MONETARY AGGREGATION AND LIQUIDITY PUZZLE: EVIDENCE FROM PAKISTAN

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CERTIFICATE

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I hereby state that my MPhil thesis titled 'Monetary Aggregation and Liquidity Puzzle: Evidence from Pakistan' is my own work and has not been submitted previously by me for taking any degree from this University Pakistan Institute of Development Economics, Islamabad or anywhere else in the country/world.

At any time if my statement is found to be incorrect even after my Graduation the university has the right to withdraw my MPhil degree.

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Dedication

I dedicate this research thesis to all people who were being part of this effort especially the respected supervisor Dr. Ahsan ul Haq Satti and my beloved Parents

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ABSTRACT

This paper attempts to check either Liquidity Puzzle exists or not in case of Pakistan using the annual data over the period 1970-2019. In the past, many researchers found the positive relationship between monetary aggregates and interest rate due to the use of monetary aggregates such as non-borrowed reserves, monetary base, narrow money and broad money. This research uses one functional approach (M2) and three different types of empirical approaches to measure the monetary aggregate by using Standard Vector Autoregressive Model. Both these approaches show the presence of Liquidity Puzzle but the Divisia Monetary Aggregate also shows the negative correlation at the end.

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LIST OF ABBREVIATIONS

CC	Currency in Circulation
CD	Call Deposits
CEM	Currency Equivalence Monetary Aggregate
DMA	Divisia Monetary Aggregate
DR	Discount Rate
FD	Fixed Deposits
SD	Saving Deposits
SS	Simple Sum Monetary Aggregate

CHAPTER: 1

INTRODUCTION

1.1 Background of the Study

For decades, monetary aggregates play a significant role for forming the monetary policies and for understanding the health of a nation's economy. It is a known fact that when there is a variation in the money supply, it brings a considerable amount of variation in inflation rate, exchange rate, interest rate and some other macroeconomic variables. Furthermore, the expansion of money supply is vital element not just for accelerating the development process of the economy but is also equally important to achieve a stable level of prices in economy. There should be a moderate increase in money supply if the aim is to achieve the development of economy in a stable state. In order for an economy to have a sound growth, neither inflation nor deflation should exist. Therefore, an expansion in money supply has vital effects on the economic growth rate. As a matter of fact, it is considered to be an appropriate medium of economic development. By keeping it in specific range can speed up the process of economic growth but surpassing a specific limit can result in hindering of economic development. Therefore, manageability of money supply is crucial in the context of sustained economic development.

Monetary policy targets at influencing the economic activity in the state mainly through two major variables that are rate of interest and the money or credit supply. Both of these variables are used alternatively. The common traditional consensus among economists is that the central bank cannot target both interest rate and money supply at the same time. According to Taylor (1993), the central bank chooses either the monetary base as its main

instrument or the common interbank rate. The relationship between money supply and interest rate should be negative but the relationship that exists between them is not negative in the short run which is known as 'Liquidity Puzzle'. All else being equal, when money supply goes up, the interest rate comes down, which encourages the consumers to borrow. According to Keynesian, for a constant level of output when money supply rises the interest rate will go down. Nichols, Small and Webster (1983).

In contrast, Irving Fisher gives his view that the supply of money is largely influenced by the interest rate. It is debated that the rise in money supply affects the interest rate which influences price level and total output. Money and interest rates are positively related. Increasing interest rates requires an increase in the rate of money growth. Padmasiri (2013).

Liquidity Puzzle exists due to some reasons. Among them one of the reason is the use of official monetary aggregates. In addition to this, measurement error has also an impact on the Liquidity Puzzle. What would happen to nominal interest rate when there is expansionary monetary policy? Many Economists believe that the instant short-run effect should be a decline in the nominal interest rate which is often described as the liquidity effect. However, it is very difficult to find influencing proof of a negative relationship between money supply and interest rate.

Many researchers have recommended that structural vector auto regressions (VAR) provide indication of the liquidity puzzle. Sims (1986) analyses that the liquidity puzzle is frequently observed in Vector autoregressive models that measure shocks of monetary policy by orthogonalized innovation in conventional monetary aggregates. According to Belongia (1996), the readings related to importance and effects of money depend on the selection of methods of monetary aggregation used to calculate money.

For the case of Pakistan the two methods of monetary aggregates are Divisia Monetary Aggregate and Simple Sum Aggregation which were compared by Tariq and Mathews (1997). The study finds the indication in support of superiority of Divisia Monetary Aggregate. Khan and Hussain (2005) stated that in Pakistan, three different types of monetary aggregations are used to measure of money stock and formulation of policy. It includes the narrow measures M0 and M1; and a broader aggregate M2. According to Haider et al. (2013), it is essential to target monetary aggregates or deviation reaction from the appropriate track if monetary policy is to be well communicated and implemented; monetary aggregates should remain, if not primary, then secondary targets in monetary policy framework for the developing nations. Munir et al (2012) stated that Vector Auto Regression (VAR) model shows the presence of liquidity puzzle and price puzzle in Pakistan while Factor Augmented VAR model did not provide any indication of puzzles and FAVAR model supports the usefulness of interest rate channel in Pakistan.

Monetary policy's shock can be contractionary or expansionary depending on the economic situations of the country. To control the money supply, the central bank may implement contractionary monetary policy, however due to scarce information sets used in VAR analysis, there will be a rise in interest rate leading to liquidity puzzle.

To examine a relationship between money aggregates and interest rate, this study use the Vector Auto Regression Model. In this study, the aim is to construct for Pakistan the Simple Sum Monetary Aggregates, Currency Equivalence and Divisia Monetary Aggregates and then relate the monetary aggregates with the interest rate and find the relationship between them.

If Liquidity puzzle exists in case of Pakistan then it contradicts the theory as well as it goes against the Liquidity effect.

1.2 Research Gap

To my best knowledge there is no study constructed in Pakistan to check the existence of Liquidity Puzzle by using the three different types of Monetary Aggregates.

1.3 Objectives of the Study

The foremost objective of the study is to estimate the three Monetary Aggregation Methods namely Simple Sum, Divisia Aggregation and Certainty Equivalence Aggregation. The ultimate goal is to link the monetary aggregation with interest rate by using Vector Auto regression (VAR) to check the existence of Liquidity Puzzle in Pakistan. To achieve this objective the following goals are constructed:

(1) To calculate the value of Monetary Aggregate by three different methods for Pakistan.
(2) To relate the Monetary Aggregates with Interest Rate to check the Liquidity Puzzle and to make recommendations on the linkage between the variables.

1.4 Significance of the Study

Monetary Aggregation is also essential for the policy makers and the researcher. The need for such aggregates to the policy-makers may arise to control inflation, in designing policies, interest rate and output. Money Supply and Interest Rate are also used as an important instrument in forming the economic and monetary policy. When the Monetary Authorities of the State rise the Money Supply the Interest Rate should fall but this phenomena exists very infrequent. So, this study will try to find the existence of Liquidity Puzzle or not in case of

Pakistan. This study will also provide a better reference for the policy makers to consider the prevailing relationship between interest rate and the monetary aggregate in Pakistan.

1.5 Organization of Study

This specific piece of work is divided into five chapters at the final stage. Chapter 1 is an introductory chapter. This paper describes research is about what? Why this research is conducted? What are the main objectives of this research? What is the research Gap and what is the Significance of the study?

The focus of Chapter 2 is the review of the already published literature. Literature Review is divided into two parts. First part includes the history of money and compare the different types of Monetary Aggregation and their pros and cons. Second part includes the literature on Liquidity Puzzle and the methodologies to relate the money stock with interest. With the help of this detailed literature review, research gap is found.

Chapter 3 is related to the data and methodology. In this chapter, the three methods of Monetary Aggregates, detail of the variables and the VAR equations are mentioned. Chapter 4 consists of the empirical evidence and the results. Chapter 5 is the last chapter which gives the conclusion and the policy recommendation.

CHAPTER: 2

LITERATURE REVIEW

2.1 Monetary Aggregation

In 1900, Gold Standard Act was passed in America which led to the formation of Central Bank. At the end of the Great Depression in 1930, the gold standard was dropped out. From then on, paper money was considered as standard form of money. Use of currency as a medium of exchange became standardized and acknowledged across the globe. In 1960's, the credit cards began to appear. Many questions arise in mind that what is money? Is it a good or service? If good then what is its price? Is it measurable? If measurable then does it possess identical degree of moneyness? If it possesses identical degree of moneyness then their quantities can be aggregated linearly with the same weights.

There is no proper definition of money that exists in Monetary Economics. In 19^{th} Century, problem arose that what should be incorporated in the definition of money. To solve this problem three modes of aggregation were introduced. Most common forms of monetary aggregates are Simple Sum Monetary Aggregates and Divisia Aggregates. Aggregator functions are the basis of aggregation theory. In the empirical research, it is not only impossible to identify the functional forms of these aggregator function but it is almost impossible for the estimation of parameters in the model.

Fisher (1922) laid the basis of statistical index numbers which are used by the Aggregation Theory. An index number shows the average percentage change from one point to another

point. Unlike the aggregator functions, statistical index numbers are independent of the unknown parameters while they depend on maximizing behavior of economic agents. After studying a great number of indices, Fisher concluded that the Simple Sum Aggregation is the worst one among the monetary aggregation method. Divisia Index is invented by Divisia (1925) which carries the vital statistical properties. Purpose of the Divisia Index was to measure the monetary services which were given by the financial assets.

Simple Sum Aggregation assign equal weights to each financial asset and is effective if financial assets are perfect substitutes. Perfect substitutability indicates that the holders of asset face linear indifference curve among the financial assets. When the concept of interest on monetary assets takes place, the monetary assets become no more the perfect substitutes for each other.

Barnett (1980) stated that a large number of central bankers and the economists used the Simple Sum Monetary Aggregates. Indeed, most of states use Simple Sum Aggregates as official monetary aggregates. However, Simple Sum Aggregates is nothing more than a simple accounting identities. He criticize on Simple Sum of Monetary Aggregation as it is unreliable with economic theory as well as index number theory and then he proposed Divisia Aggregates. In this approach, weights are assigned to each component according to its user cost and monetary assets are weighted by their expenditure shares. Concept of user cost is given as the usage of durable good is its user cost for the services offered during the time period (Barnett 1984).

According to the findings of Belongia (1991), the Divisia Monetary Aggregates had stable demand for money functions and were closely linked to the growth of nominal GDP for United Kingdom. He also criticized on the official monetary aggregates of United Kingdom

that is the simple sum weighting scheme by giving the two reasons. First one is that the simple sum aggregation is applicable only if components of the assets are perfect substitutes. A large number of Empirical results shows that there exists a low degree of substitutability between near monies and money combined in group of assets. Second reason is related to the set of assets to be aggregated. Group of assets should be consistent and separable but this condition is not satisfied in simple sum aggregation method because they are weakly separable and do not show homogeneous linearity.

Tariq and Matthews (1997) used the methodology of Cointegration to compare demand for Simple Sum Monetary Aggregates and Divisia Monetary Aggregates for Pakistan for time span of 1974Q1 to 1992Q4. Both types of monetary aggregates produce a stable demand for money and performance in the post sample stability tests was satisfactorily while the performance of Divisia Monetary Aggregates was slightly improved on the basis of conventional statistical criteria. This study concluded that there is no benefit from switching from Simple Sum to Divisia Monetary Aggregates at prevailing level of formal aggregation as the appropriate indicator of monetary policy and due to financial innovation and financial deregulation in the current time period, the Divisia Aggregation may be in future prove as a better indicator rather than Simple Sum Aggregation.

Acharya and Kamaiah (2001) analyzed the definition of money with Simple Sum Monetary Aggregation and Divisia Aggregation by using both annual and monthly data for India. They found that Divisia aggregates have an edge over simple sum aggregates. The performance of traditional Simple Sum Monetary Aggregates relative to the Divisia Aggregation in terms of forecasting the GDP deflator and real GDP was examined by Schunk (2001). Broad Divisia aggregates formed real Gross Domestic Product forecasts that are better to those generated by

simple sum aggregation. Additionally, two M1 aggregates, comparative to the broader aggregates, are better forecasters of the GDP deflator, with a little bit edge going towards Divisia M1 over Simple Sum M1. The effectiveness of monetary policy is obviously dependent on having the accurate forecasts. Improved forecasts of prices and real output presented by Divisia monetary aggregates provide a rise in information quality.

A study has constructed on Nigerian economy to assess the performance of Divisia Monetary Aggregates and Simple Sum Aggregation for the time period of 1970-2000 by Gebregiorgis (2005). He concluded that the Simple Sum Aggregates has comparatively better performance in Nigeria due to the normally regulated interest rates and they are also fixed at relatively low rates for several years while Divisia Monetary Aggregates has relatively poorer performance due to the use of industrial population as the proxy for national output.

Celik (2009) compare the Simple Sum Aggregation and Divisia Monetary Aggregation using panel data analysis by using quarterly data for the four advanced economies of UK, US, Japan and Euro Area. He concluded that the major fault of Simple Sum Aggregation is their incapability to react to financial innovation and thus provides a stable money demand function. On other side Divisia Monetary Aggregates have the capability to adjust for financial innovation.

Henrickon (2014) tests the stability of money demand for both Simple Sum Aggregation and Divisia Monetary Aggregation and finds the relationship of stable money demand with Divisia Aggregates. It is stated by Polat, U. (2018) that Divisia Monetary Aggregates has relative tendency in predicting the quantity and price variables compared to Simple Sum Aggregation in Turkish's economy and that there is a strong association between the Divisia Monetary Aggregates and short term interest rates in conduct of monetary policy.

2.2 Liquidity Puzzle

"Liquidity puzzle" is defined as the direct relationship of money supply and interest rate. If there is an expansionary monetary policy shock in economy then there will be an increase in the money supply, purchasing power of public will increase and the demand of goods and services increases. Instead of this, people can hold money and deposit in some financial institutions as their money reserves has increased. As a result of this the interest rate will fall.

Urich and Wachtel (1981) conducted a study to describe why market reacts when there is a money supply announcement. They noted that the money supply announcements and the interest rates could be related through three different channels. First, Keynesian theory predicts that when there is expansionary monetary policy and the interest rate declines through the liquidity effect. Second, there is a possibility that interest rates respond to the expectancy of future policy fluctuations. Third, money supply announcements may directly influence the nominal interest rates through their effect on expected inflation.

By late 1990s, however, virtually no major central bank in the world was a monetary targeter. Pakistan adopted monetary targeting strategy during the heydays of 'monetarism' when it was central to the conduct of monetary policy. Even in the mid 1990s, when the world around it was showing an obvious decline in the role of money in macro models, Pakistan continued with this policy. Few exploratory facts from Pakistan economy, however, suggest rethinking on the monetary doctrines and by corollary the monetary targeting strategy. Two main reasons are forwarded for the demise of this strategy. First, the constant stream of financial deregulations and innovations of the 1970s, 1980s and 1990s kept destabilizing the demand for money. In other words, velocity of money, supposed to be fixed for the smooth functioning of monetary targeting regime, turned out to be highly variable. Second, the money

growth and inflation relationship did not turn out to as predicted. Some argued it was a lack of proper commitment on the part of the central banks in implementing the monetary targeting strategy. Omer and Saqib (2009).

According to the findings of Hussain (2019), it suggest that though State Bank of Pakistan has shifted to interest rate targeting from money targeting and is building the models for monetary policy analysis where money has lesser role, monetary aggregates are still relevant for assessing the plausibility of achieving the objective of price stability.

In the past, efforts to explain the liquidity puzzle have focused on M1 or monetary base (narrowly defined monetary aggregates) such as non-borrowed reserves NBR (Strongin (1995) and Christiano, Eichenbaum, and Evans (1996)). They are unsuccessful to find a short-term negative correlation between monetary policy innovations and interest rate. Researches have investigated that there is a role of measurement error in the liquidity puzzle nearly in all situation due to the use of official monetary aggregates.

According to the New Keynesian model, which have emerged since the mid of 1990s tend to assume that the central bank of the state sets the interest rate in such a way that the monetary aggregate becomes a endogenous variable Handa (2000).

Economic theory provides apparently two different views about the money supply and interest rate. According to the view of Fisher (1896) when interest rate rises, it requires money supply to rise. According to the Liquidity effect when interest rate rise, it requires a decline in money supply. Monnet and Weber (2001) constructed a model that resolves the two views. In the model sudden rise in the current monetary growth leads unchanged expected future growth

rate and leads to decline the interest rate. Though, rise in expected future money growth may or may not be associated by rise in current money growth, lead towards higher interest rate.

Kelly et al. (2010) used the data of United States and British and the finding shows that in United States when Divisia Monetary Aggregate (M2 aggregation level) is used to calculate the money growth rate, the liquidity puzzle disappears both in the all sub-sample periods and full sample period. In this research, there exists a strong evidence that liquidity puzzle can be described by measurement error in the monetary data.

A study was conducted in Pakistan by Fatima and Sahibzada (2012), to examine the nature of relationship among money supply, interest rate and inflation rate. They have taken the time series data from the year 1980 to 2010 and used the Johansen Co-integration test and error correction model. Results from this confirms that Fisher Effect exists in case of Pakistan. So, while conducting the monetary policy, the State Bank of Pakistan (SBP) must consider the dynamic relationship between inflation and interest rate because they are related to each other.

Another study was conducted by El-Shagi (2012) and finds a negative correlation in short run between interest rates and money but in long run, this relationship reverses for the US data. After the monetary policy shock, they observed an indirect relationship between interest rate and money and lasted almost for three months. After that money continued to grow and the interest rates began to increase. The rise in interest rates became significantly positive after roughly 36 months.

A study on Nigerian economy has been conducted by Bello et al. (2013) to determine the relationship among income growth, money supply, interest rate and inflation rate for the time period of 1980-2010. To determine the relationship VAR, Johansen Cointegration test and

Granger Causality test were used. Findings show that there occurs no long run relationship among all these variables. From the Granger Causality Test, it is shown that causality runs from interest rate to inflation, money supply to inflation and income growth to inflation.

It has been identified from the findings that price puzzle and liquidity puzzle are the outcomes arising from the monetary shock. Muhanji et al. (2013) study their existence in eleven indebted small open economies of African countries by using a dynamic stochastic general equilibrium model on annual data from 1970-2007. Out of these eleven, three economies show liquidity effect and other shows a price puzzle. In most of the countries when there is positive monetary shock in the economy, it leads to a rise in external debt, consumption/investment imports and the real interest rates. ,Bilan (2005) concludes that the result of a monetary expansion is ambiguous because it depends on the characteristics of the economy (e.g., the speed and responsiveness of expectations).

Theoretically, when there is a rise in interest rate and the decline in monetary aggregates then price level will decrease with no rise in output level. Empirically, this phenomena exists very rare. Findings of Javid and Munir (2010) suggest that contractionary monetary policy through the rise in rate of interest serves slight purpose in the period 1991 to 2010 in Pakistan. Although, it continues to narrow down the private sector and hinders the private investment already experiencing worse scenario (PIDE Monetary Policy Viewpoint). Further findings also show that during the contractionary monetary policy the domestic currency of Pakistan was also depreciated comparative to US dollar.

It has been mentioned before that money supply has major impact on the development of the economy both from macro as well as economic perspective. If liquidity puzzle doesn't exist in Pakistan then by increasing the amount of money supply results in the decreasing of

interest rate, increased investment and increased consumption which speeds up the economic development. The companies keep on continuing this circle by increasing production in order to meet the increasing demands. A healthy business requires greater need for labor force and more capital goods. In a developing economy, with an increase in price of stocks, companies will issue more shares. If money supply tends to increase on the same rate, prices will accelerate primarily due to increased incomes. Assuredly, the general public anticipates an increase in the inflation due to increasing demands. The creditors ask for high interest rates for rational reasons.

If Liquidity Puzzle exists then the whole scenario will be opposite by increasing the amount of money supply the interest rate will also be increased. The increase in money supply faster than the growth in real output will cause inflation and the reason behind this is that there is more money chasing the same number of goods. Hence, the increase in monetary demand causes firms to put up prices. According to quantity theory of money, a growing money supply increases inflation. Thus, a low interest rate tends to result in more inflation. High interest rates tend to lower inflation.

CHAPTER: 3

METHODOLOGY

This chapter covers the econometric and statistical approaches that will be used to achieve the goals outlined in this study. To accomplish this, we compare the monetary aggregation empirically by different methods. After that we will link the Monetary Aggregates with the discount rate by using Vector Auto Regression Model.

3.1 Methods of Monetary Aggregation

3.1.1 Index number theory and Divisia aggregates

Divisia (1925) proposed a new approach for the monetary aggregation known as the Divisia aggregates. This approach is based on statistical index number theory and based on the data of prices and quantity and it emphasizes on the required properties of indices. Divisia Aggregates incorporate the effect of those innovations that alter the relative liquidity and demand for component assets. This approach uses the concept of user cost of assets.

Divisia Monetary Aggregate ($\widehat{M_t}$) is measured by the formula:

$$\widehat{M_t} = \prod_{i=1}^{m} z_{it}^{s'_{it}}$$

Taking natural log on both sides:

$$\widehat{lnM_t} = \sum_{i=1}^{m} s'_{it}\, lnz_{it}$$

Comparison between the two time periods *t* and *t-1* is written as:

$$z_t = z_{t-1} \prod_{i=1}^{m} \left[\frac{z_{it}}{z_{it-1}}\right]_t^{s''_{it}}$$

Where $$s''_{it} = \frac{1}{2}(s'_{it} + s'_{it-1})$$

s''_{it} is the average of the expenditure shares.

This Log linear form of the Divisia quantity index shows the change between the time t and t-1 as:

$$lnz_t - lnz_{t-1} = \sum_i s''_{it} (lnz_{it} - lnz_{it-1})$$

z_{it} is the quantity of *i*th asset in time t.

3.1.2 Simple Sum Monetary Aggregates

The simplest approach used to measure the amount of money is the simple sum monetary aggregates. Generalized form is:

$$M'' = Z_1 + \sum_i b_i Z_i \qquad i = 2,3,4,\ldots.m$$

Whereas:

M " = Nominal value of monetary aggregate

Z_1 = *M1* (Narrow money)

Z_i = Nominal value of *i*th liquid asset

The value of b_i is determined by running the regression.

$$Y_t = \beta_0 + \sum_i b_i Z_{it} + \mu$$

Y_t = nominal national expenditure

μ = stochastic term

In case of Pakistan money supply M1 consist of currency in circulation, current deposits other and deposits with SBP.

According to (Friedman and Schwartz, 1963 a, b), if the value of a_i is 1 then it should be included in monetary aggregates and it explains the level of national income in a better way rather than if it were excluded. All the included assets are the perfect substitutes if a_i is equal to 1 and there is one to one substitution among the included asset. Actually, the main fault with this process is not just the way the weights are allocated but also the potential volatility in the weights allocated to individual assets.

3.1.3 Currency Equivalence Monetary Aggregate

This is the third form of monetary aggregation which is proposed by Rotemberg (1991) and Rotemberg *et al.* (1995). Functional form of Currency Equivalence Monetary Aggregate for the monetary assets is:

$$CEM_t = \sum_{i=1}^{m} (1 - \frac{R_{i,t}}{R_t^*}) Z_{i,t}$$

We include four assets in Currency Equivalence Monetary Aggregate. Currency in circulation do not have the rate of return. Assets paying the rate of return are call deposits, saving deposits and fixed deposits.

3.2 Data and Variables for Monetary Aggregation

To find the value of Monetary Aggregation, we have used the data of different deposits corresponding to their rate of return. In monetary aggregation theory, benchmark rate of return is taken as the total rate of return on the illiquid assets which is defined as a rate of return on pure investment that provides no services other than its yield and this asset is held specially to accumulate wealth. Benchmark rate of return is the sum of the values of precious metal, stock exchange securities, merchandise, machinery, real estate, financial obligations and others. They are illiquid or we can say that they cannot be easily converted into cash. Value of the benchmark rate of return should be greater than the rate of returns on the liquid assets. All the data related to monetary aggregation is taken from the ***International Financial Statistics (IFS)*** *and* ***State Bank of Pakistan (SBP).*** Annual frequency is used from **1970** to **2019** for the data.

For the final value of Monetary Aggregates, four types of deposits are considered such as:

1). Currency in circulation

2). Call Deposits

3). Savings Deposits

4). Fixed Deposits

3.3 Methodology of Liquidity Puzzle

Vector Auto Regression (VAR) is used to examine the association between money stock and interest rate. Money stock is constructed from the three various methods. This paper explains how the three methods of monetary aggregation can lead towards liquidity puzzle by estimating the unrestricted VAR for the case of Pakistan.

For the estimation of VAR Model, we take six variables which are endogenous and there are no exogenous variable exists in our model. VAR Model for the liquidity puzzle is:

$$\mathrm{Z_t} \;=\; [\, M_{\mathrm{t}}\,, \mathrm{DR_t}\;, \mathrm{GDP_t}\,, \mathrm{CPI_t}, \mathrm{UNEMPLOY_t}\;, \mathrm{BOP_t}\;]$$

The dependent variable is dependent on its lagged values and the lagged values of other variables in the model. In our case, the VAR involves six equations. Money supply depend on the past values of money growth, discount rate, gross domestic product, consumer price index, unemployment and balance of payment and similarly for the discount rate, gross domestic product, consumer price index, balance of payment and unemployment rate equation. For the estimation of each monetary aggregates, a separate VAR model is used.

Primitive Vector Auto Regression Model

$$\mathrm{M_t} \;=\; \alpha_{11+}\; \sum_{\mathrm{i=1}}^{\mathrm{p}} \alpha_{1i}\, M_{t-i} + \sum_{\mathrm{i=1}}^{\mathrm{p}} \beta_{1\mathrm{i}}\, \mathrm{DR_{t-i}} \;+\; \sum_{\mathrm{i=1}}^{\mathrm{p}} \gamma_{1\mathrm{i}}\, \mathrm{GDP_{t-i}} + \sum_{\mathrm{i=1}}^{\mathrm{p}} \varphi_{1\mathrm{i}}\, \mathrm{CPI_{t-i}} \;+$$

$$\sum_{\mathrm{t=1}}^{\mathrm{p}} \omega_{1\mathrm{i}}\; \mathrm{UNEMPLOY_{t-i}} + \sum_{\mathrm{t=1}}^{\mathrm{p}} \theta_{1\mathrm{i}}\, \mathrm{BOP_{t-i}} \;+ \varepsilon_t\, \mathrm{M} \quad \ldots\ldots\ldots\ldots\ldots (3.1)$$

$$\mathrm{DR_t} \;=\; \alpha_{21+}\; \sum_{\mathrm{i=1}}^{\mathrm{p}} \alpha_{2i}\, M_{t-i} + \sum_{\mathrm{i=1}}^{\mathrm{p}} \beta_{2\mathrm{i}}\, \mathrm{DR_{t-i}} \;+\; \sum_{\mathrm{i=1}}^{\mathrm{p}} \gamma_{2\mathrm{i}}\, \mathrm{GDP_{t-i}} + \sum_{\mathrm{i=1}}^{\mathrm{p}} \varphi_{2\mathrm{i}}\; \mathrm{CPI_{t-i}} \;+$$

$$\sum_{\mathrm{t=1}}^{\mathrm{p}} \omega_{2\mathrm{i}}\; \mathrm{UNEMPLOY_{t-i}} + \sum_{\mathrm{t=1}}^{\mathrm{p}} \theta_{2\mathrm{i}}\, \mathrm{BOP_{t-i}} \;+\; \varepsilon_{\mathrm{t}}\, \mathrm{DR} \quad \ldots\ldots\ldots\ldots\ldots (3.2)$$

$$\mathrm{GDP_t} = \alpha_{31+} \sum_{i=1}^{p} \alpha_{3i} M_{t-i} + \sum_{i=1}^{p} \beta_{3i} \mathrm{DR_{t-i}} + \sum_{i=1}^{p} \gamma_{3i} \mathrm{GDP_{t-i}} + \sum_{i=1}^{p} \varphi_{3i} \mathrm{CPI_{t-i}} + \sum_{t=1}^{p} \omega_{3i} \mathrm{UNEMPLOY_{t-i}} + \sum_{t=1}^{p} \theta_{3i} \mathrm{BOP_{t-i}} + \varepsilon_t \mathrm{GDP} \quad \ldots\ldots\ldots\ldots\ldots (3.3)$$

$$\mathrm{CPI_t} = \alpha_{41+} \sum_{i=1}^{p} \alpha_{4i} M_{t-i} + \sum_{i=1}^{p} \beta_{4i} \mathrm{DR_{t-i}} + \sum_{i=1}^{p} \gamma_{4i} \mathrm{GDP_{t-i}} + \sum_{i=1}^{p} \varphi_{4i} \mathrm{CPI_{t-i}} + \sum_{t=1}^{p} \omega_{4i} \mathrm{UNEMPLOY_{t-i}} + \sum_{t=1}^{p} \theta_{4i} \mathrm{BOP_{t-i}} + \varepsilon_t \mathrm{CPI} \quad \ldots\ldots\ldots\ldots\ldots (3.4)$$

$$\mathrm{UNEMPLOY_t} = \alpha_{51+} \sum_{i=1}^{p} \alpha_{5i} M_{t-i} + \sum_{i=1}^{p} \beta_{5i} \mathrm{DR_{t-i}} + \sum_{i=1}^{p} \gamma_{5i} \mathrm{GDP_{t-i}} + \sum_{i=1}^{p} \varphi_{5i} \mathrm{CPI_{t-i}} + \sum_{t=1}^{p} \omega_{5i} \mathrm{UNEMPLOY_{t-i}} + \sum_{t=1}^{p} \theta_{5i} \mathrm{BOP_{t-i}} + \varepsilon_t \mathrm{UNEMPLOY} \quad \ldots\ldots\ldots\ldots (3.5)$$

$$\mathrm{BOP_t} = \alpha_{51+} \sum_{i=1}^{p} \alpha_{6i} M_{t-i} + \sum_{i=1}^{p} \beta_{6i} \mathrm{DR_{t-i}} + \sum_{i=1}^{p} \gamma_{6i} \mathrm{GDP_{t-i}} + \sum_{i=1}^{p} \varphi_{6i} \mathrm{CPI_{t-i}} + \sum_{t=1}^{p} \omega_{6i} \mathrm{UNEMPLOY_{t-i}} + \sum_{t=1}^{p} \theta_{6i} \mathrm{BOP_{t-i}} + \varepsilon_t BOP \quad \ldots\ldots\ldots\ldots\ldots (3.6)$$

$$\mathbf{X_t} = [\mathbf{M_t}, \mathbf{DR_t}, \mathbf{GDP_t}, \mathbf{CPI_t}, \mathbf{UNEMPLOY_t}, \mathbf{BOP_t}]$$

M_t = Money at time t

$\mathrm{DR_t}$ = Discount Rate at time t

$\mathrm{GDP_t}$ = Gross Domestic Product at time t

$\mathrm{CPI_t}$ = Consumer Price Index at time t

$\mathrm{UNEMPLOY_t}$ = Unemployment Rate at time t

$\mathrm{BOP_t}$ = Balance of Payment at time t

ε_t = White Noise Disturbance or Impulse at time t

Reduce form of the Vector Autoregressive is:

$$Z'_t = A_\circ + A_1 \sum_{i=1}^{p} X_{t-1} + \varepsilon_t$$

There is one error term per equation. A white noise process is one with a mean zero, infinite variance and no correlation or statistically independent between its values at different times.

3.3.1 Lag Selection Criteria

In the analysis of VAR, Akaike (AIC), Bayesian (BIC), Hannan-Quinn (HQ), Schwarz (SC), and Maximum Likelihood (LR) information criteria are used in selecting appropriate lag lengths of variables. The lag length should be chosen in such a way that the residuals aren't serially correlated.

- **AIC and BIC**

A better fit model is the one which has a minimum AIC or BIC value among all the other models. To estimate the AIC and BIC of a model the following equations are used:

AIC = -2.ln (L) + 2.K

BIC = -2 ln (L) + 2ln (N).K

L = Value of likelihood

N = Number of recorded measurement

K = Number of Parameters

3.3.2 Why we use VAR Model?

1).For the multivariate time series, the VAR model is one of the most flexible and successful model.

2).Mainly, useful for describing the dynamic behavior of economic and financial time series.

3).Analyze the response to different shocks/impacts.

3.3.3 Description of Data and Variables for Liquidity Puzzle

Main Variables

- Discount Rate:

In Pakistan, the discount rate is the monetary policy instrument. Discount Rate is used as the proxy of Interest Rate. We preferred discount rate because it is not changed frequently like other rates and it appears to be a good measure of monetary policy stance. Monetary policy stance is signaled through change(s) in discount rate as stated by Hanif and Nadim (2014). According to Omer, Haan and Scholtens (2014), the main policy tool of the SBP is the discount rate. To find the relationship between money supply and discount rate. We have taken this variable. Data of annual discount rate of Pakistan is taken from the ***International Financial Statistics*** *(IFS).*

- Money Growth:

Data of Money is extracted from the distinct methods of Monetary Aggregation as mentioned above.

Control Variables

Following are the four control variables:

- Gross Domestic Product

  The ultimate value of the goods produced and the services provided within the geographical boundaries during one year. GDP indicates the economic performance of the state.

- Consumer Price Index

  It is a measure of the weighted average of prices of a basket of consumer goods and services purchased by households, such as medical care, transportation and food,

- Unemployment Rate

  Unemployment rate is defined as the number of people who are unemployed as a percentage of the labor force.

- Balance of Payment

  Balance of Payments is explained as a statement of overall proceedings the transactions made between a specific country with any country elsewhere in the world for a specified time of period.

CHAPTER 4

EMPIRICAL ESTIMATION AND RESULTS

This chapter confirms our empirical and theoretical framework. It is divided into seven parts. First section discusses the evidence from VAR Model. Second section shows the descriptive statistics of the data, third section discusses the estimations of Simple Sum Monetary Policy, Divisia Aggregation, Currency Equivalence Monetary Aggregate and M2. Fourth section represents the lag selection for the model and fifth section shows the results of the VAR estimates. Six section represents the overall results.

4.1 Evidence from Vector Autoregressive Model

In this study, VAR model is used for the time series data to check the liquidity puzzle. Vector Auto regressive model was presented by Christopher Sims (1980). The VAR approach have been the traditional approach engaged in the analysis of monetary policy since 1992. To check the Liquidity Puzzle, Sims (1992), Eichenbaum and Evens (1995), Strongin (1995) Christiano et al. (1996) and Serletis and Chwee (1997) used the Vector Autoregressive Model in their studies.

Beauty of the VAR model is that there is no endogenous variable included in the model. Each variable influences the other variable. We haven't checked the stationarity of the data in our model because our main focus is just to find the relationship among the variables through the impulse response function (IRF). Impulse response function shows how one variable might react to a sudden shock in the other variable.

There is an issue of whether the variables in a VAR model need to be stationary or not. Sims (1980) and Sims, Stock, and Watson (1990) recommended against differencing even if the

variables contain a unit root. They argued that the goal of a VAR analysis is to determine the interrelationships among the variables, not to determine the parameter estimates. The main argument against differencing is that it "throws away" information concerning the comovements in the data (such as the possibility of cointegrating relationships. Enders (2008).

4.2 Descriptive Statistics

Descriptive statistics are used to explain the basic features of the data in the study. Descriptive Statistics which is mentioned below includes the central tendency measures for example mean and median which tell us where the mid of a cluster of the data lie after sorting observations. In the descriptive statistics, the standard deviation measures the statistical dispersion while the value of Jarque Bera test indicates goodness of fit of the sample data. It is clear that all of the data lie between minimum and maximum values, consequently, for all variables descriptive statistics includes maximum and minimum values. On average the mean value of CEM, SS, DMA, M2, DR, CPI, GDP and UR shows the positive arithmetic mean whereas the dispersion behavior of these variables is also greater than zero which is positive in nature. Skewness and Kurtosis are the measures of the normality. Skewness measures the degree of symmetry. Kurtosis measures the degree of sharpness The values of skewness of CEM, SS, DMA,M2, DR, CPI, GDP and UR shows positive numbers which depicts positively skewed distribution whereas, the value of BOP shows negatively skewed distribution. The kurtosis's values of CEM, SS, DMA ,M2, DR, CPI and BOP are greater than 3 which depicts that the distribution of these variables are leptokurtic whereas the values of kurtosis of GDP and UR are less than three which shows platykurtic.

Table 4. 1 Descriptive Statistics

	CEM	SS	DMA	M2	DR	CPI	GDP	UR	BOP
Mean	1862414.	2764847.	1035247.	3013059.	10.40500	49.11180	5300076.	4.965700	-8013.772
Median	497170.6	570165.1	296012.0	764066.0	10.00000	28.66500	4563001.	5.285000	-3356.060
Maximum	87937491.	16823712	59817585.	17459549	20.00000	182.3200	12750126	8.270000	-408.0000
Minimum	12248.92	18026.56	40027.26	20540.00	5.000000	2.890000	1267149.	3.010000	-38038.71
Std. Dev.	2584564.	4438150.	1534591	4598726.	3.160619	51.45500	3377249.	1.625943	9296.079
Skewness	1.472341	1.83	1.71	1.77	0.949683	1.193061	0.608292	0.347446	-1.623159
Kurtosis	4.05	5.27	5.03	5.111516	4.080308	3.137250	2.206224	2.028324	4.851338
Jarque-Bera	20.38	38.78	32.45	35.49	9.947197	11.90086	4.396162	2.972976	29.09589
Probability	0.00	0.00	0.00	0.00	0.006918	0.002605	0.111016	0.226166	0.000000

4.3 Measure of the Monetary Aggregates

Next, in order to find the Liquidity Puzzle, we have measured the monetary aggregates empirically by three different methods that are Simple Sum Monetary Aggregate (SS), Divisia Monetary Aggregate (DMA) and Currency Equivalence Monetary Aggregate (CEM); and one functional form that is M2. Until now there is not an accurate definition of money in monetary economics. There are conflicts on the definition of money. After measuring the monetary aggregates, we have used the Unrestricted VAR model to examine the response of discount rate to one standard deviation impulse of monetary aggregate.

4.3.1 Simple Sum Monetary Aggregates

The data of Simple Sum Monetary Aggregates is calculated by taking the four different types of deposits. To determine the values of the coefficients of the deposits we have regress the log values of gross domestic product on the log values of the four type's deposits as:

$$Y_t = \beta_0 + \sum_i b_i Z_{it} + \mu \qquad (4.1)$$

Y_t = nominal national expenditure

Z_{it} = nominal value of the *i*th deposits

Table 4. 2 Regression Results

Independent Variable : Log of Gross Domestic Product	
Dependent Variables	**Coefficients**
Log of Currency in Circulation	0.20 (0.00)***
Log of Call Deposits	0.04 (0.00)***
Log of Saving Deposits	0.13 (0.00)**
Log of Fixed Deposits	0.04 (0.01)**

Significance level at 1% is represented by ***, 5% is represented by ** and 10% is represented by *.

We will put the values of coefficients in the generalized form:

$$M'' = Z_1 + \sum_I b_i Z_i \quad 0 \leq b_i \leq 1 \qquad (4.2)$$

Z_1 = M1 (currency in circulation, current deposits, other deposits with SBP)

M " = M1 +0.209739 * Currency in Circulation + 0.047284 * Call Deposits +0.130580 * Saving Deposits + 0.049600* Fixed Deposits (4.3)

According to Fisher and Fleissig (1997), the Simple Sum method of Monetary Aggregation can be beneficial for the policy makers when the fluctuations in rate of interest are negligible. If the fluctuations in the interest rate are significant. Some doubts arises regarding the effectiveness of simple sum method of monetary aggregation. The effectiveness of the simple sum is dependent on the assumptions about the elasticity of substitution of monetary assets. It is inconvenient to treat the financial assets as perfect substitutes. The degree of moneyness of some financial assets are more than others hence, they deserve high weights. According to this, alternatives of Simple Sum are constructed.

4.3.2 Divisia Monetary Aggregate

Divisia Monetary Aggregate is proposed Francois Divisia in 1925. This approach is based on quantity and price data. Divisia Aggregate is measured by the given formula:

$$lnz_t - lnz_{t-1} = \sum_i s''_{it} \ (lnz_{it} - lnz_{it-1}) \qquad (4.4)$$

Divisia index provides the rate of change between the two time periods as t and t - 1.This index captures the changes in expenditures over time on liquid assets and this index also captures the influence of those innovations which changes the demand of component assets and relative liquidity.

$$s'_{it} = \frac{z_{it}\ p_{it}\ (R_t^* - R_{it})}{\sum_{i=1}^{m} z_{it}\, p_{it}\ (R_t^* - R_{it})} \qquad (4.5)$$

The above formula is referred as the share of the expenditure on the *i*th liquid asset divided by the total expenditure.

$$s''_{it} = \frac{1}{2}(s'_{it} + s'_{it-1}) \quad (4.6)$$

$$p_i = \frac{1}{1+R_i} \quad (4.7)$$

p_{it} = the price of the asset in period t.

s''_{it} = the average of the expenditure shares.

R_t^* = benchmark rate on the total illiquid assets

Divisia Monetary Aggregates carries the significant statistical properties of statistical indices. The construction of the index is to measure the monetary services that are provided by the financial assets.

4.3.3 Currency Equivalence Monetary Aggregate

Rotemberg (1991) and Rotemberg et al. (1995) proposed the CEM. To calculate the CEM, the rate of return on the liquid assets and the benchmark rate on the illiquid asset are used. The equation that is used to calculate the value of CEM is given below:

$$CEM_t = CC_t + \left(1 - \frac{R_{cd,t}}{R_t^*}\right) CD_t + \left(1 - \frac{R_{sd,t}}{R_t^*}\right) SD_t + \left(1 - \frac{R_{fd,t}}{R_t^*}\right) FD_t \quad (4.8)$$

CC_t = Currency in Circulation

CD_t = Cash Deposits

SD_t = Saving Deposits

FD_t = Fixed Deposits

We include these assets in CE aggregate because they contain the set of assets that have been conventionally considered to be monetary and that have the rate of return less than that of the benchmark rate. It is a time-varying weighted average of the stocks of different financial assets, with weights that depend on each asset's rate of return relative to that on a benchmark rate.

4.3.4 Broad Money (M2)

In Pakistan, to measure the money supply three different types of monetary aggregates are used as well as they are used for policy formulation. They are consist of narrow measures M0, M1 and a broader aggregate M2. The components of M2 are not consistent. With the passage of time, the components of broad money are changed with the passage of time from example from 1970 to 1990, the components of M2 are currency in circulation, other deposits with State Bank of Pakistan, schedule bank demand deposits and schedule bank time deposits but from 1991 to 2007, M2 also includes Resident Foreign Currency Deposits (RFCDs) in its previous definition of broad money.

4.4 VAR Lag Length Selection Criteria

For the estimation of VAR model, the Akaike information criteria is used for the selection of lag length. A better fit model is the one which has a minimum AIC or BIC value among all the other models. The lower value of information criteria represents the accuracy of the model. For all equations, we have selected the Akaike Information Criteria because AIC represents the minimum value in all models at Lag 1.

Table 4. 3 Lag Length Criteria for SS

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2377.92	NA	7.30+e34	97.30	97.53	97.39
1	-1947.16	7.38.44*	7.43e+27*	8.19*	82.81*	81.80*

Endogenous variables: CPI GDP DR SS BOP UR

Table 4. 4 Lag Length Criteria for DMA

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2277.11	NA	8.13e+33	95.12	95.36	95.21
1	-1853.63	723.4481*	8.18e+26*	78.98459*	80.62*	79.60*

Endogenous variables: BOP CPI DMA DR GDP UR

Table 4. 5 Lag Length Criteria for CEM

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2330.36	NA	1.05e+34	95.36	95.59	95.44
1	-1920.92	701.88*	2.55e+27*	80.11*	81.74*	80.73*

Endogenous variables: BOP CPI CEM DR GDP UR

Table 4. 6 Lag Length Criteria for M2

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2376.00	NA	6.75e+34	97.22	97.45	97.31
1	-1885. 643	840.62*	6.03e+26*	78.67*	80.30*	79.29*

Endogenous variables: BOP CPI M2 DR GDP UR

* indicates lag order selected by the criterion

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

4.5 Vector Autoregression Estimates

As all the variables included in the VAR models are endogenous so, there is no exogenous variable in the model. The statistical significance level is mostly defined as a P-value between zero and one. If the p-value of the coefficients is less than level of significance, then reject the null hypothesis and it means that the variable have a significant impact on the other variable. The setting of pre-defined threshold value which is denoted as level of significance (α) is arbitrary. The value of α is generally set to be 0.01, 0.05, 0.005, or 0.001. VAR model is run at lag order 1. The goal of the model is to examine the impact of monetary aggregate on discount rate. If the effect of the monetary aggregate is positive on the discount rate then there exists a Liquidity Puzzle in the model. If the impact of monetary aggregate is negative on discount rate then there exists the Liquidity Effect.

After the estimation of different types of monetary aggregates, we have individually linked those estimates with discount rate to find the Liquidity Puzzle in Pakistan by using the standard VAR model. We have checked the level of significance at 5% (0.05).

4.5.1 Vector Autoregression Estimates of Simple Sum Aggregation

Simple sum monetary aggregate has a positive and significant impact on discount rate at 1%, 5% and 10%. It's mean that there is the presence of the Liquidity Puzzle in the model i.e. if money supply rises the economy, the discount rate will also rise.

Table 4. 7 VAR Estimates of Simple Sum Aggregation

	BOP	**UR**	**CPI**	**GDP**	**DR**	**SS**
BOP(-1)	0.29 (0.20) [1.42]	0.00 (4.4E-05) [2.53]	-0.00 (0.00) [-1.15]	10.30 (6.72) [1.53]	7.17E-05 (0.00) [0.63]	-26.71 (17.83) [-1.49]
UR(-1)	984.80 (529.30) [1.86]	0.68 (0.11) [6.09]	-0.76 (0.40) [-1.86]	3227.15 (17091.7) [0.18]	-0.33 (0.28) [-1.17]	-16182.39 (45344.6) [-0.35]
CPI(-1)	52.90 (78.42) [0.67]	-0.017 (0.01) [-1.05]	0.95 (0.06) [15.73]	-4418.20 (2532.38) [-1.74]	-0.17 (0.04) [-4.16]	20482.62 (6718.43) [3.04]
GDP(-1)	-0.00 (0.00) [-2.33]	3.42E-07 (2.0E-07) [1.74]	1.75E-06 (7.1E-07) [2.46]	1.08 (0.02) [36.52]	1.51E-06 (5.0E-07) [3.03]	-0.06 (0.07) [-0.77]
DR(-1ð)	451.50 (151.23) [2.98]	0.05 (0.03) [1.64]	0.11 (0.11) [0.94]	-13498.16 (4883.67) [-2.76]	0.857 (0.08) [10.48]	-33721.14* (12956.4) [-2.60]
SS(-1)	-0.00 (0.00) [-0.93]	2.55E-07 (1.7E-07) [1.51]	-2.24E-07 (6.1E-07) [-0.36]	0.039 (0.02) [1.54]	1.22E-06*** (4.2E-07) [2.87]	0.86 (0.06) [12.83]
C	-5023.64 (1961.73) [-2.56]	0.340 (0.41) [0.81]	-1.50 (1.51) [-0.99]	111965.8 (63346.2) [1.76]	1.26 (1.06) [1.18]	267862.3 (168058.0) [1.59]

Significance level at 1% is represented by ***, 5% is represented by ** and 10% is represented by *.

Equation is:

DR = C(29)*BOP(-1) + C(30)*UR(-1) +C(31)*CPI(-) +C(32)*GDP(-1) +C(33)* DR(-1) +C(34)*SS(-1) +C(35)

4.5.2 Vector Autoregression Estimates of Divisia Aggregation

The Divisia monetary aggregate shows the positive and significant impact on discount rate at 1% of significance level. The P-value of the coefficient is 0.0088 which is less than 0.01.

Table 4. 8 VAR Estimates of Divisia Aggregation

	CPI	BOP	GDP	UR	DMA	DR
CPI(-1)	0.75	-145.93	-234.76	-0.02	-1456.03	-0.17
	(0.05)	(83.11)	(2775.23)	(0.01)	(3129.79)	(0.04)
	[13.00]	[-1.75]	[-0.08]	[-1.14]	[-0.46]	[-3.76]
BOP(-1)	0.00	0.69	0.95	0.00	-16.49	2.37E-05
	(0.00)	(0.19)	(6.41)	(4.2E-05)	(7.22)	(0.00)
	[1.38]	[3.60]	[0.14]	[2.57]	[-2.28]	[0.21]
GDP(-1)	3.10E-06	-0.00	1.05	3.52E-07	0.03	1.43E-06
	(6.4E-07)	(0.00)	(0.03)	(2.0E-07)	(0.03)	(5.1E-07)
	[4.87]	[-0.82]	[34.73]	[1.76]	[1.02]	[2.78]
UR(-1)	-1.05	711.42	8558.50	0.67	-5333.43	-0.38
	(0.36)	(525.55)	(17549.5)	(0.11)	(19791.6)	(0.29)
	[-2.86]	[1.35]	[0.48]	[5.81]	[-0.26]	[-1.28]
DMA(-1)	5.82E-06	0.00	-0.025	8.15E-07	0.99	3.45E-06***
	(1.7E-06)	(0.00)	(0.07)	(5.3E-07)	(0.09)	(1.4E-06)
	[3.46]	[1.87]	[-0.32]	[1.54]	[11.07]	[2.55]
DR(-1)	0.15	525.93	-17582.34	0.038	-6894.32	0.76
	(0.09)	(140.49)	(4691.31)	(0.03)	(5290.67)	(0.07)
	[1.54]	[3.74]	[-3.74]	[1.23]	[-1.30]	[9.69]
C	-1.38	-5283.97	153559.7	0.52	-15800.36	2.37
	(1.36)	(1938.22)	(64721.3)	(0.42)	(72990.0)	(1.09)
	[-1.01]	[-2.72]	[2.37]	[1.22]	[-0.21]	[2.17]

Significance level at 1% is represented by ***, 5% is represented by ** and 10% is represented by *.

Equation is:

DR = C(36)*CPI(-1) + C(37)*BOP(-1) +C(38)*GDP(-) +C(39)*UR(-1) +C(40)* DMA(-1) +C(41)* DR(-1) +C(42)

4.5.3 Vector Autoregression Estimates of Currency Equivalence Aggregation

The currency equivalence monetary aggregates shows positive and significant impact on discount rate at 5% level of significance. P-value of the coefficient is less than 0.05.

Table 4. 9 VAR Estimates of Currency Equivalence Aggregation

	CPI	UR	BOP	GDP	DR	CEM
CPI(-1)	0.90 (0.05) [16.76]	-8.54E-05 (0.01) [-0.00]	148.71 (64.06) [2.32]	-6190.55 (2114.15) [-2.92]	-0.15 (0.03) [-4.03400]	12419.19 (4220.48) [2.94]
UR(-1)	-0.87 (0.42) [-2.04]	0.69 (0.12) [5.78]	1397.83 (504.16) [2.77]	-8737.96 (16637.2) [-0.52]	-0.47 (0.30) [-1.58]	-16936.89 (33213.0) [-0.50]
BOP(-1)	-5.00E-05 (0.00) [-0.28]	7.54E-05 (5.0E-05) [1.51]	-0.05 (0.20) [-0.28]	18.72 (6.84) [2.73]	9.13E-05 (0.00) [0.73]	20.55 (13.67) [1.50]
GDP(-1)	1.94E-06 (6.1E-07) [3.20]	1.91E-07 (1.7E-07) [1.10]	-0.00 (0.00) [-2.71]	1.06 (0.02) [45.08]	8.92E-07 (4.3E-07) [2.07]	0.037693 (0.04730) [0.79685]
DR(-1)	0.19 (0.14) [1.31]	0.04 (0.04) [1.06]	153.41 (172.03) [0.89]	-4985.48 (5677.07) [-0.87818]	0.95 (0.10) [9.23]	-28804.45** (11333.2) [-2.54161]
CEM(-1)	8.89E-07 (1.3E-06) [0.67]	1.19E-07 (3.8E-07) [0.31]	-0.00 (0.00) [-3.06]	0.15 (0.05) [2.98]	2.49E-06** (9.4E-07) [2.64]	0.85 (0.10) [8.27]
C	-1.58 (1.47) [-1.07]	0.48 (0.42) [1.15]	-5661.27 (1751.77) [-3.23]	140831.5 (57807.6) [2.43]	2.04 (1.05) [1.94]	194904.3 (115402.) [1.68]

Significance level at 1% is represented by ***, 5% is represented by ** and 10% is represented by *.

Equation is:

DR = C(29)*CPI(-1) + C(30)*UR(-1) +C(31)*BOP (-) +C(32)* GDP (-1) +C(33)* DR(-1) +C(34)* CEM(- 1) +C(35)

4.5.4 Vector Autoregression Estimates of M2

Impact of M2 on discount rate is positive and significant at 5% level of significance just like Simple Sum Monetary Aggregates, Divisia Aggregation and Currency Equivalence Monetary Aggregates.

Table 4. 10 VAR Estimates of M2

	CPI	UR	BOP	GDP	DR	M2
CPI(-1)	0.983397	-0.018115	41.19929	-5587.529	-0.176248	8036.238
	(0.06532)	(0.01822)	(85.3621)	(2705.92)	(0.04684)	(2412.45)
	[15.0547]	[-0.99421]	[0.48264]	[-2.06493]	[-3.76241]	[3.33115]
UR(-1)	-0.676579	0.661817	1035.131	-3487.195	-0.463745	-33540.59
	(0.42351)	(0.11813)	(553.443)	(17543.8)	(0.30372)	(15641.1)
	[-1.59755]	[5.60238]	[1.87035]	[-0.19877]	[-1.52690]	[-2.14439]
BOP(-1)	-0.000252	0.000114	0.322648	13.03566	7.15E-05	10.15349
	(0.00017)	(4.8E-05)	(0.22287)	(7.06487)	(0.00012)	(6.29866)
	[-1.47928]	[2.39285]	[1.44769]	[1.84514]	[0.58448]	[1.61201]
GDP(-1)	1.55E-06	3.42E-07	-0.002050	1.092062	1.49E-06	0.034530
	(7.3E-07)	(2.0E-07)	(0.00095)	(0.03008)	(5.2E-07)	(0.02682)
	[2.13606]	[1.68880]	[-2.16047]	[36.3007]	[2.86940]	[1.28740]
DR(-1)	0.087423	0.053271	461.5103	-12563.81	0.856465	-20266.16
	(0.11797)	(0.03291)	(154.166)	(4886.95)	(0.08460)	(4356.95)
	[0.74105]	[1.61885]	[2.99360]	[-2.57089]	[10.1234]	[-4.65146]
M2(-1)	-5.54E-07	2.56E-07	-0.000588	0.052250	1.20E-06**	1.025638
	(6.6E-07)	(1.9E-07)	(0.00087)	(0.02752)	(4.8E-07)	(0.02453)
	[-0.83347]	[1.38075]	[-0.67718]	[1.89891]	[2.52108]	[41.8089]
C	-1.538274	0.435443	-5321.403	124380.1	1.719664	188493.3
	(1.47711)	(0.41202)	(1930.29)	(61188.9)	(1.05930)	(54552.7)
	[-1.04140]	[1.05686]	[-2.75679]	[2.03272]	[1.62340]	[3.45525]

Significance level at 1% is represented by ***, 5% is represented by ** and 10% is represented by *.

Equation is:

DR = C(29)*CPI(-1) + C(30)*UR(-1) +C(31)*BOP (-) +C(32)* GDP (-1) +C(33)* DR(-1) +C(34)*M2(-1) +C(35)

4.6 Impulse Response Function

It is difficult to interpret the coefficients of the different variables in the VAR model. Therefore, we look at the impulse response function. In impulse response function, the impulse represents the source of shock and the response represents the effects of the shock. The blue solid line shows the point estimates of the response and dotted lines in red colour shows the upper and lower error bands. At vertical axis the lengths of the response is

mentioned while on horizontal axis annual time period is mentioned. If the lower and upper lines in red colour which are known as the confidence interval does not contain zero then the impulse response is statistically significant at 95% confidence interval.

Confidence interval is calculated using asymptotic standard errors. Impulse response function represents the function of the forward time period. From the occurrence of shock response is plotted for the period of ten. To check the Liquidity Puzzle, we have created the separate impulse response function for monetary aggregates and discount rate.

4.6.1 Impulse Response Function of Simple Sum Monetary Aggregates

To check the liquidity puzzle we have estimated the impulse response function. This function shows the response of discount rate to a positive one-standard deviation shock of simple sum monetary aggregate (SS). Response is shown below:

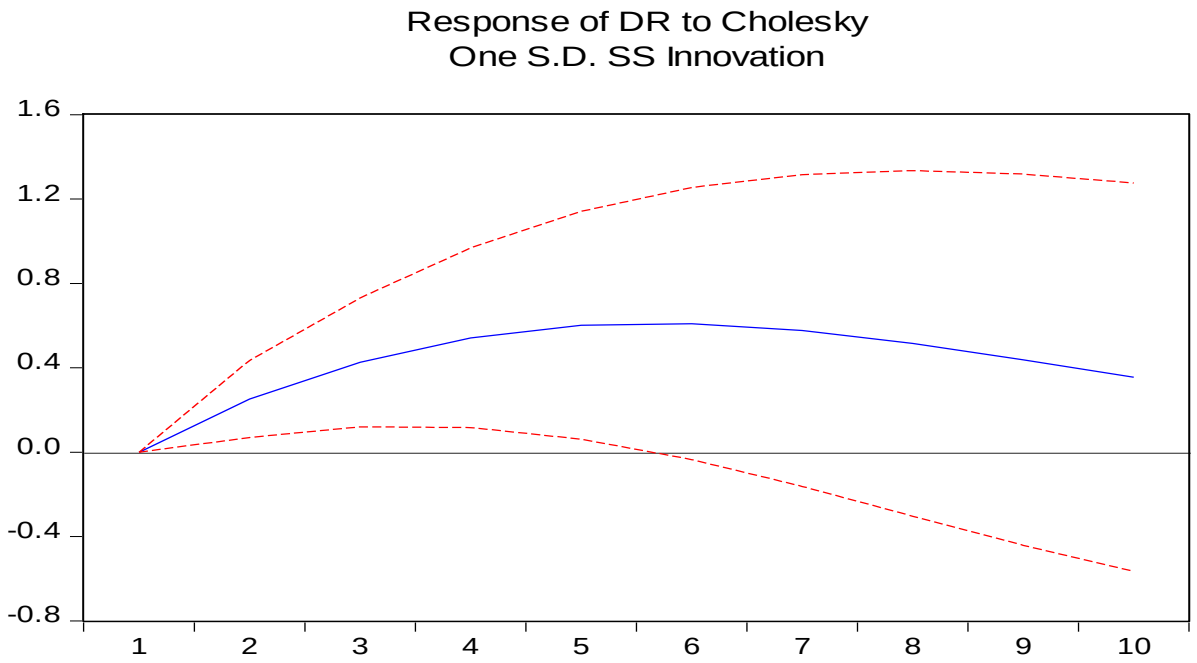

Figure 4. 1 Response of Discount Rate on Simple Sum Aggregate Impulse

A continuous rise in discount rate till period five can be observed. After that it declines slightly till period 10. Impulse responses are almost significant from period 1.0 to 5.5. After that they show the insignificance response. We find a positive correlation between the shock of simple sum monetary aggregates and the discount rate.

4.6.2 Impulse Response Function of Divisia Monetary Aggregates

The figure 4.2 represents the response of discount rate to a one standard deviation shock of Divisia Monetary Aggregate (DMA).

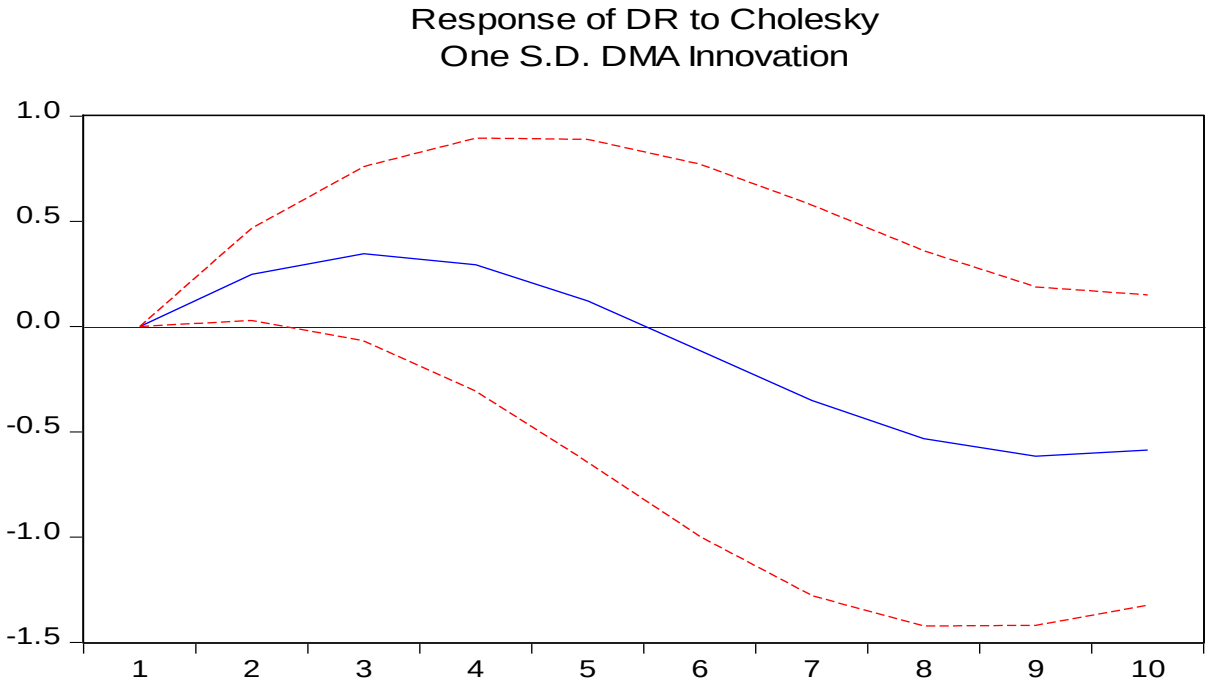

Figure 4. 2 Response of Discount Rate on Divisia Aggregates Impulse

From period one to five, the response function increases above zero from period one but converges to steady state at period 5. From period one to five, it shows positive correlation but five onwards it shows a negative correlation which shows the fisher effect. The response of discount rate to the shock of Divisia monetary aggregate is statistically insignificant at 95% of the confidence interval. Divisia Monetary Aggregates is preferred over the Simple

Sum Monetary Aggregates because it permits the weighted aggregate of the growth rates of the components of assets in order to measure the monetary services. Divisia Monetary Aggregate has the capability to react to the financial innovation.

Pagan and Robertson (1995) examined the Liquidity effect in three sub-sample period. They saw the response of federal fund rate by the shock of non-borrowed reserve over the first two periods they find a negative response but after the second period, the response of federal fund rate is positive.

4.6.3 Impulse Response Function of Currency Equivalence Monetary Aggregates

Impulse response function shows the response of discount rate to a positive one-standard deviation shock of currency equivalence monetary aggregate(CEM).

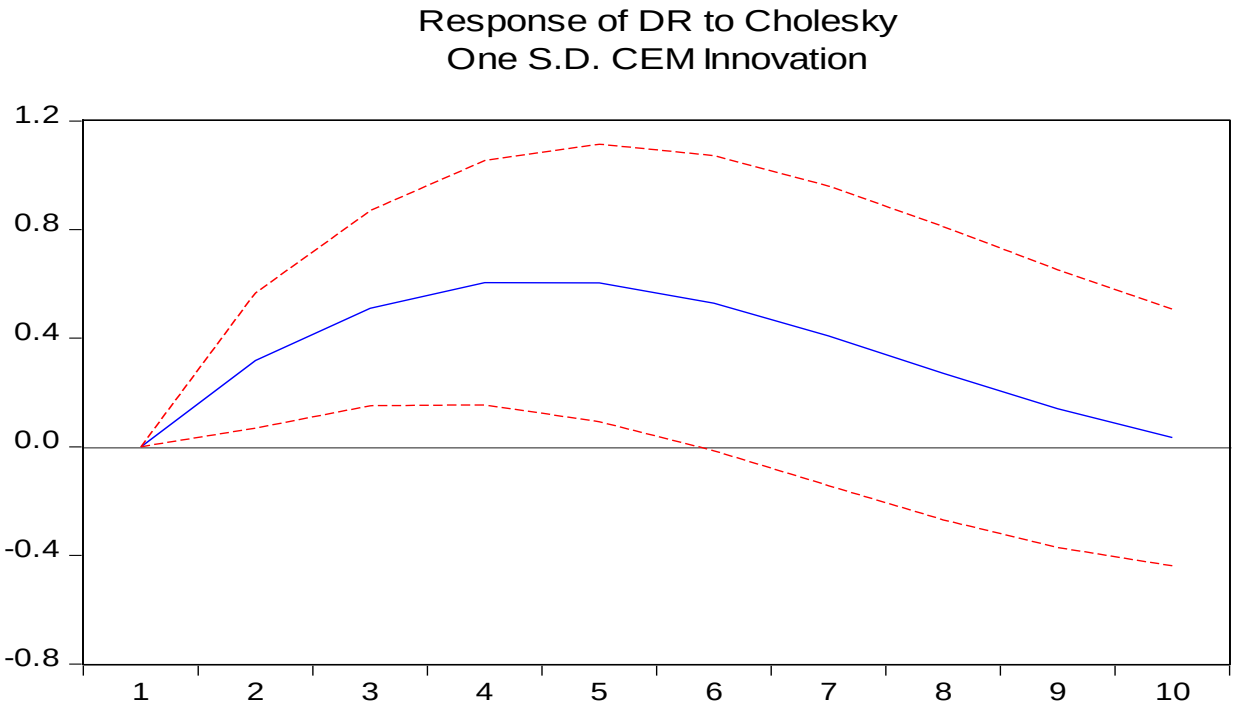

Figure 4. 3 Response of Discount Rate on Currency Equivalence Aggregates Impulse

When Currency Equivalence Monetary Aggregate are used to measure the money supply, we find a positive correlation between an impulse in the Currency Equivalence Monetary

Aggregate and the response of Discount rate but after period five it converges down. This graph shows statistically significant liquidity puzzle till the period five at 95% of confidence interval.

4.6.4 Impulse Response Function of (M2) Monetary Aggregates

The graph given below describe the response of discount rate to a positive one-standard deviation shock of M2 monetary aggregate.

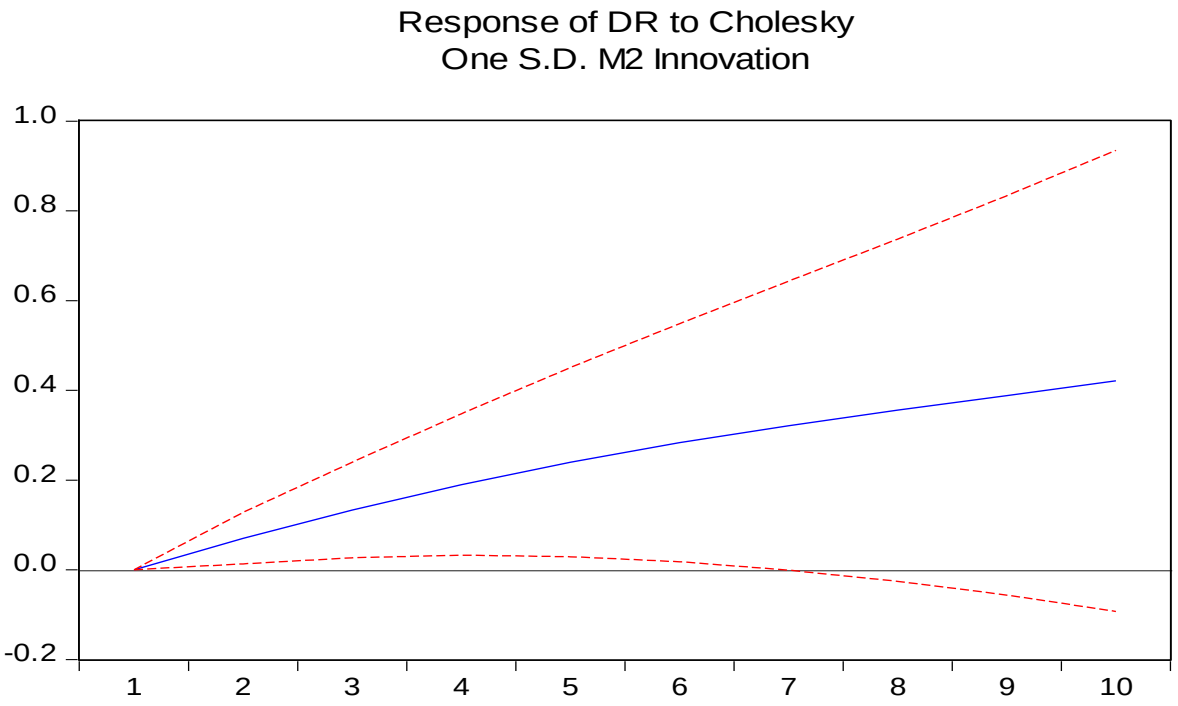

Figure 4. 4 Response of Discount on M2 Impulse

The figure 4.4 shows the upward trend between an impulse in the M2 and the response of Discount rate. While the Liquidity Puzzle is statistically significant till period 7 and from the earlier studies, it can also be examined that the correlation between the conventional monetary aggregate M2 and the discount rate is positively correlated and it also shows the upward trend till the period 7. These results are against the theory of Keynesian.

4.7 Results

To control the inflation, the Central Bank uses two tools that are Money Supply and the interest rate. Suppose the inflation rate in the economy increases, the Central Bank will use the monetary policy to increase the interest rate and the money supply should decrease but instead of decreasing it is increasing which creates more inflation and thus creates the 'Liquidity Puzzle'.

Basically, this study finds the relationship of interest rate with four different types of monetary aggregates such as: Simple Sum Monetary Aggregate, Divisia Monetary Aggregate, Currency Equivalence Monetary Aggregate and M2. M2 is the functional approach while the other three are the theoretical approaches to measure the monetary aggregate.

In this study, the VAR model provides the findings which does not support the Keynesian Theory of Money. According to Keynesian Theory of Money, when there is a rise in supply of money the interest rate will fall. The results of this study depicts that no matter what the measures of monetary aggregates are used, the problem of liquidity puzzle will exists. Munir et al. (2012) examined the relationship of M2 monetary aggregate with the discount rate and finds that the Liquidity Puzzle exists in case of Pakistan by using VAR model.

Simple Sum Monetary Aggregate, Currency Equivalence Monetary Aggregate and M2 shows the positive correlation with the interest rate while Divisia Monetary Aggregate represents the positive correlation till period five. As cited by Sims (1986), the liquidity puzzle is frequently found in VAR models due to the measure of monetary policy shocks in conventional monetary aggregates by the orthogonalized innovation.

Criticism arises on the use of VAR is that this methodology only reflects unexpected fluctuations in monetary policy. As examined by Sims and Zha (1998), mostly the changes in the policy are systematic. It means they are the responses to the deviations in the economy. The VAR does not reflect this systematic component and hence underestimates the result of monetary policy. In actual, the systematic component of the monetary policy fluctuations can be mixed up with the shocks, resulting in dynamic responses that do not resemble those that have been anticipated by the usual macroeconomic models.

Namini (2018) pointed out the influence of monetary policy shocks on the real economy by using the data of Iran, the Researcher compares the result of FAVAR with VAR and find the Liquidity Puzzle in VAR while FAVAR doesn't show any evidence of Liquidity Puzzle.

Due to the effect of renovations in financial sector and the incorporation of the new assets, the Divisia Monetary Aggregate is considered as the appropriate method for the monetary Aggregates. The response of discount rate to Divisia Monetary Aggregate impulse shows the existence of Liquidity Puzzle at the start but in mid it converges to zero and after that it shows the liquidity effect.

CHAPTER: 5

CONCLUSION AND POLICY RECOMMENDATION

It is essential for the authorities to understand the effects of monetary policy to achieve the goals of their policies .According to Keynesian theory of money when money supply increases in the economy the interest rate will decline while according to the Liquidity Puzzle is opposite of this i.e. when money supply increases the rate of interest will fall. Our research objectives is to calculate the value of monetary aggregate by three different methods and M2 for Pakistan and then relate those monetary aggregates with interest rate to check the Liquidity Puzzle. The source of data is State Bank of Pakistan (SBP) and International Financial Statistics (IFS). Vector Autoregressive Model are used to check the shocks of monetary Aggregates.

Simple Sum Monetary Aggregate, Currency Equivalence Monetary Aggregate and M2 shows Liquidity Puzzle but Divisia Monetary Aggregate shows the positive correlation till period five and five onward it shows a negative relationship. Divisia Monetary Aggregate shows different results due to the effect of developments that changes the relative liquidity and demands of component asset. The weightage used for each asset is its share of entire expenditures that differ across the time period is one of the attractive features of Divisia Monetary Aggregate. M2 totally shows the upward trend till the end while the Simple Sum and Currency Equivalence shows the converging behavior towards zero at the end of the period.

Hence, from this study it can be concluded that the measure of monetary aggregation by Currency Equivalence, Simple Sum or M2 illustrates the Liquidity Puzzle by using the VAR model. By changing the definition of money, the discount rate shows different responses.

The objectives of this study are well attained but still there is a space for further research. For example, FAVAR can be used as a model to find the existence of Liquidity by using the empirical as well as functional approaches of monetary aggregates.

On the basis of our empirical findings, now we have to give an overview of recommendations and the policy implications. As this study make an attempt to estimate the three types of monetary aggregates, so an associative objective of the study was to evaluate and examine the relationship between the monetary aggregates and interest rate. On the basis of our empirical analysis we are at this point to say that there is no difference among simple sum monetary aggregate, Currency equivalence aggregate and M2 because all of them yield the same results that is the presence of Liquidity Puzzle. The monetary authorities of the state can use any of these monetary aggregates while making the policies.

References

Acharya, D., & Kamaiah, B. (2001). Simple Sum vs Divisia Monetary Aggregates: An Empirical Evaluation. Economic and Political Weekly, 317-326.

Barnett, W. A. (1980). Economic monetary aggregates an application of index number and aggregation theory. *Journal of econometrics*, *14*(1), 11-48.

Barnett, W. A., Offenbacher, E. K., & Spindt, P. A. (1984). The new Divisia monetary aggregates. Journal of Political Economy, 92(6), 1049-1085.

Barnett, W., Kelly, L., & Keating, J. (2010). Rethinking the Liquidity Puzzle: Application of a New Measure of the Economic Money Stock (No. 201002). University of Kansas, Department of Economics.

Barnett, W., Kelly, L., & Keating, J. (2010). *Rethinking the Liquidity Puzzle: Application of a New Measure of the Economic Money Stock* (No. 201002). University of Kansas, Department of Economics.

Bello, M. Z., & Saulawa, M. A. (2013). Relationship between Inflation, Money Supply, Interest Rate and Income Growth (Rgdp) in Nigeria 1980-2010. An Empirical Investigation. Journal of Economics and Sustainable Development, 4(8)

Belongia, M. T. (1996). Measurement matters: Recent results from monetary economics reexamined. *Journal of Political Economy*, *104*(5), 1065-1083.

Belongia, M. T., & Chrystal, K. A. (1991). An admissible monetary aggregate for the United Kingdom. The Review of Economics and Statistics, 497-503.

Bilan, O. (2005). In search of the liquidity effect in Ukraine. *Journal of Comparative Economics*, *33*(3), 500-516.

Celik, S., & Uzun, S. (2009). Comparison of simple sum and divisia monetary aggregates using panel data analysis. International Journal of Social Sciences and Humanity Studies, 1(2), 1-13.

Chetty, V. K. (1969). On measuring the nearness of near-moneys. The American Economic Review, 59(3), 270-281.

Divisia, F. (1925). L'INDICE MONÉTAIRE ET LA THÉORIE DE LA MONNAIE (Suite et fin). *Revue d'économie politique*, *40*(1), 49-81

Edwards, F. R. (1972). More on substitutability between money and near-monies. Journal of money, credit and banking, 4(3), 551-571.

Eichenbaum, M., & Evans, C. L. (1995). Some empirical evidence on the effects of shocks to monetary policy on exchange rates. *The Quarterly Journal of Economics*, *110*(4), 975-1009.

Elger, T., Jones, B. E., & Nilsson, B. (2006). Forecasting with monetary aggregates: recent evidence for the United States. Journal of Economics and Business, 58(5-6), 428-446.

El-Shagi, M., Giesen, S., & Kelly, L. J. (2012). Monetary Policy in a World Where Money (Also) Matters (No. 6/2012). IWH Discussion Papers.

Enders, W. (2008). *Applied econometric time series*. John Wiley & Sons.

Fatima, N., & Sahibzada, S. A. (2012). Empirical evidence of Fisher effect in Pakistan. World Applied Sciences Journal, 18(6), 770-773.

Fisher, D., & Fleissig, A. R. (1997). Monetary aggregation and the demand for assets. *Journal of Money, Credit, and Banking*, 458-475.

Fisher, I. (1896). *Appreciation and Interest: A Study of the Influence of Monetary Appreciation and Depreciation on the Rate of Interest with Applications to the Bimetallic Controversy and the Theory of Interest* (Vol. 11, No. 4). American economic association.

Fisher, I. (1922). The making of index numbers: a study of their varieties, tests, and reliability (No. 1). Houghton Mifflin.

Gazely, A. M., & Binner, J. M. (2000). The application of neural networks to the Divisia index debate: Evidence from three countries. *Applied Economics*, *32*(12), 1607-1615.

Gebregiorgis, B. S., & Handa, J. (2005). Monetary aggregation for a developing economy: A case study of Nigeria. The Journal of Developing Areas, 119-141.

Hanif, M. N. (2014). Monetary Policy Experience of Pakistan.

Hendrickson, J. R. (2014). Redundancy or mismeasurement? A reappraisal of money. Macroeconomic Dynamics, 18(7), 1437-1465.

Hussain, F. Flexible Inflation Targeting and Relevance of Monetary Aggregates for Inflation in Pakistan.

Jan, A., Haider, A., & Bukhari, S. K. H. (2013). *On The (Ir) relevance of Monetary Aggregate Targeting in Pakistan: An Eclectic View* (No. 62). State Bank of Pakistan, Research Department.

Javid, M., & Munir, K. (2010). The price puzzle and monetary policy transmission mechanism in Pakistan: Structural vector autoregressive approach. *The Pakistan Development Review*, 449-460.

Khan, M. U. H., & Hussain, F. (2005). *Monetary Aggregates in Pakistan: Theoretical and Empirical Underpinnings* (No. 7). Working Papers.

L, R. C. P., & Dayaratna-Banda 2013, O. G. The Relationship between Money Supply and Interest Rates: An Empirical Investigation in Sri Lanka.

Monetary Economics by Jadish Handa, page no. 65.

Monnet, C., & Weber, W. E. (2001). Money and interest rates. Federal Reserve Bank of Minneapolis Quarterly Review, 25(4), 2-13.

Muhanji, S., Malikane, C., & Ojah, K. (2013). Price and liquidity puzzles of a monetary shock: Evidence from indebted African economies. *Economic Modelling*, *33*, 620-630.

Munir, K., & Qayyum, A. (2012). Measuring the effects of monetary policy in Pakistan: a factor-augmented vector autoregressive approach. *Empirical Economics*, *46*(3), 843-864.

Munir, K., & Qayyum, A. (2014). Measuring the effects of monetary policy in Pakistan: a factor-augmented vector autoregressive approach. *Empirical Economics*, *46*(3), 843-864.

Nichols, D. A., Small, D. H., & Webster, C. E. (1983). Why interest rates rise when an unexpectedly large money stock is announced. *The American Economic Review*, *73*(3), 383-388.

Omer, M., Saqib, O. F., & Riazuddin, R. (2008). *Monetary targeting in Pakistan: A skeptical note*. State Bank of Pakistan.

Omer, M., de Haan, J., & Scholtens, B. (2014). *Impact of interbank liquidity on monetary transmission mechanism: a case study of Pakistan* (No. 70). State Bank of Pakistan, Research Department.

Pagan, A. R., & Robertson, J. C. (1995). Resolving the liquidity effect. *Review-Federal Reserve Bank of St. Louis*, *77*(3), 33.

PIDE (2010) PIDE Monetary Policy Viewpoint, October

Polat, U. (2018). Divisia and Simple Sum Monetary Aggregates: Any Empirical Relevance for Turkey? Journal of Central Banking Theory and Practice, 7(1), 175-206s

Schunk, D. L. (2001). The relative forecasting performance of the Divisia and simple sum monetary aggregates. *Journal of Money, Credit and Banking*, 272-283.

Siami-Namini, S. (2018). The Effect of Monetary Policy Shocks on the Real Economy: A FAVAR Approach. Res J Econ 2: 1. *of*, *9*, 2.

Sims, C. A. (1986). Are forecasting models usable for policy analysis?. *Quarterly Review*, (Win), 2-16.

Sims, C. A., & Zha, T. A. (1998). *Does monetary policy generate recessions?* (No. 98-12). Working paper.

Strongin, S. (1995). The identification of monetary policy disturbances explaining the liquidity puzzle. *Journal of Monetary Economics*, *35*(3), 463-497.

Tariq, S. M., & Matthews, K. (1997). The demand for simple-sum and Divisia monetary aggregates for Pakistan: A Cointegration approach. The Pakistan Development Review, 275-291.

Urich, T., & Wachtel, P. (1981). Market response to the weekly money supply announcements in the 1970s. *The Journal of Finance*, *36*(5), 1063-1072.