of Third-tier banks shows that banks are sensitive to past shocks, as coefficient beta3 for standardized residual error shows significant values. a peculiar behavior in response to changes in interest rates. This sensitivity is expected of relatively smaller institutions as they struggle to handle shocks related to macroeconomic factors or any other crisis affecting the markets. Besides, JS is one of the banks in portfolio whose stock show dependence on its own past values through significant beta1 for ARCH term. This is attributable to lower expected performance of the Bank, which may have fallen short to boost its stock return.

Result for mean spillover from interest rate to stock returns for TTB portfolio comes out to be insignificant. This is due to the business strategy of smaller banks who usually stay away from booking long term assets and concentrate instead on extending short term working capital or trade loans. Their deposit mix also matches the strategy and they are able to reprice their return on deposit whenever there is a drop in interest rate. Hence effectively passing the asynchronous movement to its depositors and hedging their net interest income. This strategy adopted by banks in the TTB portfolio is in line with the research that by eliminating duration gap between assets and liabilities of a bank, its sensitivity to interest rate can be reduced effectively (Dinenis and Staikouras, 2010).

We have used Durbin-Watson (DW) test to verify the suitability of the aforementioned ARCH models. We have found that that the results of DW test have remained in the acceptable range of 1.9 – 2.1, (ref: www.eviews/time series regression/testing for serial correlation) indicating absence of autocorrelation in the residuals.

4.3 Investigating Asymmetry in behavior of Time series using Exponential Generalized Autoregressive Heteroscedastic (EGARCH) Model

Table – 4.4: Maximum Likelihood estimate for Mean and Volatility Spillover from Interest Rate to Stock returns of Large Banks (LGB) portfolio using EGARCH (1, 1) model

	NBP*	HBL	UBL	MCB	ABL*
C		0.0000	0.0002	-0.0003	
		(0.9185)	(0.6575)	(0.2910)	
β1		0.2209	0.3337	0.9483	
		(0.4558)	(0.6468)	(0.1268)	
β2		-0.1693	-0.3147	-0.9394	
		(0.5664)	(0.6656)	(0.1307)	
θ		0.0011	0.0017	0.001	
		(0.0114)	(0.0001)	(0.0024)	
Volatility parameters					
C5		-1.06	-1.1542	-1.8282	
		(0.0000)	(0.0000)	(0.0000)	
C6		0.1714	0.2836	0.306	
		(0.0000)	(0.0000)	(0.0000)	
C7		0.0116	0.0148	-0.0132	
		(0.3315)	(0.2564)	(0.3777)	
C8		0.8829	0.8835	0.8025	
		(0.0000)	(0.0000)	(0.0000)	

P-values are mentioned in parenthesis. Values for volatility parameters are mentioned for support, since Interest rate series is found to be homoscedastic. Therefore, θ, the mean spillover is taken as substitute for the volatility regressor. EGARCH term C7 shows a negative sign if asymmetry exists in the relationship and leverage effect is found. NBP and ABL stock return series show homoscedastic structure, hence ARCH type modelling is not suitable.

As discussed in the literature earlier, Exponential GARCH model has been used to investigate possible asymmetric relationship between interest rate and bank stock returns in various studies. Asymmetric relationship may cause varying behavior of stock returns to good or bad news (Verma, 2016). Results confirms mean return spillover from interest rate to stocks returns of the three banks: HBL, UBL and MCB in the portfolio. The other two banks, NBP and UBL do not yield to ARCH models due to lack of heteroscedasticity. Being large banks with access to low cost deposit and a well matched maturities of assets and liabilities, they are able to take advantage of movement in interest rates as reflected by positive direction of the coefficient theta. As narrated by Elyasiani and Mansur (2004), when interest rate rises, the lending rate adjust quicker than the deposit rates; while when interest rates fall, the deposit rates adjust quicker than the lending rates.

Building on the above argument, large banks have the ability to leverage their position when a tight monetary policy regime comes into play. They are quick to respond to an increase in interest rate by increasing price on their asset portfolio. On the contrary, rate of return on deposit is enhanced with a time lag and comparatively with a lower increment.

Due to homoscedastic nature of interest rate series, C7, i.e. the EGARCH parameter that may reflect asymmetric relationship between interest rate and stock return does not add any value to the results. Besides, no significant values are found for the coefficients of ARCH effect (beta1) and GARCH term (beta2).

Table – 4.5: Maximum Likelihood estimate for Mean and Volatility Spillover from Interest Rate to Stock returns of Second-tier Banks (STB) using EGARCH (1, 1) model

	AKBL	BAFL	BAHL*	BOP	HMB	MEBL	SCBPL	FABL
C	0.0000	0.0000		-0.0004	0.0003	0.0006	0.0008	-0.0005
	(0.8541)	(0.8408)		(0.5183)	(0.3916)	(0.1112)	(0.0772)	(0.2379)
β1	0.5493	0.7092		-0.5703	-0.0445	0.0891	0.1772	0.3866
	(0.7559)	(0.1230)		(0.4803)	(0.8086)	(0.2526)	(0.0230)	(0.0627)
β2	-0.5384	-0.7576		0.5861	-0.0762	-0.3802	-0.4857	-0.698
	(0.7607)	(0.0985)		(0.4681)	(0.6794)	(0.0000)	(0.0000)	(0.0231)
θ	0.0023	0.0016		0.0014	-0.0006	0.001	0.001	0.001
	(0.0211)	(0.0119)		(0.1213)	(0.1687)	(0.0058)	(0.2064)	(0.2195)
Volatility Parameters								
C5	-0.4897	-1.0779		-1.337	-3.8815	-2.9945	-0.8024	-0.8629
	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
C6	0.1372	0.1718		0.3302	0.3903	0.3517	0.2278	0.1763
	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
C7	-0.0279	-0.0283		-0.0071	0.0042	0.1899	0.0127	0.0065
	(0.0014)	(0.0106)		(0.5305)	(0.8060)	(0.0000)	(0.2771)	(0.5229)
C8	0.9489	0.8798		0.8467	0.5396	0.6476	0.9139	0.9014
	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

P-values are mentioned in parenthesis. Beta1 reflects effect of ARCH term, while Beta2 mentions effect of Standardized residual term. Values for volatility parameters are mentioned for support, since Interest rate series is found to be homoscedastic. Therefore,θ, the mean spillover is taken as substitute for the volatility regressor. EGARCH term C7 shows a negative sign if asymmetry exists in the relationship and leverage effect is found.

The banks included in the STB portfolio have strong country-wide presence and they usually mirror the performance of large banks. Stocks of three banks in the portfolio exhibit sensitivity to past shocks through significant values of beta2 coefficient. These banks are Standard Chartered (SCBPL), Meezan (MEBL) and Faysal Bank (FABL). The reason for SCBPL is its low percentage of free float i.e. 5.0% that may not be sufficient enough to gauge Bank's performance or its sensitivity to shocks through stock return behavior alone. The other two banks have large Islamic finance portfolios that render them more susceptible to shocks more than their conventional counterparts (Zainol and Kassim, 2010).

Only three of the eight banks in this portfolio; i.e. Askari (AKBL), Bank Alfalah (BAF) and Meezan (MEBL) are showing significant coefficient values of theta, the mean spillover from interest rate. Stock returns of these banks exhibit sensitivity to interest rate changes in this EGARCH model. The reason for the sensitivity of AKBL and BAF can be contributed to the maturity profile of the assets and liabilities of these banks. However, MEBL have its own peculiar reason being an Islamic bank as discussed in the earlier paragraph. Most banks in STB portfolio reflect resilience as they are able to utilize their franchise power to hedge their NII and pass on the adverse effect of interest change to their clients.

Table – 4.6: Maximum Likelihood estimate for Mean and Volatility Spillover from Interest Rate to Stock returns of Third-tier Banks (TTB) using EGARCH (1, 1) model

	BOK	JSBL	SBL	SNBL
C	0.0004	-0.0003	-0.0021	-0.0006
	(0.5210)	(0.6817)	(0.0097)	(0.2157)
β1	-0.037	0.2267	0.1166	0.0030
	(0.5475)	(0.0175)	(0.1061)	(0.9770)
β2	-0.3508	-0.4754	-0.4766	-0.2507
	(0.0000)	(0.0000)	(0.0000)	(0.0187)
θ	-0.0006	0.0021	0.0000	-0.0005
	(0.5764)	(0.0415)	(0.9791)	(0.5940)
C5	-1.4677	-1.078	-0.5217	-2.0314
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
C6	0.239	0.2931	0.2153	0.4033
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
C7	0.0369	0.0438	-0.0085	0.0334
	(0.0062)	(0.0000)	(0.2716)	(0.0081)
C8	0.8125	0.8698	0.0729	0.7616
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

P-values are mentioned in parenthesis. Values for volatility parameters are mentioned for support, since Interest rate series is found to be homoscedastic. Therefore,θ, the mean spillover is taken as substitute for the volatility regressor. EGARCH term C7 shows a negative sign if asymmetry exists in the relationship and leverage effect is found.

Third-tier banks (TTB) portfolio is exhibiting significant dependence upon past shocks in totality, as reflected by values of coefficient beta2. All four banks are showing negative and significant effect to the lagged error terms. All four banks are showing negative and significant effect to the lagged error terms. Sensitivity of banks in the portfolio to economic shocks is understandable due to their relatively weaker footing. Banks are likely absorb an economic shock if they are unable to pass it on to their customers (Elyasiani and Mansur, 2003).

Stock returns of JS Bank are showing dependency on own past values (beta1) in addition to lagged error term, thus indicating inadequate financial performance of the Bank. Stock return of the Bank is not reflective of its recent financial performance and carries the lag.

It is remarkable to note that TTB portfolio is not showing sensitivity to interest rate, with one exception of JSBL. Despite their high cost deposit and comparatively riskier asset portfolio, they are able to manage the maturities of their assets and liabilities in a manner that they are able to effectively reduce the duration gap and thus reduce their sensitivity to changes in the monetary policy.

Table – 4.7: Derbin-Watson and Akaike Information Criterion (AIC) for Mean and Volatility spillover from Interest rate to Bank Stock returns

GARCH-M	Durbin-Watson	AIC	EGARCH	Durbin-Watson	AIC
NBP	2.000	-4.699	NBP	n/a	
HBL	2.000	-5.168	HBL	2.024	-5.177
UBL	2.000	-5.259	UBL	2.000	-5.263
MCB	1.965	-5.286	MCB	1.969	-5.288
ABL	1.999	-5.219	ABL	n/a	
AKBL	1.925	-4.857	AKBL	1.934	-4.856
BAFL	1.985	-5.075	BAFL	1.981	-5.079
BAHL	1.999	-5.252	BAHL	n/a	
SCBPL	1.910	-4.559	SCBPL	1.907	-4.561
MEBL	1.942	-4.883	MEBL	1.925	-4.919
HMB	1.984	-4.863	HMB	1.922	-5.005
FABL	1.913	-4.640	FABL	1.904	-4.640
BOP	1.924	-4.358	BOP	1.924	-4.358
BOK	1.908	-4.085	BOK	1.893	-4.072
JSBL	1.864	-3.817	JSBL	1.855	-3.821
SBL	1.992	-3.190	SBL	1.974	-3.154
SNBL	1.945	-4.518	SNBL	1.909	-4.511

DW results confirm a good fit as values remain between the range of 1.9 – 2.1. For the tiers of large banks and second-tier banks, GARCH-M shows lower AIC values as compared to EGARCH, reflecting better fitness for GARCH-M. Whereas, for the Third-tier banks portfolio, EGARCH shows lower value of AIC confirming better fitness for the asymmetric model.

4.4 Mean and Volatility spillover from Market to Bank Stock returns

Table – 4.8: Maximum Likelihood estimate for Mean and Volatility Spillover from Market return (KSE 100) to Stock returns of Large banks (LGB) applying ARMA-GARCH-M

	NBP*	HBL	UBL	MCB	ABL*
β0	-0.0003	-0.0004	0.0007	0.0005	0.0002
	(0.5589)	(0.5686)	(0.3456)	(0.6614)	(0.5869)
β1	-0.2135	0.2838	0.5753	1.06	0.5314
	(0.7254)	(0.4334)	(0.4894)	(0.2158)	(0.0892)
β2	n/a	1.0764	-1.7023	-2.024	n/a
		(0.6032)	(0.5245)	(0.5947)	
β3	0.2464	-0.224	-0.5528	-1.0537	-0.5977
	(0.6854)	(0.5354)	(0.5067)	(0.2189)	(0.0565)
φ	0.0000	0.0013	0.0011	0.0004	0.0018
	(0.8838)	(0.0002)	(0.0041)	(0.2855)	(0.0000)
Volatility parameters					
γo	n/a	0.0000	0.0000	0.0000	n/a
		(0.1583)	(0.1062)	(0.0000)	
γ1	n/a	0.1868	0.1133	0.1217	n/a
		(0.0000)	(0.0000)	(0.0000)	
γ2	n/a	0.6966	0.8105	0.7056	n/a
		(0.0000)	(0.0000)	(0.0000)	
τ	n/a	0.0000	0.0000	0.0000	n/a
		(0.0000)	(0.0000)	(0.0000)	

P-values are mentioned in parenthesis. The parameters ∅ and τ represent mean and volatility spillover from market (KSE 100 index) respectively.

**NBP and ABL are homoscedastic series therefore do not yield to conditional volatility equation.*

While investigating effects of market wide movement on bank stock returns, it is found that with the exception of NBP and MCB, the portfolio comprising of large banks exhibits sensitivity to market movements captured through PSX stock index – KSE 100. In a previous study by Kasman et al. (2011) covering Turkish stock market, there was an identical observation that market return plays an important role in determining conditional return of bank stocks.

Banking sector in Pakistan enjoys one of the highest market capitalization at PSX and the sectoral share is also among one of the highest (23% approx). For this reason, the banking sector represented by large banks show responsiveness to market changes.

Regarding the exceptions, a plausible explanation is NBP's role as a banking agent on behalf of Government of Pakistan. The role provides exclusivity to NBP for large size Government owned deposits and fee related business. This reduces sensitivity of Bank to market related changes. Likewise, MCB ranks among top five banking institutions in Pakistan that has one of the highest share of zero-interest deposits (current accounts) and other inherent strengths stemming from large shareholding of a foreign investor and exceptional performance. These factors effectively insulate it from market changes, consequently Bank's stock maintains a low volatility.

Additionally, stock returns of LGB portfolio are neither affected by their own previous values, nor GARCH term and lagged error terms.

Results for volatility transmission reflect that volatility is dependent on its past values as well as shocks indicated by significant coefficient value of GARCH term. The three banks in LGB portfolio, HBL, UBL and MCB show significant and positive relationship with the market volatility, though the values of volatility coefficient τ are low, indicating weak sensitivity. Stock returns of NBP and ABL are not showing heteroscedasticity, therefore do not yield to conditional volatility equation.

Table – 4.9: Maximum Likelihood estimate for Mean and Volatility Spillover from Market return (KSE 100) to Stock returns of Second-tier Banks (STB) applying ARMA-GARCH-M

	AKBL	BAFL	BAHL	BOP	HMB	MEBL	SCBPL	FABL
β0	0.002	0.0019	0.0002	-0.0005	0.0012	0.0004	0.0005	0.0005
	(0.5874)	(0.0986)	(0.7335)	(0.7534)	(0.1400)	(0.7346)	(0.6214)	(0.7380)
β1	-0.622	0.6861	0.6538	-1.0207	-0.0074	0.0646	0.157	0.3845
	(0.8403)	(0.1378)	(0.5253)	(0.3307)	(0.9690)	(0.4578)	(0.0394)	(0.1306)
β2	-2.4848	-4.6626	n/a	0.1293	-2.0963	-0.3033	-0.1763	-0.9918
	(0.5660)	(0.1529)		(0.9408)	(0.3173)	(0.8995)	(0.9188)	(0.7007)
β3	0.6661	-0.7364	-0.6774	1.0393	-0.1277	-0.3368	-0.4613	-0.4658
	(0.8292)	(0.1106)	(0.5106)	(0.3219)	(0.5067)	(0.0001)	(0.0000)	(0.0651)
φ	0.0015	0.0014	0.0011	-0.0002	0.0014	0.0009	0.0018	0.0011
	(0.0211)	(0.0007)	(0.0021)	(0.7157)	(0.0009)	(0.0353)	(0.0003)	(0.0318)
Volatility parameters								
γo	0.0004	0.0000	n/a	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0145)		(0.6184)	(0.0000)	(0.0000)	(0.1289)	(0.0514)
γ1	0.0984	0.0574	n/a	0.0864	0.2299	0.1474	0.1049	0.0618
	(0.0003)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
γ2	0.5413	0.8632	n/a	0.8617	0.4634	0.6678	0.8629	0.8667
	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
τ	(0.0000)	0.0000	n/a	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

P-values are mentioned in parenthesis. The parameters ∅ and τ represent mean and volatility spillover from market (KSE 100 index) respectively.

Standard Chartered is the only bank whose stock return shows dependence on its previous values. As discussed in earlier results, this is primarily due to low free float of the Bank that deprives stock return as a reliable proxy to measure performance of the Bank. Whereas Meezan Bank (MEBL) shows significant value for coefficient beta3 alongwith SCBPL. In the case of MEBL, as mentioned earlier, the peculiar nature of Islamic banking assets make the Institution more susceptible to economic shocks. Besides, the entire STB portfolio does not show any effect of the GARCH term in the stock returns.

Results indicate that the whole STB portfolio with the exception of BOP registers market return spillover. The direction relationship is positive that means that any uptick in the market contributes towards the stock returns of banks included in the STB portfolio. This is in line with multiple studies that render market movement to have more pronounced impact on bank stock returns than any single macroeconomic factor (Chance and Lane, 1980). Exemption of BOP is due to its ownership of Provincial Government of Punjab that provides the Bank sizeable captive business opportunities from the Government projects. This exclusivity provides an inherent strength to BOP to withstand adverse market movements.

Further, volatility parameters exhibit positive significance to both ARCH and GARCH terms, showing strong correlation to past values. This observation is across the entire STB portfolio depicting identical behavior of banks and confirms that current volatility can be forecasted by using past stock returns behavior. Significant GARCH term reflected by γ_2 registers persistence of volatility. Volatility spillover from market is established for the portfolio though values are weak for the coefficient τ are low.

Banks in general in STB tier exhibit resilience and they are able to use market movement to their benefit. Their business models are built to sustain any asynchronous development and even if they are caught in an adverse development, they are quick to hedge their bottom line.

Table – 4.10: Maximum Likelihood estimate for Mean and Volatility Spillover from Market return (KSE 100) to Bank Stock returns of Third-tier banks (TTB) applying ARMA-GARCH-M

	BOK	**JSBL**	**SBL**	**SNBL**
β0	0.0003	-0.0007	-0.0021	-0.0083
	(0.8312)	(0.6817)	(0.2619)	(0.1233)
β1	-0.0401	0.2242	0.0386	0.0571
	(0.5333)	(0.0230)	(0.5907)	(0.7496)
β2	-0.2097	0.3479	0.973	5.9324
	(0.8887)	(0.7833)	(0.2098)	(0.1318)
β3	-0.3408	-0.4676	-0.3886	-0.2667
	(0.0000)	(0.0000)	(0.0000)	(0.1451)
φ	0.0000	0.0022	0.0000	-0.0001
	(0.9154)	(0.0026)	(0.9671)	(0.8950)
Volatility parameters				
γo	0.0001	0.0000	0.0000	0.0006
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
γ1	0.1188	0.1054	0.0900	0.1115
	(0.0000)	(0.0000)	(0.0000)	(0.0003)
γ2	0.7571	0.822	0.8811	0.5481
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
τ	0.0000	0.0000	0.0000	(0.0000)
	(0.0000)	(0.0000)	(0.1012)	(0.0000)

P-values are mentioned in parenthesis. The parameters ∅ and τ represent mean and volatility spillover from market (KSE 100 index) respectively.

The TTB portfolio shows that JS Bank is the only one whose stock returns are impacted by own previous values, showing weakness in financial performance. With the exception of Soneri Bank (SNBL) which has an old market presence, the portfolio of third-tier banks reflects significant dependence on lagged residuals. This means that stock returns of these smaller banks carry impact of past shocks. SNBL due to its franchise value and strong ownership structure, created over the last 25 years or so, has relatively sound footing in market and has been able to post healthy financial results all these years.

JS Bank stands out as an exception with respect to return spillover from the market. It shows significant and positive relationship, while the other banks in the portfolio do not register any impact of the mean return from market.

Conditional volatility equation generates significant values for the coefficients for the TTB portfolio. Significant and positive $\gamma_1$indicates that volatility of the current period can be predicted by using the past prices trend. Likewise significant and positive value for the coefficient γ_2 confirms persistence in volatility for the banks included in the portfolio. Thus there is marked volatility transmission from market to stock returns except Summit Bank which is not showing a significant result. The direction of transmission is positive except in the case of Soneri Bank which is showing an opposite direction. Volatility in bank stocks is also covered in a previous study by Koutmos and Booth (1995), where a reason for increase in volatility is attributed to leverage, since any reduction in stock price increases the leverage ratio. In case of smaller banks in Pakistan, regulatory capital shortfall is usually met through issuing debt instruments under ‘Tier-1’ nomenclature that may be treated as quasi-equity, but considered debt for analysis purpose.

4.5 Dynamic Conditional Correlation (DCC) – GARCH Model

In this section, the study resorts to DCC - GARCH investigation to establish presence of time-varying correlation between interest rates and stock returns, since ARMA-GARCH makes basic assumption of Constant Conditional Correlation.

The version of DCC-GARCH, that measures asymmetric behavior of relationship i.e. Asymmetric Dynamic Conditional Correlation (ADCC) has captured result of few banks. Due to presence of volatility and outliers in the series, results for most banks were not found through ADCC.

Table – 4.11: DCC-GARCH Estimates between Interest rate and Large Banks (LGB) portfolio

	NBP	HBL	UBL	MCB	ABL
rho	0.0382	0.0275	0.0231	0.03698	0.0229
	(0.0868)	(0.1159)	(0.2445)	(0.3044)	(0.2784)
alpha	0.0217	0.0000	0.0000	0.0053	0.0187
	(0.1970)	(0.8804)	(0.2289)	(0.0003)	(0.3578)
beta	0.9399	0.8009	0.8708	0.9916	0.9143
	(0.0000)	(0.1689)	(0.0000)	(0.0000)	(0.0000)

The coefficients of DCC-GARCH model are displayed in the Table along-with corresponding p-values shown in the parenthesis. Rho is the coefficient for constant. Alpha registers the past residual shocks and Beta registers the lagged dynamic conditional correlation.

Stability condition is met as value of coefficients alpha + beta is less than 1. MCB is the only bank in the portfolio of large banks that exhibits a significant coefficient value for alpha. This means that the conditional correlation of the stock returns of MCB with the interest rate is affected by past residual shocks.

Regarding the dynamic conditional correlation, it is found that large banks exhibit strong correlation over time with the interest rates. The value for coefficient beta is highly positive and significant for the portfolio with the exception of HBL. Stock returns may depict a highly correlated behavior with macroeconomic changes especially in times of high volatility and there could be a dynamic increment in correlations. This time-varying impact was identified by an earlier study of Rajwani and Kumar (2016).

Table – 4.12: DCC-GARCH Estimate between Interest rate and Second-tier Banks (STB) portfolio

	AKBL	BAFL	BAHL	BOP	HMB	MEBL	SCBPL	FABL
rho	0.0674	0.0332	0.0222	0.0275	0.0145	0.0377	0.0271	0.0134
	(0.0165)	(0.0605)	(0.1503)	(0.1431)	(0.4158)	(0.1636)	(0.2060)	(0.4188)
alpha	0.0037	0.0257	0.0102	0.0054	0.0121	0.0021	0.0000	0.0000
	(0.2116)	(0.2953)	(0.0881)	(0.5265)	(0.0817)	(0.3670)	(0.0001)	(0.0242)
beta	0.9912	0.7829	0.9502	0.9336	0.9257	0.9942	0.8159	0.8409
	(0.0000)	(0.0177)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

The coefficients of DCC-GARCH model are displayed in the Table along-with corresponding p-values shown in the parenthesis. Rho is the coefficient for constant. Alpha registers the past residual shocks and Beta registers the lagged dynamic conditional correlation.

Stability condition is met in this case as well and the sum of coefficients alpha + beta is showing a value of less than 1, thus confirming suitability of model. Two banks in the STB portfolio i.e. Standard Chartered (SCBPL) and Faysal (FABL) are showing significant values of alpha, however the value of coefficient is low. This reflects that correlation of stock returns of these banks is impacted by past residual shocks.

Further, beta coefficient is not only significant but also carries high value for all the banks in the portfolio, confirming strong dependence of respective stock returns on lagged conditional correlation. Thus stocks of these banks reflect strong dynamic correlation with the interest rates over time and possible correlated behavior to volatility.

Table – 4.13: DCC-GARCH Estimate of Interest rate on Third-tier Banks (TTB) portfolio

	BOK	**JSBL**	**SBL**	**SNBL**
rho	-0.0128	0.0146	0.0179	-0.0068
	(0.6633)	(0.3890)	(0.4603)	(0.7788)
alpha	0.0060	0.0000	0.0062	0.0145
	(0.5038)	(0.7586)	(0.1599)	(0.2605)
beta	0.9733	0.8786	0.9458	0.9519
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

The coefficients of DCC-GARCH model are displayed in the Table along-with corresponding p-values shown in the parenthesis. Rho is the coefficient for constant. Alpha registers the past residual shocks and Beta registers the lagged dynamic conditional correlation.

First of all, the stability condition is met for TTB portfolio as alpha + beta comes out to be less than 1, hence the suitability of model.

Value for the coefficient alpha is not significant for any bank in the Third tier that means there is no impact of past residual shocks on conditional correlation. On the contrary, value of beta is significant for the entire portfolio that confirms highly positive impact of lagged dynamic correlation on their stock returns.

Table – 4.14: Asymmetric Dynamic Conditional Correlation (ADCC-GARCH) Estimate between Interest rate and Stock returns of Selected Banks

	UBL	**ABL**	**MEBL**	**SCPBL**	**BOK**
rho	-0.0034	0.0328	0.0698	0.028	-0.1029
	(0.9290)	(0.2948)	(0.0798)	(0.1833)	(0.1541)
alpha	0.0000	0.0201	0.0018	0.0000	0.0000
	(1.0000)	(0.3826)	(0.3410)	(1.0000)	(1.0000)
beta	0.8986	0.9101	0.9876	0.8229	0.9195
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Gamma	0.026	-0.0096	-0.003	-0.0013	0.0674
	(0.5920)	(0.6230)	(0.1969)	(0.4472)	(0.2931)

There is an additional coefficient Gamma in ADCC as compared to DCC tests that captures the asymmetry reflected by the negative sign. P-values are reported in parenthesis.

Most banks in the three portfolios of banks do not yield to ADCC model, due to presence of frequent outliers. A smaller group of five banks is however selected that exhibit results for ADCC-GARCH model.

All five show strong significant dependence on lagged conditional correlations, reflected by high values of coefficient beta. Asymmetry or the leverage effect is indicated by negative value of coefficient Gamma. Aforementioned estimates indicate that three out of five banks, i.e. Allied Bank (ABL), Meezan (MEBL) and Standard Chartered (SCBPL) show negative values for Gamma but the statistical significance is not found. We can therefore conclude that the selected banks do not show an asymmetric pattern or leverage effect.

Table: 4.15 Summary of Hypotheses Testing

No	Hypothesis Statement	Result
I	There exists a return spillover from interest rate to bank stock returns of commercial banks listed on PSX	Accepted
II	There exists a volatility spillover from interest rate to bank stock returns of commercial banks listed on PSX	Not measured due to homoscedasticity
III	There exists a return spillover from market to bank stock returns of commercial banks listed on PSX	Accepted
IV	There exists a volatility spillover from market to bank stock returns of commercial banks listed on PSX	Accepted
V	Sensitivity of banks to interest rate changes depends upon their respective size	Accepted
VI	The correlation between interest rate and bank stock returns is asymmetric in nature	Not measured due to homoscedasticity
VII	There exists a time-varying correlation between interest	Accepted

	rate and bank stock returns	
VIII	There exists an asymmetric time-varying correlation between interest rate and bank stock returns	Not measured due to insignificant results

5.0 Conclusion and Recommendation

5.1 Discussion and Conclusion

Extensive estimation under ARCH type modeling has indicated that stock returns of commercial banks in Pakistan behave uniquely to changes in the monetary policy and market movement. Research literature covering different global markets and sectors present mixed findings, where the equities exhibit both negative and positive response to the movement in interest rate (Gali and Gambatti, 2015).

As per the findings, overall response of the banking sector remains mostly identical across the three portfolios tested for conformity. We have found that banks are mostly resilient to interest rate and returns of few banks are affected by spillover from return and volatility of interest rate. Interest rates over the period of ten years however do not show heteroscedastic behavior. The relationship between bank stock returns and the interest rate is found to be positive.

EGARCH model which was used to investigate the asymmetric behavior and response of bank stocks to the bad news showed positive and significant response of large size banks to the interest rates. The other two tiers of banks i.e. Secondary and Third-tier banks however showed mixed sensitivity to interest rate under EGARCH modeling. This result was in line with the ability of large banks to leverage upon an interest rate hike by building it in their asset price instantly, whereas the change is incorporated on the deposit side with a considerable lag, thus generating an advantage for the banks. Statistically we have found evidence for significant volatility spillover from interest rate series, but coefficient values show a weak relationship that confirms the ability of banks to withstand the transmission.

The interesting aspect of this research is determination of the fact that bank stock returns listed on PSX reflect higher sensitivity to market movement as represented by the index, than the interest rate. This is in line with the findings of similar studies in other markets where the market effect is found to be more significant on bank stock returns than the interest rate and the exchange rate. This also complements the research thought that interest rates affect the stock returns through market and not directly (Kasman et al, 2011).

Besides, the results of estimation indicate that large and second-tier banks are more responsive to interest rate and market wide changes as compared to tertiary banks. As indicated in the literature review the sensitivity of bank stock returns to interest rate changes in particular are dependent upon the maturity profile of their respective assets and liabilities. Also large and second tier banks are in a better position to take advantage of the increase in interest rate due to their franchise power. Banks often exhibit better profitability in times of tightened monetary policy.

Like other low performing markets in the world, stock returns of banks traded on PSX show strong dependence on lagged conditional correlation. This correlation is essentially across all banks regardless of their size, therefore the three portfolios, LGB, STB and TTB are exhibiting identical behavior. Results of ADCC-GARCH though reflect significant and positive dependence upon time varying correlation between the stock returns and the interest rate, however the asymmetric behavior is not statistically found significant. Hence, we can conclude that the bank stock returns do not carry leverage effect and do not show more sensitivity to bad news in the market.

The study also concludes that GARCH-in-Mean confirms to be a better model to capture spillover from monetary policy to bank stock returns as compared to larger banks. Small banks however are more responsive and show lower AIC values for EGARCH model.

5.2 Recommendation and Future Research

Since the sensitivity of bank stock returns to interest rate is dependent upon the size of bank and the maturity profile of its assets and liabilities, therefore it is recommended that a potent hedging strategy should be adopted to minimize portfolio risk of bank stocks by including equities from various tiers of banks instead of a single tier.

Besides, considering the peculiar business model of Islamic banks where the short term financing modes like murabaha, salam and istisna have specific maturities, they may exhibit a peculiar behavior with respect to their sensitivity to interest rate as well as market wide movement. A study comprising of comparative behavior of banks stock returns of conventional versus Shariah complaint banks would make an interesting investigative analysis.

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