Money-price Nexus: An Application of Markov Chain Methodology

By

Rabail Mir
Registration No. PIDE2016FMPHILETS07

Supervisor
Dr. Abdul Jalil

Department of Econometrics and Statistics
Pakistan Institute of Development Economics
Islamabad, Pakistan

2019

Pakistan Institute of Development Economics

CERTIFICATE

This is to certify that this thesis entitled: **"Money Price Nexus: An Application of Markov Chain Methodology"** submitted by Ms. Rabail Mir is accepted in its present form by the Department of Econometrics and Statistics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in **Master of Philosophy in Econometrics**.

Supervisor:

Dr. Abdul Jalil
SBP Chair
PIDE, Islamabad.

External Examiner:

Dr. Farzana Naheed Khan
Assistant Professor
School of Economics
Qauid-i-Azam University, Islamabad

Head,
Department of Econometrics and Statistics:

Dr. Amena Urooj

This dissertation is dedicated to

My parents, my husband & my son.

(for their endless love, support, prayers and encouragement)

ACKNOWLEDGMENTS

All thanks and praises to ALLAH Almighty, the merciful, the compassionate, who provided me

the opportunity and strength to complete the research work within the stipulated time.

“ONE GOOD MENTOR COULD BE MORE INFORMATIVE THAN A COLLEGE EDUCATION AND MORE VALUABLE THAN A DECADES INCOME”

I would like to express my gratitude to my mentor Dr. Abdul Jalil . I am highly obliged to him for his guidance and cooperation. It is due to his intense support from beginning to the end that I have completed this research study successfully.

I would like to thank all the teachers of Econometrics department and my external examiner

Professor Dr. Farzana, whose guidance and encouragement has helped me during my academic period at Pakistan Institute of Development Economics. I am grateful to my parents and all family members for their blessings and encouragement in completing this study.

I feel indebted to my my husband for his assistance and encouragement throughout the time period of the study. I appreciate his interest and support during this study. In the end I would like to thank my friends (**Lubna , Namal and Fatima**) for their support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATION

HH: High-High

LH: Low-High

HL: High-Low

LL: Low-Low

MCM: Markov Chain Method

MS: Money Supply

CPI: Consumer Price Index

M2: Broad Money

TP: Transition Probability

QTM: Quantity theory of Money

WDI: World Development Indicator

MP: Monetary Policy

GC: Granger Causality

ABSTRACT

This study has been conducted to investigate the empirical evidence for money-price nexus by using a new econometric methodology i.e. Markov Chain Method (MCM) and compared it with the existing methodology. MCM has many essential differences from those currently in use. One of them is that we do not treat data as being capable of giving us final answer to any question, but only as a way to give clues about reality. The broad money (M2) and CPI data retrieved from WDI World Bank from 1960-2016. By using MCM based on median measure the analysis of CPI has shown that among all the countries, there are exceptional countries which remain in low inflation category with unusual too high transitions are United States, Trinidad and Tobago, Thailand, Switzerland, Sweden, South Africa, Philippines, Pakistan, Norway, New Zealand, Morocco, Mauritius, Libya, India, Denmark, Canada and Australia which have 28/14 unusual H-L and 28/13 L-H transitions in CPI respectively. The MCM results for broad money have not shown any unusual behavior among any of the countries used in the sample studies. To re-examine the hypothesis, broad money led to CPI the data show some unusual behavior in low and high category of ΔM2 and ΔCPI for six countries i.e. Ecuador, India, Myanmar, Trinidad and Tobago, Peru and South Africa. In order to assess hypothesis for low and high M2/CPI countries the results of Cross MCM have shown that there is a unidirectional causation from broad money to CPI for Ecuador and Myanmar. South Africa, Trinidad and Tobago and India supports a bidirectional causal relationship among broad money and CPI. Congo, Dem. Rep has a unidirectional causality running from CPI to broad money. On the other hand side results of Standard Granger Causality Test on the same data set, indicate that Ecuador, Myanmar, India, Trinidad and Tobago South Africa and Congo, Dem. Rep. has significant causal relationship between money and CPI.it is bidirectional. For Peru, the Granger Causality test shows there is no significant causal relationship among broad money and CPI. The result of panel cointegration shows a long run relationship between money supply and inflation. For the magnitude of coefficient, cointegration test shows a partial effect of money supply on inflation. The difference in the findings for each country is may be due to the change in the system of incentives, implementation of different monetary policies, and structure of economy.

CHAPTER 1

INTRODUCTION

The relationship between price and money is one of the most important concept in economics. It is most debated and addressed issue with in the historical development process of economy. Because these type of relationship reveals the suitable monetary policy(MP) and its efficiency. It is also debated amongst different economics school of thoughts mainly among the Keynesians and the Monetarists. The Monetarists school of thought considers that money stocks effect price level. It can be also said that the causality's direction is from money to price showing that money supply(MS) can control the price. On the contrary, Keynesians proclaim that money is significant but does not result in fluctuation in price levels. Alternatively, significant role is played by structural factors indicating that MS is not an effective tool in controlling the change in price(Humphrey 1974).

In the current era of finance, money is much more complex than it was used earlier as a simple gold and silver form and the price level is also a difficult measurement. The relationship between price and money is traditionally related with quantity theory of money(QTM). QTM was most challenging, however as controversial as it is primeval, in the field of monetary theory, the quantity theory seemed to result in more debate than any other particular subject. The past two centuries, including the Bullionist and Currency School-Banking School debates of the 1800's, and the controversy between Keynes and the neoclassical economists in the 1930's, have revolved around issues relating to the quantity theory are some of the leading monetary controversies.

Historical evidences show that continuous rise in price is directly related to the rise in money growth. Countries like Zimbabwe from March 2007 to November 2008,

Hungary from August 1945 to July 1946, Greece from May 1941 to December 1945, Germany from August 1922 to December 1923 and Yugoslavia from April 1992 to January 1994are the world's major hyperinflation occurrences that were predominantly associated with immoderate MS by the government (Hanke and Krus, (2012)). Price stability is a precondition for economic growth and development and main objective for attaining this stability is MP.

Similarly, we cannot ignore the role that money plays in economy, is an important one. In the economy numerous interior and exterior factors influence the price level in which MS is the foremost interior factor affecting price level as excessive MS can lead to an increase in price level. For the functioning of economy the most important requisite is the stability of money.

In last few years, the vital problem for policy makers, researchers, and economists, is the study of the causation between MS and price. Because such association unveils the suitable MP as well as its efficiency. Indeed, the money-price nexus is well researched in the literature of economics and econometrics and there is an ample literature available on the relationship between money and price and this causal association between money and price is not questionable. However, it is quite clear that the empirical findings may be sensitive to methodology to methodology, technique to technique, sample to sample and variable to variable. Therefore, there is always a room to reinvestigate the nexus. The present study is also an attempt in this way.

Furthermore, no study can yet discuss the changes and transitions of only money and price within economy. However, the money and price has not been constant and changes over time. Therefore, in our study we will discuss the role of transitions of price and broad money. Transitions of money represent the process where narratives

and economic structures are constructed to give people the ability to move away from the mainstream economy that may have been on the decline. It is important to keep an eye at past changes and transitions for lesson about how they might unfold in the future. Here in our study we will observe the phases of transitions (i.e. lower to lower, higher to lower, lower to higher and lower to lower) whether these transitions are same for the economies and for all the time periods or not.

The present study separate itself from the literature in several ways. Specifically, we use a MCM. To the best of our knowledge we could not find any study in which money price nexus is examined. Existing regression methodologies rely on normality and linearity assumptions which are not supported by the data used in the analysis and may lead to inconclusive results. This new methodology in which the system is independent as each trial is independent of other and system is fully observable i.e. two states low and high are observed. In this study the assumption of stability of the transition matrix is also satisfied across time and space for the data used.

1.1 Objectives of the Study

In the backdrop of above introduction the present study is going to pursue the following specific objectives:

- The objective of the study is to re-estimate the Money-price nexus through conventional cointegration estimation techniques.
- Then we shall use the Markov Chain Process to re estimate the Money-Price nexus and to compare the findings with conventional estimation process.

1.2. Proposed Hypothesis

MCM is applied on broad money (M2) and price (CPI) to assess the price-money nexus in this study. The data set is retrieved from WDI for 249 economies[1] during 1960-2016. The median measure splits the countries into two equal groups i.e. low MS/low pricing and high MS/high pricing countries, for each variable to check the transition (i.e., HH(High-High), HL(High Low) LL(Low-Low) and LH(Low-High)) that happen over time.

The probability of transition from any given state *low* is equal to the proportion of countries that were initially in state *low* and later on in state *high* as a proportion of all the countries that were initially in state *low.* In our study we tried to assess hypotheses as follows:

Hypothesis 1:

$H0$: $The\ transition\ probabilities\ are\ same\ for\ all\ the\ countries\ and\ all\ the\ time\ periods$

$H1$: $The\ transition\ probabilities\ are\ not\ same\ for\ all\ the\ countries\ and\ all\ the\ time\ periods$

Hypothesis 2:

$H0$: $\Delta Mt{-}1\ is\ not\ associated\ with\ \Delta Cpi_t\ \ in\ each\ state$

$H1$: $\Delta Mt{-}1\ is\ associated\ with\ \Delta Cpi_t\ in\ each\ state$

$H0$: $\Delta Cpi_{t-1}\ is\ not\ associated\ with\ \Delta Mt\ in\ each\ state$

$H1$: $\Delta Cpi_{t-1}\ is\ associated\ with\ \Delta Mt\ in\ each\ state$

[1] There are 249 economies in the WDI, so we take data on both the variables on all the economies available.

Where $\Delta M t-1$ is broad money M2 of a country in the previous period while ΔCpi_t is the change in price in the current period. By using hypothesis 2, we tried to assess whether the broad money M2 of a country in the previous period is associated with price the current period and vice versa.

1.3. Significance of the Study

Finding of existing literature on price – money nexus over the time has had mixed results. Many studies shows negative association between economic growth and inflation. While some studies show a causation between money growth and inflation. The existing studies differ on the basis of sample size, assumptions, methodology but none of them reached to a firm conclusion. Stationarity of the data, Unit root testing and determination of lag length are some prerequisite for other methodologies(i.e. cointegration, granger testing) but Markov chain methodology does not required such assumptions. In the present study we have assessed the evidence of price money nexus by using the existing literature for or against the hypothesis to make a decisive study. The core focus of this study is to evaluate and compare methodologies in use and also use MCM as a new methodology. Markov Chain process uses simple and robust methods with least assumptions. This study try to indicate which kind of polices might be made for better growth and development of an economy.

1.4. Organization of the study

The following chapter has described theoretical underpinnings and empirical literature review of previous studies on money- price nexus. Chapter 3 contains analytical framework of the study and existing methodologies. In chapter 4 data and econometric methodology i.e. MCM is described. In chapter 5 we have to look at the results of the analyses and make a discussion of the findings. The chapter 6 discusses the conclusion and recommendation for future research.

CHAPTER 2

LITERATURE REVIEW

Theoretically and empirically money contributes, for the understanding of dynamic force inflation and remain a vital part for the MP (Gerlach 2004). In this chapter, there are two sections i.e. theoretical underpinnings and empirical literature. Here we give a brief review of theoretical review of the literature on the relationship between Price, inflation and money later gives the literature with respect to different empirical methods.

2.1. Theoretical Underpinning

Quantity theory of money has a long history. The quantity theory had a rich and varied tradition, going as far back as the eighteenth century. It is the proposition that in long-run equilibrium, a change in the money supply in the economy causes a proportionate change in the price level, though not necessarily in disequilibrium. The quantity theory was dominant in its field through the nineteenth century, though more as an approach than a rigorous theory, varying considerably among writers and periods.

Classical School of Thought on Price and Money:

The first half of the 19th century, an era in which the doctrines of the British classical school dominated economic thought, saw the emergence of a concentrated and systematic application of the quantity theory to policy problems. Having been quickly absorbed into the mainstream of classical analysis, the quantity theory became the standard conceptual framework for the analysis of monetary problems and for the formulation of practical policy recommendations.

The Bullionist controversy that took place in the first two decades of the 19th century during and immediately after the Napoleonic Wars and the Currency School- Banking

School controversy during the middle decades of the century are the two great monetary debates of the classical era. The Bullionist controversy was provoked by events following a major policy shift in 1797. The Bullionists concluded the quantity of money determines domestic prices; domestic prices affect the exchange rate; and the exchange rate between inconvertible paper and gold standard currencies determines the premium on gold. It follows, therefore, that the depreciation of the exchange rate below gold parity (i.e., below the ratio of the respective old mint prices of gold in each country) and the existence of the premium on bullion both constituted evidence that prices were higher and the quantity of money greater in Britain than would have been the case had the country still been on the gold standard. The second great 19th century debate in which the quantity theory played a leading role was the Currency-Banking controversy over the question of the regulation of the bank note issue.

The main policy objectives of this period included maintenance of fixed exchange rates and the automatic gold convertibility of the pound. Members of the Currency School, applying the precepts of their Bullionist forebears, held that such preservation of the gold standard could be secured only through rigid adherence to the "Currency Principle" of making the existing mixed gold-paper currency behave exactly as would a wholly metallic currency, i.e., by requiring banknotes to expand and contract one for one with variations in gold reserves(Humphry 1974).

The Neo-Classical Reformulation

The neo-classical reformulation of the quantity theory consisted of at least three separate contributions. First, there was the mathematical framework that neo-classical economists employed to expound and empirically test the key propositions of the theory. The second neo-classical contribution was the formalization, elaboration, and extension of the Bullionist-Currency School ideas on control of the money supply.

Irving Fisher, A. C. Pigou, and other neo-classical analysts demonstrated that monetary control could be achieved in a fractional reserve banking system via control of an exogenously determined stock of high-powered money.

Finally, neo-classical quantity theorists stressed the short-run non-neutrality of money, a topic that had been relatively neglected in the classical analysis. Neo-classical writers integrated the quantity theory into their analysis of business cycles, showing how changes in the quantity of money were a major cause of booms and slumps and how monetary regulation of the price level was a prerequisite to the stabilization of economic activity. By opinion of neoclassical economists, the interest rate in economy does not depend on the quantity of money; it is determined by the supply and demand ratio of the loan capital. At that, in the neoclassical theory the demand for loan capital is equal to the investments, while the supply is equal to savings.

According to the neoclassical theory both savings and investments depend on the interest rate dynamics: as long as the saving interest rate is increasing, the investments are decreasing. Thus, the interest rate is determined by the demand and supply of the capital, but not of money. However, the increase of money quantity can invoke temporary shift of the interest rate from the level determined by the equilibrium between savings and investments. Keynes wrote in this respect that classical school in fact suggests two different contradicting theories: one theory binds the interest rate with the balance of savings and investments, the other theory binds it with supply and demand of money(Sedova and Ratzlaf 2014).

Keynes School of Thought

Keynes's attack on the quantity theory consisted of following interrelated elements. First, he argued that the quantity theory assumed an automatic tendency of the economy to operate at full capacity, an assumption patently at odds with experience in the

depressed 1930's. Only if production and employment are fixed at full capacity, said Keynes, would monetary-induced changes in spending manifest themselves solely in price level changes. Second, Keynes criticized the particular version of the quantity theory expressed in the neo-classical quantity equations. Keynes contended that, in actuality, the velocity variable in Fisher's equation of exchange was extremely unstable and that it might passively adapt to independent changes in the other elements of the equation. Keynes said, the impact of any change in M might be absorbed by an offsetting change in V and therefore would not be transmitted to P.

Monetarists School of Thought

Quantity theorists responded to the Keynesian attack with counterarguments based on theoretical developments and empirical research. Chief among the theoretical developments contributing to the revival of the quantity theory were (1) the theory of the real balance or wealth effect, and (2) Milton Friedman's reformulation of the quantity theory as a theory of the demand for money. The theory of the real balance effect was used to demonstrate that money matters, at least in principle, even in the extreme Keynesian case where the interest rate channel is blocked by a liquidity trap and/or an interest-insensitive investment spending schedule. According to the real balance argument, prices would fall in a depression, thereby raising the purchasing power of wealth held in money form, The price-induced rise in the real value of cash balances would then stimulate spending directly until full capacity utilization had been attained. In sum, the real balance argument weakened the Keynesian attack in several important respects. At the theoretical level, it offered both an avenue of escape from the Keynesian liquidity trap and a means of thwarting the interest inelasticity of the investment spending schedule, thus contradicting the Keynesian doctrine of underemployment equilibrium.

Moreover, it cast doubt on the Keynesian view of money as a specific substitute solely for bonds. It created this doubt by emphasizing the relation between real balances and spending, thus suggesting that money was a general substitute for a wide range of goods and services. Finally, it suggested that the Keynesian view of the monetary transmission mechanism was seriously incomplete.

Finally, Friedman's treatment of velocity as a stable functional relationship refuted the Keynesian arguments (1) that velocity is a mere arithmetic calculation devoid of economic content ; (2) that the quantity theory assumes velocity to be constant; and (3) that velocity is an unstable magnitude subject to erratic, unpredictable shifts. In Friedman's formulation, fluctuations in velocity are perfectly consistent with the idea of a stable functional relation, since those shifts may be caused by changes in the independent variables of the velocity function. The conclusions of monetarism are close to the old quantity theory of money(Hayes 1989).

Therefore, in economics there is hardly any single, absolutely correct trend that missions to reject all other directions. Every trend reflects a particular system of assumptions which simplifies the reality. In certain phases of time and in certain situations some particular system of assumptions can be more acceptable than the other system; accordingly, the relevant economic theory can be more acceptable and useful.

2.1.1 Empirical Literature

Relationship between price and money is the most debated topic between different schools of thoughts. In order to resolve the theoretical debate between Keynesians and monetarists, researchers have spent excessive time for examining in the developed and developing countries the contributory relationship between MS and aggregate prices. However, the existing empirical studies thus far have failed to produce consent causal link evidence (Chor 2010).

The results obtained from the paper of Azam and Rashid (2014) demonstrates that inflation is neither effected by one to one relationship with money growth nor statistically significant. This indicates that MS is not only the reason which explain inflation but there could be other factors than MS and negating the monetarist's view that higher prices is always the reason of excessive MS. These findings are consistent with the results of other studies of Dhakal and Kandil(1993) and Polan and De Grauwe(2005).

In various countries the causal relationship between money and price has been extensively examined. For example Chor (2010) explained a bidirectional causality between MS and aggregate prices, as both the monetarist's and also the structuralists' assessments are justified for the economy of Malaysia. However, Mohammad et al. (2008) findings support the quantity theorist's views that claim there is a unidirectional causality between monetary aggregates to price. So monetary authorities should consider the control of money to influence and control inflation with care.

According to the study of Bikash *et al* (2015) indicates long run unidirectional causality running from price level to MS and output. These findings suggest that MS is a reason for increasing price level. Therefore short-run fluctuation in price must be handled with caution to stabilize MP, as it would increase price fluctuations in the long-run. Fazal and Tariq (1998) study postulate long run relationship between money and price using the data for Pakistan. These findings are different from earlier studies as it shows unidirectional causality between money to price.

Gerald and Victor (2010) study exhibited bidirectional causality running between money to price in countries with under developed financial markets. The evidence also indicated that monetary expansion is not a reason for all inflation. The findings also

shows that the influence of MS expansion on inflation is diffused in countries with developed financial markets.

MP always have its own limits. When if there is inflation in an economy, MS is not the only reason for it. On the other side, if excess MS is the reason for inflation than it is not guaranteed that inflation can be down after reducing MS. Tight MP can be the reason Inflation but liberal MP cannot get the economy out of inflation. (Sabade 2014). The results of the paper of Darat (1986) for countries particularly Morroco and Tunisia shows positive and important impact of MS upon inflation with a high long-run inflation elasticity. So to fight against inflation, preventive MP can play a substantial role.

Benboziane and Benamar (2004); Benamar et al Cherif (2011) examine price money relationship in Three Maghrib countries namely Algeria, Morocco and Tunisia and results do not supports the QTM. Indeed these results supports Darrat's (1986) finding that money is the reason of inflation in Morocco and Tunisia.

The probable determinants of CPI and inflation has been identifies by the paper of Murshed and Nakibullah(2015) for the Gulf Cooperation Council (GCC). In three out of six countries (Oman, Qatar, and UAE), price level is affected by MS in the long run.

According to the findings of Khan and Gill (2010) CPI in the long run is affected by M2 supply of money, hence negating the previous supposition. Our study describes that consumer price are not altered by changes in MS. CPI does not response much to changes in MS. Assuming market to be perfect, classical and monetarists give the concept of neutrality of money. As imperfect markets are a part of developing economy in Pakistan so it is right to say that money is less significant than real sector variables

in explaining inflation. Furthermore, according to findings of GDP deflator, the course of inflation is not the result of rise in MS.

To manage inflation has conventionally been one of the main macroeconomic challenges that developing Asian countries are facing. Surging inflation in the region in 2007-2008 is considered to be the only greatest macroeconomic challenge. According to consumer price indices, inflation increased in 2007 and also accelerated in the initial months of 2008. We come to know through conclusion that inflation is actually homegrown in Asia and instead of external price shocks, the increased aggregate demand and inflationary expectations has raised it. We can therefore conclude that the MP can resolve risks of deflation in Asia and can fight the inflation in Asia too (Jongwanich and Park 2009).

The paper of Ma and Sun (2007) has demonstrated the effectiveness of money on two regimes i.e. inflation and deflation. In the deflation regime for the maintenance of prices, money is less effective. This finding is consistent with neo-keynesian macroeconomic model. Before 1998, in the inflation regime money is endogenous. Here MS is not recommended as a policy instrument because it is ineffective in manipulating the price level.

For the case of Indonesia, Parikh and Norwich (1984) demonstrates the causality with in MS and price. The direction of causation is neither running from money to prices nor it is from prices to money, it takes at least one quarter to clear itself. Both variable treated as a endogenous variable while in econometric modeling. Here the study cannot refute the hypothesis of contemporaneous correlation of money and price.

However, the results of the paper of Dexter *et al.* (2001) shows that the connectivity between change in the MS and change in the inflation is because of the possible

significance of price regulations. it is possible that the empirical studies of money and inflation is prejudiced by

Presence of controlled items in the overall CPI. Price regulations are the reason to bring change in the cost or demand conditions. Todter and Reimers(1994) has used a P-star approach that represents the long run connection with in MS and price level. Here the estimated results supports the long-run link with money and the price level. Although the alteration of prices to a new equilibrium is fairly slow.

Haque and Qayyum(2006) concluded that the output growth and the velocity growth depends upon the excessive MS. Hence, main reason for the inflation in Pakistan is the excess MS. It implies that the tight MP can control the inflation in Pakistan. The development in the real and financial sectors should be considered as the constraints on the policy while making up the MP. He concludes that Pakistan's inflation is monetary related and inflation is affected by three fourth of money growth. The results of the paper of Shagi and Giesen (2013) examined that money extension is the heavy reason for the inflation. These findings supports the monetary phenomenon.

Furthermore, Jonathan D. Jones and Nasir M. Khilji (1988) concluded that in modelling of whole-sale price, either M1 or M2 can be used as the explanatory variables. On the contrary, M1 or M2 variables do not have any explanatory powers when consumer price are being modelled. As the price movement is calculated by the consumer price index, the role played by international factors, services sector and supply shocks in elaborating movements should be researched. These results will help in building of monetary block in macro-econometric models of economy of Pakistan.

The results of Shirvanai and Wilbratte (1994) do not agree with the monetarist thesis that too much monetary growth results in inflation. According to their findings only

high inflation rates are a monetary phenomenon. In the countries where inflation is high the rapid increase in MS dominates the sources of inflation. However, the places where growth of MS is slow, the main causes of inflation may be the factors such as cost push variables and capacity utilization rate. Thus, the monetarist model couldn't explain price behavior in the sample of countries where the inflation rates are below 15 percent. The paper of Rowthorn (1997) clearly negates about monetary theory which suggests a direct causal link from money to prices, for this the study provide a second and self-regulating explanation of inflation, in addition to the original conflict theory. The study concluded that within the present analytical framework, prices may be influenced by monetary factors through the following causal chain. Money →demand →conflict →prices.

For Chinese economy, the study of Yi (1990) has examined the relationship with in price instability and inflation. The study hypothesized that there is a strong relationship between price instability and inflation and the hypothesis is accepted. Stable economic policy and low-inflation consistent policies is preferably recommended for the economy of China. Jiang *et al.*(2014) has investigated time frequency relation with in money growth and inflation through the wavelength analysis. This study finds a strong but not homogenous associations with money and inflation from a time-domain. In the short run due to the momentary shocks, money and inflation departs from a positive relation while in the long run money growth and inflation are positively and stably related one-to-one. The results of this study supports the modern QTM in the medium-run.

The study of Nguyen (2015) has applied Pooled Mean Group (PMG) estimation-based error correction model and GMM estimations. The results show that inflation is significantly affected by positive MS in PMG estimation whereas, in GMM estimations

the broad money M2 has not significant impact on inflation. For the economy of Argentina, D'Amato (2009) has investigated the regime dependence of money-price relationship by using descriptive and cointegration analysis. In high inflation proportionality hold but weakens when inflation lowers. Under high inflation, money growth is positively correlated with money velocity. Under low inflation, this relation reverts. Inflation dynamics is explained by money in Argentina.

The paper describes that over the longer period, the higher rate of inflation can be due to the increase in MS. Hence it proves the quantum theory of money. It therefore proves that inflation is a monetary phenomenon. The price levels are however not immediately affected by the MS but it takes a reasonable time period of about 9 months. Studies have revealed that the MS is carried out through the system than a year. It also tells that the time taken by the system to converge to equilibrium shocks is longer in the three variables, viz, GDP, money. (Kemal 2006).

With regard to the relationship between the pattern of MS and consumer price, numerous works have been done on different economies. Some of the most relevant studies are discussed below.

2.1.2 Studies Based on Regression and Correlation Techniques

A lot of studies used simple regression analysis and correlation coefficient to empirically examine the association between price and money. The studies of Nawaz (2017) and Chow (1986) concluded a positive relationship exist between money and price by using multiple regression and on the basis of correlation matrix there exist a positive association between inflation and MS. Laryea and Sumaila(2001) have found that in the long run there is a positive relationship exist between MS and inflation. However, Akbari and Rankaduwa (2006) discussed for the case of Pakistan that MS,

foreign import price and domestic level of output highly effect the price level in the economy.

The paper of Osman and Maryam (2014) demonstrates the relationship of consumer price index on different variables through multiple regression. All variables have negative impact on CPI except MS. MS is positively correlated with CPI. Similarly, Abidemi and Malik (2010) also shows the positive relationship between MS with CPI. There is instantaneous interrelationship between inflation and its major factors in Nigeria for the period from 1970-2007.

According to Farooq *et al.(*2010), the variable broad money (M2) has a positive but insignificant effect on consumer price index(CPI). McCandless and Weber (1995) has used sample of 110 countries and shows a long run relationship between MS and inflation. They show a strong correlation (with a correlation coefficient close to one) between MS and price level.

Waingade (2011) revealed a positive correlation between the growth in MS and price through regression analysis. This connotation between these two variable has not been proportionate. Most of the time the growth in price level is less than the growth in MS.

The study of Gabrielli *et al*.(2004) perform various time series tests i.e.(Granger causality tests , VAR models, unit root and calculated correlation) on price and money for the economy of Argentina. Correlation is almost one to one relationship in the early time period. Later on relationship implies much smaller change in the money stock. As money leads prices, the period of maximum correlation is of six month which is quite short.

For Kenyans economy, the study of Kiganda (2014) designates that all-time series variables of MS and inflation are positively correlated, having long run relationship between them. Causation between these variable is unidirectional. The study concluded a long run positive relationship between inflation and MS in Kenya. The study of Tyrkalo & Adamyk (1990) analyzed the relations between both the MS and inflation and between MS and GDP. The results identify a long-run link between money growth and inflation and they are negatively correlated.

Likewise, In Malaysia, Tang & Lean (2007) investigated relation between MS and inflation. The results of regression outcome portrays that inflation is negatively influenced by MS and statistically significant at 1% level. The monetarist's view that inflation is purely a monetary phenomenon, is not supported here in this study.

Through multiple linear regression, Gavrilovic(2018) analyzed inflation . World bank data set has been used for European Union. For inflation, CPI is used as a measurement indicator. The study concluded coefficient of determination is 0.98 which means reals and estimated values are strongly correlated. One can conclude, in comparison to real data and there is no strong differences.

In the Paper of Siklos (1990), Money price relationship was found to be closely correlated during the hyperinflation only. It is clearly stated that none of the policies could effectively back to Hungarian currency. The study of King (2002) shows strong correlation with in money and prices. Similarly, the study of Walsh (2003) supports the QTM argument that the growth of MS leads to an equal rise in the price level and shows the high correlation between the growth rate of MS and inflation.

2.1.3. Studies Based on Time Series Techniques

In recent years the empirical studies on time series have increased. Among time series most of the studies used Grangers causality to evaluate the evidence for money price nexus and also see the direction of relationship. Most of the researchers use Autoregressive Distributed Lag and Granger causality to evaluate the price and money long and short run relationship. Rumi and Abdul (1997) has used Pakistan as a case study and applied granger causality testing on price and money. This study shows price as a leading variable and MS is a lagging variable and a bidirectional causality running from price to money. Whereas for the case of Bangladesh Parikh and Starmer(1988) shows a unidirectional causality running from price to money by using monthly data in his studies that are consistent with the structuralist's view.

On the contrary, the studies of both Bikash *et al* (2015) and Mishara(2010) support the monetarists view that indicates long-run bidirectional causality between MS and real output infers that money is not neutral in its effect and unidirectional causality from price level to money and output in the long run. But, in the short-run the bidirectional causality exists between MS and price level and unidirectional causation exists from output to price level.

Similarly Sharma's *et al* (2010) findings indicate a long run causality running from MS to prices that is consistent with the monetarist's view. With regard to the relationship both money and price affect each other with bidirectional causation by using different cointegration tests DAS (2010).

Hanudin (2008) investigated through Johansen cointegration method a long run equilibrium relationship exist between MS with price. Toda-Yamamoto causality test

also applied in this study that shows unidirectional causality running from MS to price for Malaysia which supports the quantity theorist's view.

For case of Pakistan, the analysis of the paper of Husain and Abbas (2010) indicates a bidirectional causality between money and price by using granger causality test. Nevertheless, the ECM shows in the long run one way relationship from money to price. As against bidirectional causality the study of Bengali, Khan and Sadaqat (1999) shows unidirectional causality running from money to price.

Ghatak and Deadman (1989) examined causality through ARIMA causality test in developing countries. The results show there may be a passively respond in price when there is increase in MS. It indicates either there is a very short lead/lag relationship between money and prices or instant causality. According to the study of Paun and Topan(2013), there is a unidirectional causality and price is being determined by MS for the Romanian economy. Crowder (1994) investigated the link between inflation and money in US. Economically and statistically he found a strong long run relationship between these two variables.

Similarly in Indian context, many studies demonstrates the linkage between money and prices. By using Granger (1969) and Sims (1972) methods Sharma (1984) examined the causation between MS and prices and found bidirectional causation between MS and prices. He demonstrates strong causality from MS to price as compared to the causality from prices to money.

Nachane and Nadkarni (1985) shows a unidirectional causality running from money to prices. Biswas and Saunders's (1990) studies reversed to Sharma's findings, as there is weak and reverse bidirectional causality between MS to prices. The study of Zulkhibri and Majid (2007) examined the causality association between prices and monetary

aggregates through vector autoregression (VAR) model applying the Granger no-causality procedure developed by Toda and Yamamoto (1995) for Malaysian economy. The results indicate strong one way causality from MS to prices but there is no evidence for reverse causality. In other words, the empirical results supports the argument that inflation is a monetary phenomenon.

Sola and Peter (2013) has investigated the relationship between MS and inflation through Vector Auto Regressive (VAR) model in Nigeria. The result shows, there is unidirectional causality runs from money to inflation and interest rate to MS. In conclusion the level of inflation should be used as an operational guide for policy effectiveness. Moreover, Inam(2014) empirically investigate in his study the nature and direction of causality between MS and inflation for the economy of Nigeria. He examined the negative impact on inflation of past 1 year's value of MS. The study found no causation between these two variables. With regard to the relationship, there exist a long run relationship. It indicates MS should be managed properly to avoid causing inflation.

Togay and kose(2013) has investigated the causal relationship between money and prices. The results demonstrate, in the long run a bi-directional causality exists between money and CPI when M1 and M2 are taken as the monetary aggregate.

The findings of Amassoma et al.(2017) studies suggests that both in the long run and in the short run, inflation is not influenced by MS. According to the Granger causality test, there is no causality between inflation and MS. Similarly, Akinbobola(2012) studies for Nigerian economy has examined that in the short run , increase in MS will lead to an increase in inflation. But in long run, effect will be insignificant.

For the Chinese economy, the paper of Xie, Tang, Cui (2009) analyzed the relationship between MS, economic growth, and inflation through cointegration and Granger causality test. The results shows that there is cointegration association between MS and inflation. There finding and conclusion suggests that there might be a possibility to implement loose MP contemporaneously.

Makinen and Woodward (1989) investigated a unidirectional causality between money and inflation from their studies in Taiwan on hyper-inflation. This causation is running from inflation to money. On contrary, Lahiri(1991) revealed from their empirical studies a bidirectional relationship between money and inflation from the economy of Yugoslavia.

For the economy of Iran, Salmasi and Heidari's(2010) paper sought to determine the causal relationship between money and inflation growth, by employing the bounds test approach to cointegration, in the QTM. The study shows money is the most important variable that effect the inflation in long run, as there is 72 percent increase in inflation because of 1 percent increase in money growth. On contrary, Mostafavi's(2007) study examined that money causes inflation in the short run but in the long run inflation is not effected by money. Moreover the results shows that MP will be effective in the short run for Iranian economy. For Algeria, Beltas and Jones (1993) demonstrates the unidirectional causality running from MS to inflation with no feedback effects through granger causality.

For the economy of Russia, the paper of Oomes and Ohnsorge (2005) explores the effect of money demand on inflation. The study explore this on monthly data from April 1996 to January 2004 by using the error correction model. The results approve that inflation is due to the excess supply of broad money while the narrower monetary

aggregates are not. Inflation is strongly and persistently effected by money growth in the short run.

Hoover (1991) has explained the linkage between prices and money. His study didn't show any presence of direct link between money and prices which clearly deny the strict monetarism. It shows that prices are affected through indirect channels. Browne and Cronin (2010) investigated the long run relationship through cointegrating VAR framework. The result indicates that both variables have equilibrium relationship with money.

According to Ashra's *et al*.(2004) findings, there is bidirectional causality between price level and MS. The results of Ramachandran (2004) study shows a bidirectional causality between MS and prices. They shows in long run money plays a vital part for stability of prices. Das (2003) also provided an evidence of bidirectional causation between MS and prices in the framework of India.

However, the behavior of broad money demand has been investigated by Hossain (2010) in Bangladesh. By using annual data over the period of 1973- 2008 by the Johansen co-integration test and the error correction model, the Empirical results proposes that there is existence of a causal relationship between MS growth and inflation. On the basis of quarterly data for 1992-2003, Pelipas (2006) empirically examines the money demand and inflation by using co-integrated VAR and equilibrium correction model. The results of this study shows that inflation is positively corelated by MS.

Regarding the relationship between MS and price level, Suliman and Ahmed (2011) has investigated the causation through Granger causality test in the case of Sudan. The

results indicates unidirectional causality that is running from MS to prices. Whereas, cointegration analysis suggested a long run relationship between them.

All these papers have presumed that Granger Causality is a test of causality and used different sample sizes to compare the efficiency of different methods. These methods only differ in either at assumption or in sample sizes. All these studies showed inconclusive results. In this study we used Markov Methodology which does not based on the assumption of linearity and normality of the data.

To determine the direction, strength and significance of association between two variable Markov chains is being used. We could not find any study in which money price nexus is evaluated, by using this methodology over the period 1960-2017. The objective of this study is to examine the Markov chain process to assess money price nexus in support of historical and qualitative evidence.

CHAPTER 3

ANALYTICAL FRAMEWORK AND ECONOMETRICS METHODOLOGY

"The procedures of good statistical practice are founded on experience and commonsense; it is good practice to stop and think before running a regression".

(Preece 1987, p. 387)

The purpose of our study is to determine the evidence for price- money nexus by comparing different methodologies in use. Different methodologies have been used by different authors and different conclusions have been drawn from their findings. In this study a new methodology is introduced i.e. based on MCM. A. A. Markov (1856-1922) has started the theory of stochastic processes named after a Russian mathematician. Markov chain process is a special form of stochastic process, where the next state of a system depends on the present state, not on the preceding state. MCM does not depend on normality and linearity assumptions used by most existing regression based methods. In our study MCM is applied to the broad money and inflation data by using different steps mentioned in the Apendix[2].

3.1. Model

The model has been used in the study contain two variables Broad money (current LCU) and price (CPI). This model does not base on functional form assumptions.

3.2. Cross Correlation Methodology

The objective of the correlation analysis is to test the strength or degree of linear relationship between two variables. It's a measure of how things are related. Some assumptions are necessary to check the correlation i.e. observations should be

[2] see Appendix Steps in MCM

independent and variables assumed to be random. Under same these assumptions the null hypothesis i.e. correlation is 0 is tested but for interpretation of confidence interval of correlation coefficient both variables should be normally distributed. Correlation analysis assumed the linearity between two variables as it is only appropriate for linear relationship. But in the real scenario linearity may not exist between the variables that would be imperfectly described, or might be even undetected by the correlation coefficient. Sometimes in the real world there may exists outliers in the data that cannot be handled by correlation analysis. On money price nexus lots of work done on this methodology (Qayyum 2006: Nawaz 2017). Here in our study we used MCM to check the money price nexus which does not depends upon the assumptions of normality and linearity.

3.3. Methodology Based on Regression

Regression analysis estimates the dependence of a response variable on one or more predictors, along with prediction of future values of a response variable, and discovering important variables. It is the study of dependence. Statistical significance is also tested by regression analysis along with estimation of parameters of a model. A lot of literature is available on regression analysis to check the direction of causation between price and money (Chow 1986; Nawaz 2017; Azam , Rashid ; Sharma 1984). Although regression does not necessarily imply causation, it deals with the dependence of one variable on other variables.

Linearity and normality of the data are basic assumptions for estimating the confidence interval and testing the hypothesis followed by regression theory but in the real world, the observations may be non-normal or non-linear. Sometimes observations may contain outliers, because of outliers regression analysis may give misleading results.

Our study MCM based on simple and minimal assumptions which is being used for attaining vigorous results.

3.4. Cointegration and Error Correction Model Based Methodology

For attaining short run and long run relationship between money and price few studies (Chimobi 2010; P K Mishra, Mishra and Mishra 2010; Khairul Islam 2016; Ghazali 2008) follows Johansen methodology while others adopted Engle and Granger cointegration methodologies (Ashra , Chattopadhyay and Chaudhuri 2004; Benboziane and Benamar 2004; Chandran 2004). Unit root testing and determination of lag length are some pre requisite for cointegration methodology. Sufficient sample size is required for testing the unit root. Finite sample have limited power to reject the null hypothesis of non- stationary, hence could not test cointegration. For second pre requisite of lag length determination is the error term assumed to be Gaussian in the error correction model, which is again not possible in the real world data. Several specifications are needed for the performance of unit root testing as one can access desired results by changing these specifications (Atiq-ur-Rehman 2011). Causality is sensitive to functional form and model selection in econometrics (Gujrati 2004). On price money nexus studies based on time series methodologies gave different results. In this study of price money nexus there is no difference between the dependent and independent variables. Time series techniques (e.g. Granger Causality tests, cointegration and Error correction model) are conditional upon assumptions but Markovian method does not depend on the fancy assumptions like linearity and normality as in the real world, the data used for analysis may be non-linear and non-normal. In this study Markov method has been used to analyze whether all the countries follow same process and have done the separate Markov analysis for each country.

3.5. Methodology Based on Granger Causality

Many researchers used Granger causality testing procedure on price-money nexus in time series data analysis. For the estimation of hypothesis these studies had used the choice of lag length arbitrary (Jones and NOEL 2006; Jones 2006; Masih and Masih ; Mudabbir 2006). Most of these studies applied f-test statistics for causality and concluded different results. The time series must be stationary while proceeding to granger testing.(Gujrati 2004). Asghar (2007) in his study has shown how Granger causality is sensitive to small changes in specifications, the selection of lag length, time period of data, variable transformations. By comparing other methodology here we proposed a new methodology that shows price-money nexus analysis.

3.6. Introduction to Markov Modeling

Markov modeling is named after Andrew Markov (1856-1922). Among other things he studied Markov processes. A Markov process is a stochastic process where it is assumed that only the present value of variable is relevant for predicting the future value. The way that current value has emerged and past history of the variable is irrelevant. It is a changeable process that is memory less. It's a probability of moving to a given state depends only on the current state. There are four types of Markov models that are used situational where important state is perceptible or not and whether the system is to be adjusted on the basis of observations made:

i) **Markov Chain:** it is used by system that is autonomous and has fully observable states.

ii) **Hidden Markov Model**: it is used by systems that are autonomous where the state is partially observable.

iii) **Markov decision processes:** it is used by controlled systems with a fully observable state.

iv) **Partially observable Markov decision processes**: it is used by controlled systems where the state is partially observable.

In our study the system state is fully observable (i.e. two states low and high are observed) and the system is independent (each trial is independent of the other) so here in this study MCM is used.

3.6.1. Markov Chain Method

Among Markov models, MCM is the simplest method. When we study a system that can change over time, we need a way to keep track of those changes. A Markov chain is a particular model for keeping track of systems that change according to given probabilities. It is a way of modeling a system of random variables that has states and transition. It depends on the property that the distribution for the variable depends only on the distribution of previous state.

In other words it is the collection of random variables that depends on the property in which given the current, the future is conditionally independent the previous state. It's a discrete time stochastic process that occurs in a series of time- steps in each of which a random choice is made. It has no memory means "the probability distribution of the future state depends only on the present state and not on the sequence of events that preceded it. The full state of the system is observable at any point in time. As a statistical model Markov chain have many applications of real world processes.

For the ease, the study focuses on discrete time and discrete state space case. The assumption of MCM that the transition matrixes are stable across time and space may satisfy in this data. As the time parameter is usually discrete; many applications of

Markov chain employ finite state spaces, which have more straightforward statistical analysis. Besides time index and state space parameters, there are many other variations, extensions and generalizations. A discrete time random process involves a system which is in a certain state at each step, with the state changing randomly between the steps. Since the system changes randomly it is generally impossible to predict with certainty; the state of a Markov chain at a given point in future. However the statistical properties of the system's future can be predicted.

3.6.2. Characteristics of Markov Chain Process

Following are the important Characteristics of a first order Markov process or the simple Markov Process:

1. The probabilities of going to each of the sates of the system depend only on the present state and not on the previous state. This implies that the future state of the system is dependent on the present state and is completely independent of the previous states of the system. This property is popularly known as the property of "No Memory" which simply means that there is no need to remember how the process reached a particular state at a particular period.

2. There are initial conditions that take on less and less importance as the process operates eventually 'washing out' when the process reaches the steady state. Accordingly, the term steady sate probability is defined as the long run probability of being in particular state, after the process has been operating long enough to wash out the initial conditions.

3. In a Markov process we assume that the process is discrete in state space and also in time.

4. We also assume that in a simple Markov process the switching behavior is represented by transition matrix, where "Transition Matrix" is a matrix used to describe the transition of a Markov chain. Each of its entries is a non-negative real number along with its respective probability. There are different types of transition matrices used in the estimation of Markov process:

Right transition matrix (RTM): it is a real square matrix with transition probability of each row summing to 1.

Left transition matrix (LTM): it is a real square matrix with transition probability of each column summing to 1.

Double transition matrix (DTM): it is a square matrix of non-negative real numbers, with transition probability of each row and each column summing to 1.

On the number line the Markov chain is a random walk, where the position may change by +1 or -1 at each step with equal probability. It is famous as "Drunkard's walk". There are two possible transitions from any position, to the next or previous integer. The TP depend only on the current position, not on the manner in which the position was reached. For example, TP from 4 to 3 and 4 to 5 are both 0.5 and all other TP from 4 are 0. These probabilities are independent of whether the system was previously in 3 or 5.

3.7. Data and Variables

The data is taken from World Bank, World Development Indicator (WDI), on the variables of broad money (current LCU) and CPI during 1960-2015 for 249 economies. From this data we have to re-examine the price – money nexus empirically by using new method "MCM" through time domain approach. These variables are compatible

as they are in same terms. All the variables fall into one out of four major categories of measurement scale of the variables and that is ratio scale. The WDI data is cleaned to get rid of grouping, worlds and many points of missing data.

3.7.1. Two State MCM to assess the Transition across countries

Two states MCM has been used as it satisfies many properties i.e. it's automatically take cares about outliers, non-linearity and lack of normality in the data. It is a simple, plan and common sense method. One of the measure of central tendency 'Median' is used to organize the data into high broad money and low broad money, high inflation and low inflation countries to check the transition that happened over time. The measure central tendency "Median[3]" is preferred over mean because it is not sensitive to outliers.

The simplest MCM based on two states one-step right transition matrix is being applied to all the variables. When the transition is observed in sequence of states for each country then estimating a transition matrix is a comparatively straight process. Transition matrix is constructed on the basis of Bernoulli Trials[4]. Low state countries may remain in low state or make a transition from low to high state, and it can also be possible that high state countries may remain in high state or make a transition from high to low state. The median measure splits the countries into two equal groups, half of the countries lie above the median country and half lie below median. Different steps of Markov chain process has been used for estimation in excel[5].

[3] Median is preferred over mean because it is insensitive to extreme values
[4] By using excel software
[5] See Appendix steps in MCM

3.8. Hypothesis Formation:

To check whether the TP across all the countries over time remained same a hypothesis is formed for the period used in the study. It may be written as follows:

Suppose the Markov Chain Process follows the following sequence, LHLHLHLH….

$\boldsymbol{H0}$: *The transition probabilities are same for all the countries during* 1961 − 2016

$\boldsymbol{H1}$: *The transition probabilities are not same for all the countries during* 1961 − 2016

Suppose, we reach to the conclusion from the valuation of above hypothesis that data is non-confirmative with the null hypothesis and we may find at least one country with different TP in price or broad money or both, over time. Then the next step is to check the association among both the variables in either direction by using first step two state MCM. The hypotheses may be formulated as follows:

$\boldsymbol{H0}$: $\Delta Mt{-}1$ *is not associated with* ΔCpi_t *in each state*

$\boldsymbol{H1}$: $\Delta Mt{-}1$ *is associated with* ΔCpi_t *in each state*

$\boldsymbol{H0}$: ΔCpi_{t-1} *is not associated with* ΔMt *in each state*

$\boldsymbol{H1}$: ΔCpi_{t-1} *is associated with* ΔMt *in each state*

Where $\Delta Mt{-}1$ is broad money M2 of a country in the previous period while ΔCpi_t is the change in price in the current period. By using hypothesis 2, we tried to assess whether the broad money M2 of a country in the previous period is associated with price the current period and vice versa.

3.9. Multiple Tests and Family wise Error Rate:

Multiple comparison tests are used in order to evaluate whether the TP for all the countries or at least one country are significantly different or not. We do collection of comparisons which is described as family. The family wise error rate is the probability that at least one of these comparisons will include Type I error i.e. more tests we performed on a set of data, the more likely we are to reject a true null hypothesis.

This is the result of the logic of the hypothesis testing when we reject the null hypothesis if we witness a rare event. When we perform multiple tests it is much easier to find rare events and therefore it is also easier to make a mistake of thinking that there is an effect when there is none.

This mistake leads us to a problem which is called inflation of the alpha level. To avoid this problem, one tactic is to correct the alpha level as it will create less error when we perform multiple tests by making the alpha more rigorous.

A series of tests performed on set of data which is technically referred as a family of tests. We set the significance level at $\alpha = 0.05$ for computing the probability of rejecting the null hypothesis at least once in a family of tests when the null hypothesis is true. The probability is equal to $\alpha = 0.05$ of Type I error for each test. Type I error and not making Type I error are complementary events i.e. cannot occur simultaneously. So probability of not making type I error is equal to $1 - \alpha = 0.95$.

For example when 53 events (countries) are independent, the probability of observing these 53 countries together is the product of their probabilities. As the tests are independent, the probability of not making a Type I error on all the 53 test is to 0.95^{53}. for a family of n tests the probability of not making a Type I error for the whole family is $(1 - \alpha)^n$. Now we are interesting in the probability of making one or more Type I

errors on the family of tests. This event is the complement of the event not making a Type I error on the family and therefore it is equal to$1 - (1 - \alpha)^n$. For our example we find $1 - (1 - 0.05)^{53}$ = 0.93 so, with a significance level 0.05 for each of the 53 tests, the probability of wrongly rejecting the null hypothesis is 0.93. This example makes clear the need to differentiate between two meanings of alpha when performing multiple tests:

Test wise alpha is a probability of making Type I error when dealing with specific test is denoted by alpha per test.

Experiment wise alpha is the probability of making at least Type I error for whole family of tests which is also denoted by alpha per family of tests.

3.9.1. Shidak Correction for alpha:

As $\alpha = 1 - (1 - p*)^N$ is the probability of making at least one Type I error for a family of N tests. This equation sometimes also called Shidak equation for independent tests and can also be written as$p* = 1 - (1 - \alpha)^{\frac{1}{N}}$. It shows that we need to adapt the p* values used for each test sin order to reach to a given α level.

3.9.2. Critical p-value approach used in MCM:

Critical p-value approach involves determining 'likely' or 'unlikely' by determining whether or not the observed test statistics is more extreme than would be expected if the null hypothesis were true. Compare the observed statistics to some cutoff value called 'critical value'. The critical value is determined where the probability of an event by using binomial model is less than the p* value. If the test statistics is more extreme than the critical value, than the null hypothesis is rejected in favor of alternative hypothesis. If the test statistics is not as extreme as critical value then the null hypothesis

is not rejected. P-value is the sum of all the test statistics which lies in the rejection region. P-value approach is used to assess the hypothesis; it is the measure of the mismatch. The smaller is the p-value, the greater is the mismatch and larger is the p-value, greater the match. The intuitive idea of p-value is very simple, if there is something unlikely happens, we may reject the null hypothesis. So we set a critical value $\boldsymbol{p}*$ that is a small number and if any outcome has a value less than $\boldsymbol{p}*$ then we have to reject the null hypothesis. There is one thing complicated that is if we talk about rejection then we are not talking about a specific outcome, we have to think about all possible events which we have to reject i.e. those similar events who have p-value less than the critical p-value. We have to divide the whole p-value obtained from the data into two sets, one region that is called the acceptance region where all the events have the p-value bigger than the critical p-value and the other region is the rejection region where all the events have p-value less than the critical p-value. P-value is not the critical value but actually it is the probability of the rejection region, all those similar outcomes who have p-value less than the critical value and then aggregating them. Instead of evaluating particular events we have to evaluate all possible events in the rejection region. For example if we flip a coin ten time then there may come up ten heads we also have to take into consideration ten tails to get the p-value for rejection region. Reject the null hypothesis when match for all outcomes having $p \leq p*$. Form rejection region[6] $\{k: P\mathrm{N}\ (X = k) \leq p*\}$ and p value is the probability of the rejection region.

[6] see Lecture 7 and 8 of Bayesian Econometrics (Feb. 2016-June 2016) at PIDE by Professor Dr. Asad Zaman

CHAPTER 4

RESULTS AND DISCUSSION

In chapter we will deal with the empirical analysis of the above mentioned issue by using Markov Chain Process: a simple random process in which the distribution of future state depends only on the present state and not on how it arrived in the present state. Here we have applied 1st step two state MCM to assess whether the TP are same across all the countries during 1961- 2016 or not. We also used cross MCM to assess the association between broad money (ΔM2) and consumer price index (Δcpi).

4.1. Analysis Broad money M2 and detection of countries having high/low broad Money:

Almost all countries stay in category which ever initially they are during 1961-2016 according to the results of the broad money. For example Algeria, Australia, Cameron, Pakistan and Canada's broad money remain in L-L category for 56 times with the transition probability 1 and has not shown any single transition into H-L or L-H and H-H category. Bahrain, Bolivia, Ecuador and Ethiopia broad money data show 100 percent transition into H-H and zero transition in L-H, H-L and L-L.

According to the results of Broad money transitions we can classify the countries into low and high groups of broad money in the following Tables.

Table 4.1: Low broad money Countries identified by using MCM during 1961-2016.

Algeria	Colombia	Iran,Islamic rep.	Norway	Senegal
Australia	Cote d'Ivoire	Japan	Pakistan	South Africa
Cameron	Gabon	Korea, Rep.	Paraguay	Sweden
Canada	India	Madagascar	Philippines	Thailand
United States				

Table 4.2: High Broad Money Countries identified by using MCM during 1961-2016.

Bahrain	El Salvador	Guatemala	Kenya	Panama	Uruguay
Bolivia	Ethiopia	Haiti	Libya	Peru	Turkey
Dominican Republic	Gambia, The	Honduras	Mauritius	Samoa	Trinidad and Tobago
Ecuador	Ghana	Jamaica	New Zealand	Sudan	

Countries: Burkina Faso, Burundi, Costa Rica, Denmark, Egypt Arab Rep, Iceland, Israel, Malaysia, Mexico, Morocco, Myanmar, Nepal, Saudi Arabia, Singapore and Togo have shown transition from one category to another. Average Broad money transitions and their probabilities of these countries are used under null hypothesis "m2 TP of all these countries are same during 1961-2016" in following table:

Table 4.3: Average M2 Transitions based on whole data during 1961-2016

M2	L	H
L	28	0
H	0	28

Results have shown that on average 28 times countries remain in low category in the current period followed by low state in initial period with the transition period 0.63. In high to high group 64 percent transitions are seen for staying in high group while 4 percent are from high to low group.

4.2. Two State one step Markov Chain Process for ΔM2:

There are different steps involved in estimating the one step MCM based on two states i.e. low and high. Difference of the variable is used instead of level because in the level form there are not observed fluctuations to assess the effect. We are left with 66 countries after cleaning the data of ΔM2 over time period 1961 to 2016. By using median measure through sequences of binary outcomes of 0's and 1's we have to estimate whether the current outcome follows the recent past outcome or not in both the low and highly broad money of countries. The transitions are being estimated for all the countries from high to low (HL), high to high (HH), low to low (LL) and low to high (LH) states that happens over time. H-H transition counts show that how many times a country remained in high state in the current period followed by high state in the previous period, H-L transitions showed that how many times a country moved to a low broad money of countries in the current period that was previously in a high category and vice versa. These four transition counts (i.e. LL, LH, HL and HH)

construct a 2 by 2 matrix called transition matrix. To find out the transition proportion, we have considered total trials for low state countries (n1) and total trial for high state countries (n2). The transition proportion for LL is p^(LL) = LL/n1, for LH it is p^(LH) = LH/n1, for HL it is p^(HL) = HL/n2 and for HH it is p^(HH) = HH/n2. This process is repeated for all the countries for each time period. The final table for ΔM2 across each country is given in the Appendix ΔM2.

Table I. The average of the whole transition counts and TP are taken for the null hypothesis and further check out whether all the countries have same TP during 1961-2016 or not.

Table 4.4: Average transition counts based on Aggregate data for ΔM2 during 1961-2016.

ΔM2	H	L
H	9	18
L	18	9

The result of the above transition matrix has shown that there are on average 54 transitions occurred in the ΔM2 series for all the countries. The aforementioned table of aggregate data transitions shows that 27 trials come for the Low Countries and 27 trials for the high countries. The transition matrix is a real square matrix for two states with transition probability of each row summing to 1. In the second row and second column 9 shows that if a country is in high broad money in the initial year, in the next year it would remain in the high broad money 9 times out of 27 trails with the transition probability 0.34. The third row and second column 18 times show transition from low to high broad money with 0.66 transition probability. In the high broad money group of

countries total transitions occurred for 27 times. Third row of the transition matrix shows that a country move 18 times from high to low broad money group of countries with the transition probability 0.66 and rest of 9 times countries remain in low group of countries with 0.34 transition probability.

4.3. Hypothesis Formulation for ΔM2 in a two sate Markov chain process

Null hypothesis is formulated on the basis of average transition matrix in table 4.4. Suppose

Markov chain process follows the following sequence L.H.L.H.

$\boldsymbol{H0}$: *The transition probabilities are same for all the countries during* 1961 − 2016

$\boldsymbol{H1}$: *The transition probabilities are not same for all the countries during* 1961 − 2016

In order to assess the above hypothesis for ΔM2 the number of trials has been 27 for low state and 27 for high state, these trials are independent and each has a p-value α=0.05. We used Sidak correction to avoid the inflation of alpha level in order to check whether the transitions are significantly different for at least one country. For ΔM2 series there are N=66 contingency tables then we obtained p*= 0.0007 for each contingency by using the following formula: $1-(1-p*)N = \alpha$.We have to find out the critical values for transition for both states low broad money countries and high broad money. For critical values we have to compute individual probabilities for all the events P(X=k) and then the cumulative probability has been calculated for P(X$\leq k$) or P(X$\geq k$) cutoff points has formed where the p-value of the outcome is found out i.e. less than or equal to p*. Labelling the time as k=1, 2, 3….27 for low state and k=1, 2, 3…27, we

observe X (1), X(2), X(3) … X (27) and we wish to model these as Bi (n, p), where n is the number of time periods and p is the probability of success which is constant across each trial.

To make this more specific, concrete, and detailed, take p (LL) =0.33, p (HH) = 0.34, obtained from the average of overall transition proportion of the whole data on ΔM2. For lower group Bi (27, 0.33) model is used to compute the p-value to assess the null hypothesis while Bi (27, 0.34) is used for transitions in high broad money group of countries. The result obtained from the binomial model have found out the p value for L-L and H-H is 0.00034 and 0.00037 respectively which is less than the p*ΔM2 and p*Δcpi value. The range of uncertain transitions through critical approach for ΔM2 in LL case has been found if 18<X<1 and for H-H has been found if 18<X<1. If the transition of at least one of the low/high income country is less than or equal 1 years or greater than or equal to 18 years than there are 0.07 percent chance that the null hypothesis of same transitions over the time period is being rejected.

4.4. Analysis of CPI and Detection of high/low Inflation Countries:

Cleaned data on consumer price index is available on 66 countries. On the basis of 1st step two state MCM almost all countries stay in category which ever initially they are during 1961-2016. For example Australia, Bahrain, Cameron and Canada's inflation remain in L-L category for 50 times with the transition probability 0.98 and has shown single transition into H-L or L-H and 5 times with transition probability 0.02 in H-H category. Average CPI transitions and their probabilities of these countries are used under null hypothesis "CPI TP of all these countries are same during 1961-2016" in following table:

Table 4.5: Average CPI Transitions based on whole data during 1961-2016

CPI	L	H
L	27	1
H	1	26

Results have shown that on average 27 times countries remain in low category in the current period followed by low state in initial period with the transition period 0.92. In high to high group of inflation 94 percent transitions are seen for staying in high group while 4 percent are from high to low inflationary group. In order to assess whether these countries has same TP during 1961-2016, we have calculated p*=0.0007 for 12 tests by setting alpha 0.05. Average Δ*CPI* transitions and their respective probabilities are used under the null hypothesis for 12 countries during 1961-2016:

Table 4.6: Average ΔCPI Transitions based on whole data during 1961-2016

Δcpi	L	H
L	22	6
H	6	22

Results of Δcpi transition countries have shown that on average all the countries remain in high inflation group for 22 times with the transition probability 0.77.Second row and third column of the above table has shown that 6 times all the countries which are initially in high inflation move to low inflation in the next period with transition probability 23 percent. In low state, moving from one period to another on average 21

percent transitions have seen for low to high case and 79 percent low inflationary countries remain in low group.

By using the Bi (28, 0.79) and Bi (28, 0.77) models the range of uncertain transitions through critical approach for Δcpi in LL case has been found if 14<X<28 and for H-H has been found if 13<X<28. If the transition of at least one of the low/high inflation country is less than or equal 13 years or greater than or equal to 28 years than there are 0.07 percent chance that the null hypothesis of same transitions over the time period is being rejected.

4.4.1. Unusual Transitions and respective Probabilities for low to low category of inflation during 1961-2016:

By using the two state MCM, Congo Dem. Rep., Dominican Republic, Ecuador, Myanmar and Peru these are five countries who are remained in L-L category with unusual transitions. Congo Dem. Rep. remain in low inflation group for 8 times with the transition probability 0.72 and rest of the 27 percent has a transition from low inflation countries to high inflation group. Dominican Republic remain in low inflation for 11 times with 0.58 transition probability and 8 times it showed a transition of low-high inflation countries. Ecuador also remain in low inflation group for 7 times but with 64 percent transition probability. All these three countries have unusual too less LL transitions which means that these are in bottom of the low inflationary countries. On the other side, countries which remain in low inflation category with unusual too high transitions are United States, Trinidad and Tobago, Thailand, Switzerland, Sweden, South Africa, Philippines, Pakistan, Norway, New Zealand ,Morocco, Mauritius ,Libya, India, Denmark, Canada and Australia. South Africa remain in the low inflation group with 89 percent which showed that out of 45 trials 40 times South Africa has remained in lowest inflationary countries.

Table 4.7 Unusual Too low Transitions:

HH	P^(HH)		HH	P^(HH)	
Gambia, The	9	0.67	Philippines	6	0.40
India	3	0.27	Samoa	9	0.47
Libya	12	0.62	South Africa	5	0.5
Mauritius	7	0.50	Sri Lanka	9	0.45
Nepal	4	0.24	Trinidad and Tobago	4	0.5

4.4.2. Unusual Transitions and their respective Probabilities for high to high inflation Category:

Table 4.8 Unusual Too High Transitions:

	6			HH	P^(HH)
Bahrain	29	0.85	Iran	33	0.94
Colombia	29	0.85	Turkey	36	0.97
Congo Dem. Rep.	41	0.93	Israel	34	0.91
Peru	38	0.92	Jamaica	29	0.90
Ecuador	40	0.90	Madagascar	29	0.82
Ghana	34	0.94	Myanmar	34	0.85
Iceland	30	0.85	Nigeria	31	0.88
Sudan	33	0.94			

4.5. Comparison between Unusual High/Low Inflationary Countries and High/Low broad money Countries on the Basis of Unusual Transitions:

By using 1st step two state MCM, data on ΔM2 and ΔCPI is non confirmative with null hypothesis i.e. TP are same for all the countries during1960-2016. On the basis of these findings we may compare high ΔCPI countries with ΔM2 countries of unusual transitions with unusual probabilities and vice versa. The comparison among ΔM2 and ΔCPI in each state is done by looking at the countries' TP within same category and cross category for each variable.

Table 4.9 Unusual Too High L-L Transitions

ΔCPI			ΔM2		
Congo Dem. Rep.	8	0.73	Congo Dem. Rep.	10	0.34
Dominican Republic	11	0.58	Dominican Republic	10	0.36
Ecuador	7	0.64	Ecuador	10	0.36
Myanmar	10	0.67	Myanmar	9	0.33
Peru	12	0.86	Peru	9	0.33

Table 4.10 Unusual Too High H-H Transitions

ΔCPI			ΔM2		
Bahrain	29	0.85	Bahrain	10	0.36
Colombia	29	0.85	Colombia	6	0.24
Congo Dem. Rep.	41	0.93	Congo Dem. Rep.	7	0.27
Myanmar	34	0.85	Myanmar	10	0.36
Iran	33	0.94	Iran	11	0.38
Ecuador	40	0.90	Ecuador	10	0.36

4.6. Cross Markov Chain process among ΔCPI and ΔM2 during 1961-2016:

The next step is to check causation among ΔCPI and ΔM2 by using a new methodology MCM. In this section we tried to assess the null hypothesis that M2 in the previous period has no association with the CPI in current period and vice versa. Firstly, we used Cross MCM to assess the null hypothesis i.e. ΔM_{t-1} and ΔCPI_t has no association. The results of cross markov process are in Appendix Table 1 and for CPI led to M2

hypothesis on the same data are reported in appendix Table 2. In order to assess the null hypothesis the average of the high/low M2/CPI countries' transitions and their respective probabilities are calculated.

The average of the data helps us in the computation of bi (56, 0.49) and bi (56, 0.49) for L-L and H-H transitions. By using the Bi (56, 0.49) and Bi (56, 0.49) models. The range of uncertain transitions through critical approach for cross MCM in LL case has been found if 14<X<41 and for H-H has been found if 14<X<41. If the transition of at least one of the low/high inflation country is less than or equal 14 years or greater than or equal to 41 years than there are 0.07 percent chance that we may reject the null hypothesis of no association among $\Delta M2t-1$ and $\Delta CPIt$.

Following countries support that money M2 leads to CPI. Ecuador, India, and Myanmar has 45, 12, 11 and 42 transitions respectively with 0.63, 0.29, and 0.61 probability of having evidence of high broad money led to high inflation. Trinidad and Tobago, Peru and South Africa has 52, 11 and 44 transitions with 0.62, 0.27 and 0.60 probability of low broad money led low CPI during 1961-2016. After obtaining the above interesting results of broad money led to CPI, we used Cross MCM to assess the null hypothesis i.e. ΔCPI_{t-1} and ΔM_t has no association. Congo, Dem. Rep, South Africa, Trinidad and Tobago, Peru has 11, 47, 12 and 50 transitions with 0.28, 0.64, 0.29 and 0.65 probability of low CPI led low M2 during 1961-2016. Whereas, India has 9 transitions with 0.22 probability of high CPI led high broad money during 1961-2016.

4.7. Results and Interpretation of Granger Causality (GC) Test

To evaluate the direction of causation between M2 and CPI we performed granger causality test on existing method on the same data used in the study. Bivariate Granger causality test is based on the assumption that the past cannot caused by future. There may arise four cases of causal relationship between M2 and CPI i.e. M2 led to CPI, CPI

led to M2, bidirectional relationship or no relationship. The empirical results in the Table 4.8 report the null hypothesis, the F-statistics and probability value for all exceptional countries in high/low category of M2 and CPI variable during 1961-2016. From the probability value, it is clear that, at a 5 percent significance level Ecuador, Myanmar, India, Trinidad and Tobago South Africa and Congo, Dem. Rep. are the countries for which we can reject the null (prob. < 0.05). In these countries the granger causality test has shown bidirectional causality between M2 and CPI. There is single country Peru that does not show any relationship between M2 and CPI.

Table 4.11 Granger Causality Results on high/low CPI/M2 countries during 1961-2016

Country	Null Hypothesis	F-Statistic	Prob.	Causal Inference
Ecuador	M2 ↛ CPI	4.18662	0.0105	Reject H_0
	CPI ↛ M2	4.60622	0.0066	Reject H_0
	M2↛ CPI	12.2905	9.00E-07	Reject H_0
India	CPI ↛ M2	7.03007	0.0002	Reject H_0
	M2 ↛ CPI	10.0098	8.00E-06	Reject H_0
Myanmar	CPI ↛ M2	78.3599	2.00E-19	Reject H_0
	M2 ↛ CPI	0.67707	0.5127	Accept H_0
Peru	CPI ↛ M2	1.63217	0.2057	Accept H_0
	M2 ↛ CPI	9.1619	0.0004	Reject H_0
South Africa	CPI ↛ M2	17.2074	2.00E-06	Reject H_0
	M2 ↛ CPI	6.28447	0.0004	Reject H_0
Trinidad and Tobago	CPI ↛ M2	5.38088	0.0013	Reject H_0
	M2 ↛ CPI	3.50184	0.0225	Reject H_0
Congo, dem. Rep.	CPI ↛ M2	8.64158	0.0001	Reject H_0

↛ Does not Granger Cause

5% criteria of probability

4.8 Comparison among GC Test and Cross MCM Results

From the above findings using cross MCM, we may reach to the conclusion about the four cases of causal relation of broad money and CPI i.e. Broad money led to CPI, CPI led to broad money, bidirectional relationship or no relationship among the variables. The results indicate that there is a unidirectional causation from broad money to CPI for Ecuador and Myanmar. South Africa, Trinidad and Tobago and India supports a bidirectional causal relationship among broad money and CPI. Congo, Dem. Rep has a unidirectional causality running from CPI to broad money. The results of the Granger causality on the same sample has shown that Ecuador, Myanmar, India, Trinidad and Tobago South Africa and Congo, Dem. Rep. has significant causal relationship between money and CPI.it is bidirectional. For Peru the null hypothesis of Granger Causality test is not rejected at 5 percent significance level which shows there in no significant causal relationship among broad money and CPI.

4.9. Long Run Multivariate Model for Money –Price relationship

$$inf_{it} = \alpha_0 + \alpha_1 M2_{it} + \alpha_2 GDP_{it} + \alpha_3 FD_{it} + \alpha_4 GEx_{it} + \alpha_5 int_{it} + \alpha_6 Ex_{it} + \alpha_7 O_{it} + \mu_{it}$$

4.9.1 Panel Unit Root Test :

Here we apply Fisher type ADF unit root test. The results of ADF tests reject the null hypothesis of unit root in the case of inflation rate and interest rate rate. That is the inflation rate and interest rate are I(0). However, we can not reject the null hypothesis of unit root in the case of all other variables. Therefore, rest all are integrated at level one. Consequently , we can apply ARDL panel method in this case.

Table 4.12. ADF Test Unit Root test with two lags _Fisher Type :Prob>chi2

	Without Trend	With Trend
Inflation	0.0663	0.0876
M2	0.4086	0.6322
Real GDP	0.0767	0.3544
Fiscal Deficit	0.3277	0.6296
Government expenditure	0.3982	0.1154
Interest Rate	0.0583	0.0147
Exchange rate	0.2709	0.1758
Openness	0.1039	0.3842

4.9.2. Panel Cointegration Test:

Westerlund Cointegration test is used to test the cointegration for the long panels and heterogenous panel data. The null hypothesis of cointegration is tested in this test through the group mean and pool mean. More specifically, we test the existence of long run relationship among the variables. The table 4.13 presents panel cointegration results. The null hypothesis of no cointegration is rejected and this implies, there is a long run relationship exist between inflation, M2, GDP, Fiscal deficit, exchange rate, interest rate, government expenditure and openness.

Table 4.13. Westerland Cointegration Test when Inflation is Normalized Variable

Covariates	Gt	G0	Pt	Pa
M2	0.0000	0.0000	0.0002	0.0001
RGDP	0.0002	0.0002	0.0001	0.0000
Fiscal Deficit	0.0000	0.0002	0.0000	0.0000
Government expenditure	0.0000	0.0001	0.0001	0.0001
Interest Rate	0.0002	0.0000	0.0000	0.0001
Exchnage rate	0.0002	0.0002	0.0000	0.0000
Openness	0.0002	0.0002	0.0002	0.0002

Note: Gt and G0 are the group mean statistics. Pt and Pa are panel mean statistics.

4.9.3. Long Run Estimates:

The pooled mean group coefficient of all variables has positive and significant relationship with inflation. The estimated coefficient of money supply shows that 1 percent increase in money supply leads to 0.1 percent increase in inflation. For the each country case, it varies from 0.1 to 0.9. Thus generally, there is only a partial effect of money supply on inflation. The coefficient of all variables GDP, Fiscal deficit, exchange rate, interest rate, government expenditure and openness are positive and significant and shows a long run relationship.

The ECM term is correct in sign which is negative and significant but higher than the expectations. For the estimation of individual country, it will according to our expectations. This term shows the speed of adjustment. It implies nearly 50% of the disequilibria in inflation the previous year shock adjust back to the long-run equilibrium in the current year. For the estimation of individual country, it will according to our expectations.

4.14. Long Run Estimates : Error Correction Model (PMG estimations)

	Coefficient	Std Error	T-stat
M2	0.1249***	0.0284	4.3945
RGDP	0.0066***	0.0012	5.6211
Fiscal Deficit	0.1006*	0.0600	1.6782
Government expenditure	0.3381***	0.0699	4.8349
Interest Rate	0.2760***	0.0528	5.2256
Exchange rate	0.0591***	0.0102	5.7645
Openness	0.0145***	0.0026	5.5299
ECM	-0.5825***	0.0425	-13.7193

CHAPTER 5

CONCLUSION AND POLICY RECOMMENDATIONS

In the existing literature there is an extensive adoption of Money Price nexus but the findings of the literature differs on the basis of sample size, assumptions and methodologies and had mixed results. By using a new econometric methodology i.e. MCM, this study re-examined the empirical evidence of Money price nexus and compared it with the existing methodology. With the currently existing methodology, MCM has many important differences from them. One of them is that we do not treat data as being capable of giving us final answer to any question, but only as a way to give hints about reality. To supplement the investigation, we also used historical studies in our work. The broad money and CPI data used in the study is retrieved from WDI World Bank from 1960-2016 for 249 countries.

To summarize, then, we have the following observation. In the first step MCM is applied on the broad money and Consumer price index, the results indicate among all the countries, broad money level remained stable throughout the period studies. There are exceptional countries which have LL case has been found if $14<X<28$ and for H-H has been found if $13<X<28$ in CPI. The clues obtained from the data are supported by the real world events that are the actual cause of unusual increase or decrease in CPI of the underling exceptional countries. To assess M2 led to CPI hypothesis, the broad money and CPI are used for the period 1961-2016. By using MCM we identified unusual low broad money/CPI and high broad money/CPI countries with unusual transitions. Countries: Ecuador, India, Myanmar, Congo, Dem. Rep, South Africa, Trinidad and Tobago, Peru have shown unusual behavior in each state while moving from one period to another.

Going one step ahead the next objective is to use the Granger Causality test as an existing method to assess the hypothesis of on the same data set. The results of the Granger causality on the same sample has shown that Ecuador, Myanmar, India, Trinidad and Tobago South Africa and Congo, Dem. Rep. has significant causal relationship between money and CPI.it is bidirectional. For money led to CPI, CPI led to money or feedback mechanism is not found for Peru. On the other hand, by using MCM South Africa, Trinidad and Tobago and India supports a bidirectional causal relationship among broad money and CPI. By looking at the finding we may conclude that all the four cases of M2 and CPI relationship holds during 1961-2016 and the findings vary from country to country. In the findings for each the difference is may be due to the change in the system of incentives, implementation of different monetary policies, abundance of natural resources, and structure of economy.

The results of panel cointegration further assert that money supply is indeed a critical variable in explaining inflation, As its coefficient is positive and significant. Moreover, the estimated coefficient 0.124 shows that 1 percent increase in money supply leads to 0.1 percent increase in inflation. Thus there is only a partial effect of money supply on inflation.

Overall there are not much exceptional fluctuations in the results. The countries remains the same in which they are. So there are may be the other factors that are the cause of the changes in the economy. There are some other endogenous variable that is the cause of excessive MS and CPI. Here required a careful explanation of the history of observation that we obtained is matter in this way and the cause of unusual transition that seems in an economy should be addressed. Through this transitional behavior they can learn from the mistakes of the predecessor and should iron themselves.

5.1 Further Research

There is a room for modification in every research. Here in this study we used a new method MCM to assess the transitions of CPI and M2 among countries that happen over time by using two categories. The categories i.e. low and high are made on the basis of MEDIAN measure which is insensitive to outliers. We may split the countries into more than 2 categories i.e. low, middle and high by using the 33rd and 66th percentile to do detailed analysis. In order to get the deeper study we may include other variables (i.e. interest rate, exchange rate and GDP etc.) which act as a role of mediator among MS and consumer price index (i.e. interest rate), so that we may get the actual direction and size of influence among different countries. The other alteration we may perform in the future research can be the contemporaneous effect of prices on money and money on prices hypothesis instead of using lag effect used in the present study.

REFERENCE

Abdi, H. (2007). Bonferroni and Šidák corrections for multiple comparisons. *Encyclopedia of measurement and statistics*, *3*, 103-107.

Ahmed, A. E. M., & Suliman, S. Z. (2011). The long-run relationship between money supply, real GDP, and price level: Empirical evidence from Sudan. *Journal of Business Studies Quarterly*, *2*(2), 68.

Ahmed, M. (2002). Money-Income and Money-Price Causality in Selected SAARC Countries: Some Econometric Exercises. *Indian Economic Journal*, *50*(1), 55-62.

Akinbobola, T. O. (2012). The dynamics of money supply, exchange rate and inflation in Nigeria. *Journal of Applied Finance and Banking*, *2*(4), 117.

Amassoma, D., Sunday, K., & Onyedikachi, E. E. (2018). The influence of money supply on inflation in Nigeria. *Journal of Economics & Management*, *31*, 5-23.

Asghar, Z., (2007), *Investigation of Granger Causality*, Ph.D. Thesis, Quaid-e-Azam

University, Islamabad.

Ashra, S., Chattopadhyay, S., & Chaudhuri, K. (2004). Deficit, money and price: The Indian experience. *Journal of policy Modeling*, *26*(3), 289-299.

Atiq-ur-Rehman, A. U. R., & Zaman, A. (2009). Impact of model specification decisions on unit root tests.

Azam, M., & Rashid, S. (2015). The monetarist hypothesis of inflation in Pakistan–a critique. *Journal of the Asia Pacific Economy*, *20*(4), 559-576.

Azam, M., & Rashid, S. (2015). The monetarist hypothesis of inflation in Pakistan–a critique. *Journal of the Asia Pacific Economy*, *20*(4), 559-576.

Baharumshah, A. Z., Mohd, S. H., & Masih, A. M. M. (2009). The stability of money demand in China: Evidence from the ARDL model. *Economic systems*, *33*(3), 231-244.

Basco, E., D'Amato, L., & Garegnani, L. (2009). Understanding the money–prices relationship under low and high inflation regimes: Argentina 1977–2006. *Journal of International Money and Finance*, *28*(7), 1182-1203.

Bashir, F., Nawaz, S., Yasin, K., Khursheed, U., Khan, J., & Qureshi, M. J. (2011). Determinants of inflation in Pakistan: An econometric analysis using Johansen co-integration approach. *Australian Journal of Business and Management Research*, *1*(5), 71.

Beltas, A., & Jones, T. (1993). Money, inflation and causality in a financially repressed economy: Algeria, 1970—88. *Applied Economics*, *25*(4), 473-480.

Benamar, A., Cherif, N., & Benbouziane, M. (2011). Money and prices in the Maghreb countries: cointegration and causality analyses. *International Journal of Business and Social Science*, *2*(24).

Benbouziane, M., & Benamar, A. (2004). The relationship between money and prices in the maghreb countries: a cointegration analysis.

Bickenbach, F., & Bode, E. (2001). *Markov or not Markov-This should be a question* (No. 1086). Kiel working paper.

Biswas, B., & Saunders, P. J. (1990). Money and price level in India: An empirical analysis. *Indian Economic Journal*, *38*(1), 103.

Brillembourg, A., & Khan, M. S. (1979). The Relationship between Money, Income, and Prices: Has Money Mattered Historically?: Note.

Browne, F., & Cronin, D. (2010). Commodity prices, money and inflation. *Journal of Economics and Business*, *62*(4), 331-345.

Chow, G. C. (1966). On the long-run and short-run demand for money. *Journal of Political Economy*, *74*(2), 111-131.

Chow, G. C. (1987). Money and price level determination in China. *Journal of Comparative Economics*, *11*(3), 319-333.

Cogoljević, D., Gavrilović, M., Roganović, M., Matić, I., & Piljan, I. (2018). Analyzing of consumer price index influence on inflation by multiple linear regression. *Physica A: Statistical Mechanics and its Applications*, *505*, 941-944.

Crowder, W. J. (1998). The long-run link between money growth and inflation. *Economic Inquiry*, *36*(2), 229-243.

Darrat, A. F. (1986). Money, inflation, and causality in the north African countries: An empirical investigation. *Journal of Macroeconomics*, *8*(1), 87-103.

Das, S. (2003). Modelling money, price and output in India: a vector autoregressive and moving average (VARMA) approach. *Applied Economics*, *35*(10), 1219-1225.

Dhakal, D., & Kandil, M. (1993). The inflationary experiences of six developing countries in Asia: An investigation of underlying determinants. *Applied Economics*, *25*(3), 413-425.

Dwyer Jr, G. P., & Hafer, R. W. (1999). Are money growth and inflation still related?. *Economic Review-Federal Reserve Bank of Atlanta*, *84*(2), 32.

Dexter, A. S., Levi, M. D., & Nault, B. R. (2002). Sticky prices: the impact of regulation. *Journal of monetary Economics*, *49*(4), 797-821.

El-Shagi, M., & Giesen, S. (2013). Money and inflation: Consequences of the recent monetary policy. *Journal of Policy Modeling*, *35*(4), 520-537.

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

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.

Gabrielli, M. F., Mc Candless, G., & Rouillet, M. J. (2004). The intertemporal relation between money and prices: evidence from Argentina. *Cuadernos de economía*, *41*(123), 199-215.

Ghatak, S., & Deadman, D. (1989). Money, prices and stabilization policies in some developing countries. *Applied Economics*, *21*(7), 853-866.

Ghazali, M. F., Amin, H., Muhammad, M. Z., & Samsu, S. H. (2009). Linkage between money and Prices: A causality Analysis for Malaysia. *International Business Research*, *1*(4), 82.

Ghosh, B. C., Islam, M. K., & Hossain, M. E. Causal Links between Money, Price, and Output in Bangladesh: A Cointegration and VECM Approach.

Giap Tan, K., & Cheng, C. S. (1995). The causal nexus of money, output and prices in Malaysia. *Applied Economics*, *27*(12), 1245-1251.

Grauwe, P. D., & Polan, M. (2005). Is inflation always and everywhere a monetary phenomenon?. *Scandinavian Journal of Economics*, *107*(2), 239-259.

Gujarati, D. N. (1995). Basic Econometrics, McGraw-Hill, New York. *Basic econometrics. 3rd ed. McGraw-Hill, New York*

Hallman, J. J., Porter, R. D., & Small, D. H. (1991). Is the price level tied to the M2 monetary aggregate in the long run?. *The American Economic Review*, 841-858.

Haque, N. U., & Qayyum, A. (2006). Inflation everywhere is a monetary phenomenon: An introductory note. *The Pakistan Development Review*, *45*(2), pp-179.

Hayes, F. (1989). The quantity theory of money.

Hashim, M. J., Osman, I., & Elias, N. L. (2014). The determinants of inflation in Malaysia. In *3rd International Conference on Accounting, Business and Economics (ICABEC2014)*.

Heidari, H., & Johari Salmasi, P. (2010). Re investigation of the long run relationship between money growth and inflation in Iran: An application of Bounds test approach to cointegration. In *International Conference on Business and Economics, Malaysia*.

Hittner, J. B., May, K., & Silver, N. C. (2003). A Monte Carlo evaluation of tests for comparing dependent correlations. *The Journal of general psychology*, *130*(2), 149-168.

Hoover, K. D. (1991). The causal direction between money and prices: An alternative approach. *Journal of Monetary Economics*, *27*(3), 381-423.

Hossain, A. A. (2010). Monetary targeting for price stability in Bangladesh: How stable is its money demand function and the linkage between money supply growth and inflation?. *Journal of Asian Economics*, *21*(6), 564-578.

Hossain, A. A., & Arwatchanakarn, P. (2017). Does Money Have a Role in Monetary Policy for Price Stability under Inflation Targeting in Thailand?. *Journal of Asian Economics*, *53*, 37-55.

Humphrey, T. M. (1974). The quantity theory of money: its historical evolution and role in policy debates. *FRB Richmond Economic Review*, *60*, 2-19.

Husain, F., & Abbas, K. (2010). Money, Income, Prices, and Causality in Pakistan: A Trivariate Analysis. *Working Papers & Research Reports*, RR-No.

Husain, F., & Mahmood, T. (1998). Causality between Money and Prices: Evidence from Pakistan. *The Pakistan Development Review*, 1155-1161.

Inam, U. S. (2014). An Empirical Investigation of the Relationship between Money Supply and Inflation in Nigeria (1970-2011). *International Journal of Humanities Social Sciences and Education (IJHSSE)*, *1*(12), 65-76.

Javed, Z. H., Farooq, M., & Akram, S. (2010). Cost-push shocks and inflation: An empirical analysis from the economy of Pakistan. *Journal of Economics and International Finance*, *2*(12), 308-312.

Jiang, C., Chang, T., & Li, X. L. (2015). Money growth and inflation in China: New evidence from a wavelet analysis. *International Review of Economics & Finance*, *35*, 249-261.

Jones, J. D. (1989). A comparison of lag–length selection techniques in tests of Granger causality between money growth and inflation: evidence for the US, 1959–86. *Applied Economics*, *21*(6), 809-822.

Jones, J. D., & Khilji, N. M. (1988). Money growth, inflation, and causality (Empirical Evidence for Pakistan, 1973—1985). *The Pakistan Development Review*, 45-58.

Khan, R. E. A., & Gill, A. R. (2010). Determinants of inflation: A case of Pakistan (1970-2007). *Journal of economics*, *1*(1), 45-51.

Kiganda, E. O. (2014). Relationship between inflation and money supply in Kenya. *Journal of Social Economics*, *2*(2), 63-83.

Lahiri, A. K. (1991). Money and inflation in Yugoslavia. *Staff Papers*, *38*(4), 751-788.

Majid, A., & Zulkhibri, M. (2007). Causality link between money, output and prices in Malaysia: an empirical re-examination. *Applied Econometrics and International Development*, *7*(1).

Makinen, G. E., & Woodward, G. T. (1989). The Taiwanese hyperinflation and stabilization of 1945-1952. *Journal of Money, Credit and Banking*, *21*(1), 90-105.

Masih, A. M., & Masih, R. (1997). Bivariate and multivariate tests of money–price causality: robust evidence from a small developing country. *Journal of International Development: The Journal of the Development Studies Association*, *9*(6), 803-825.

Masih, A. M., & Masih, R. (1998). Does money cause prices, or the other way around? Multi-country econometric evidence including error-correction modelling from South-east Asia. *Journal of Economic Studies*, *25*(3), 138-160.

McCallum, B. T., & Nelson, E. (2010). Money and inflation: Some critical issues. In *Handbook of monetary economics*(Vol. 3, pp. 97-153). Elsevier.

McCandless, G. T., & Weber, W. E. (1995). Some monetary facts. *Federal Reserve Bank of Minneapolis Quarterly Review*, *19*(3), 2-11.

Mishra, P. K., Mishra, U. S., & Mishra, S. K. (2010). Money, price and output: A causality test for India. *International Research Journal of Finance and Economics*, *53*(2).

Mishra, P. K., Mishra, U. S., & Mishra, S. K. (2010). Money, price and output: A causality test for India. *International Research Journal of Finance and Economics*, *53*(2).

Mostafavi, S. M. (2007). Causality between Money and Inflation in the Iranian Economy.

Mostafavi, S. M. (2007). Causality between Money and Inflation in the Iranian Economy.

Murshed, H., & Nakibullah, A. (2015). Price level and inflation in the GCC countries. *International Review of Economics & Finance*, *39*, 239-252.

Nachane, D. M., & Nadkarni, R. M. (1985). Empirical testing of certain monetarist propositions via causality theory: The Indian case. *Indian Economic Journal*, *33*(1), 13.

Nawaz, M., Naeem, M., Ullah, S., & Khan, S. U. (2017). Correlation and Causality between Inflation and Selected Macroeconomic Variables: Empirical Evidence from Pakistan (1990-2012). *iBusiness*, *9*(04), 149.

Nawaz, M., Naeem, M., Ullah, S., & Khan, S. U. (2017). Correlation and Causality between Inflation and Selected Macroeconomic Variables: Empirical Evidence from Pakistan (1990-2012). *iBusiness*, *9*(04), 149.

Odusanya, I. A., & Atanda, A. A. (2010). Analysis of Inflation and its Determinants in Nigeria.

Oomes, N., & Ohnsorge, F. (2005). Money demand and inflation in dollarized economies: The case of Russia. *Journal of Comparative Economics*, *33*(3), 462-483.

Parikh, A. (1984). Causality between money and prices in Indonesia. *empirical economics*, *9*(4), 217-232.

Parikh, A., & Starmer, C. (1988). The relationship between the money supply and prices in Bangladesh. *The Bangladesh Development Studies*, 59-70.

Păun, C., & Topan, V. (2013). The monetary causes of inflation in Romania. *Romanian Journal of Economic Forecasting*, *16*(1), 5-19.

Pelipas, I. (2006). Money demand and inflation in Belarus: Evidence from cointegrated VAR. *Research in International Business and Finance*, *20*(2), 200-214.

Qayyum, A. (2006). Money, inflation, and growth in Pakistan. *The Pakistan development review*, 203-212.

Ramachandran, M. (2004). Do broad money, output, and prices stand for a stable relationship in India?. *Journal of Policy Modeling*, *26*(8-9), 983-1001.

Rowthorn, R. E. (1977). Conflict, inflation and money. *Cambridge Journal of Economics*, *1*(3), 215-239.

Sedova, A., & Ratzlaf, A. (2014). Monetary Theory from Neoclassicists to Monetarism (Evolution Aspect). In *Young Scientist USA* (pp. 51-54). Lulu Press.

Sabade, S. (2014). Is money supply the cause of inflation in India? An alternative postulate to understand inflation. *Procedia-Social and Behavioral Sciences*, *133*, 379-382.

SHARMA, R. (1984). Causality between money and price level in India. *Indian Economic Review*, *19*(2), 213-221.

Shirvani, H., & Wilbratte, B. (1994). Money and inflation: International evidence based on cointegration theory. *International Economic Journal*, *8*(1), 11-21.

Siklos, P. L. (1990). The link between money and prices under different policy regimes: The postwar Hungarian experience. *Explorations in Economic History*, *27*(4), 468-482.

Sola, O., & Peter, A. (2013). Money supply and inflation in Nigeria: Implications for national development. *Modern Economy*, *4*(3), 161-170.

Sumaila, U. R., & Laryea, S. A. (2001). Determinants of inflation in Tanzania. *CMI Working Paper*.

Sun, H., & Ma, Y. (2004). Money and price relationship in China. *Journal of Chinese Economic and Business Studies*, *2*(3), 225-247.

Tang, C. F. (2010). The money-prices nexus for Malaysia: New empirical evidence from the time-varying cointegration and causality tests. *Global Economic Review*, *39*(4), 383-403.

Tang, C. F., & Lean, H. H. (2007). Is the Phillips curve stable for Malaysia? New empirical evidence. *Malaysian Journal of Economic Studies*, *44*(2), 95-105.

Tödter, K. H., & Reimers, H. E. (1994). P-Star as a Link between Money and Prices in Germany. *Review of World Economics*, *130*(2), 273-289.

Togay, S., & Kose, N. (2013). Money-price relationships under a currency board system: the case of Argentina. *Journal of Applied Economics*, *16*(2), 373-389.

Tyrkalo, R., & Adamyk, B. (1999). Monetary policy transmission and its meaning to the effectiveness of NBU activity. *Herald of NBU*, *7*(6), 11.

Waingade, R. A. (2011). Money Supply and Inflation: A Historical Analysis. *IUP Journal of Monetary Economics*, *9*(1).

Walsh, C. E. (2003). *Monetary theory and policy*. Cambridge, Massachusetts: The MIT press, 2003.

Xie, C., Tang, H., & Cui, Y. (2009, April). Money supply, economic growth and inflation of China: 1998-2007. In *2009 International Joint Conference on Computational Sciences and Optimization* (Vol. 2, pp. 562-566). IEEE.

Yi, G. (1990). Inflation and price instability: An empirical study of the People's Republic of China. *China Economic Review*, *1*(2), 155-165.

Zaman, A. (2009). Causal Relations via Econometrics. *International Econometric Review*, *2*(1), 36-56.

Sedova, A., & Ratzlaf, A. (2014). Monetary Theory from Neoclassicists to Monetarism (Evolution Aspect). In *Young Scientist USA* (pp. 51-54). Lulu Press.

APPENDIX A

Steps in MCM

1. Data extraction from the site
2. Data Cleaning- Filter-Delete the Worlds Groups
3. Variables are used instead of level form to get rid of trending (non-stationarity) problem in the series.
4. Split the data according to years for all the countries e.g. data on all the filtered countries for 1961:1962, 1962:963, 1963:1964,……,2015:2016
5. Find the Median by using =MEDIAN(B3:B89) for whole time period for a single unit
6. By using Excel formula =SIGN(B3-B$1) (where B3 is median and B$1 is the value of for first country) assign value -1 if country is below median, +1 if country is above median and 0 if there is any median country. (0 occurs when the number of countries are odd)
7. After giving the signs to countries above median and below median, we have used the excel =IF(number<=0,0,1) statement to make a sequence of 0's and 1's, 0's for the countries below median and 1's for above median.
8. The next step after finding out the sequence of binary outcomes of 0's and 1's, is to estimate whether the current outcome follows the recent past outcome or not. For this purpose the excel syntax is used for each state low and high and to calculate its transition from low to high and high to low. LL=IF ((B4=0)*(B3=0), 1, 0) this statement gives the value 1 if a country remained in low state in the current period followed by low state in the previous period (e.g. country follow a sequence of 00 or LL) and 0 otherwise. LH=IF ((B4=1)*(B3=0), 1, 0) this statement gives the value 1 if a country have a

transition to a high state in the current period followed by low state in the previous period (e.g. country follow a sequence of 01or LH) and 0 otherwise. HL=IF ((B4=0)*(B3=1), 1, 0) this statement gives the value 1 if a country have a transition to a low state in the current period followed by high state in the previous period (e.g. country follow a sequence of 10 or HL) and 0 otherwise. HH=IF ((B4=1)*(B3=1), 1, 0) this statement gives the value 1 if a country remained in high state in the current period followed by high state in the previous period (e.g. country follow a sequence of 11 or HH) and 0 otherwise.

9. =SUM command is used for all the outcomes for LL, LH, HL, HH column.

10. Sum total obtained from the above step is equal to the number of trial (time periods) used in the study that is 53. To find out the transition proportion, we have to consider the total trials for low state countries (LL+LH=n1) and total trial for high state countries (HL+HH=n2), the transition proportion for LL came out to be p^ (LL) = LL/n1, for LH came out to be p^ (LH) = LH/n1, for HL it is p^ (HL) = HL/n2 and for HH it is p^ (HH) = HH/n2. This process is repeated for all the countries for each time period.

11. Take the average of the whole transition counts and TP to be used for the null hypothesis and check out whether all the countries have same TP and all the time period have same TP.

APPENDIX FOR CPI

Table I: Transition Counts of CPI for all countries during 1961-2016

Country Name	LL	LH	HH	HL
Algeria	27	4	21	21
Australia	50	1	5	0
Bahrain	50	1	5	0
Bolivia	14	2	37	3
Burkina Faso	50	1	5	0
Burundi	6	0	49	1
Cameroon	50	1	5	0
Canada	50	1	5	0
Colombia	8	2	43	3
Congo, Dem. Rep.	6	0	49	1
Costa Rica	2	2	50	2
Cote d'Ivoire	50	1	5	0
Denmark	50	1	5	0
Dominican Republic	0	0	56	0
Ecuador	7	3	42	4
Egypt, Arab Rep.	6	0	49	1
El Salvador	22	1	32	1
Ethiopia	31	1	23	1
Gabon	50	1	5	0
Gambia, The	14	7	28	7
Ghana	6	0	49	1
Guatemala	6	1	47	2
Haiti	6	1	47	2
Honduras	6	0	49	1
Iceland	10	2	42	2
India	32	1	22	1
Iran, Islamic Rep.	6	0	49	1
Israel	24	1	30	1

Jamaica	6	0	49	1
Japan	50	1	5	0
Kenya	6	0	49	1
Korea, Rep.	50	1	5	0
Libya	56	0	0	0
Madagascar	6	0	49	1
Malaysia	50	1	5	0
Mauritius	36	2	17	1
Mexico	8	2	43	3
Morocco	50	1	5	0
Myanmar	3	1	50	2
Nepal	31	1	23	1
New Zealand	50	1	5	0
Niger	50	1	5	0
Nigeria	6	0	49	1
Norway	50	1	5	0
Pakistan	24	1	29	2
Panama	54	1	1	0
Paraguay	6	0	49	1
Peru	17	1	37	1
Philippines	18	5	28	5
Rwanda	17	3	33	3
Samoa	41	2	12	1
Saudi Arabia	45	2	8	1
Senegal	50	1	5	0
Singapore	52	1	3	0
South Africa	4	1	49	2
Sri Lanka	6	0	49	1
Sudan	6	0	49	1
Sweden	50	1	5	0
Switzerland	50	1	5	0

Syrian Arab Republic	15	3	35	3
Thailand	50	1	5	0
Togo	50	1	5	0
Trinidad and Tobago	35	1	18	2
Turkey	6	0	49	1
United States	50	1	5	0
Uruguay	6	0	49	1

APPENDIX FOR ΔCPI

Table I: Transition Counts and their Respective Probabilities for ΔCPI from 1961-2016

Country	LL	LH	HH	HL	p(LL)	p(LH)	p(HH)	p(HL)
Algeria	17	10	17	16	0.63	0.37	0.52	0.48
Australia	29	3	21	2	0.91	0.09	0.91	0.09
Bahrain	16	5	29	5	0.76	0.24	0.85	0.15
Bolivia	21	4	25	5	0.84	0.16	0.83	0.17
Burkina Faso	17	11	17	10	0.61	0.39	0.63	0.37
Burundi	16	7	24	8	0.70	0.30	0.75	0.25
Cameroon	19	8	20	8	0.70	0.30	0.71	0.29
Canada	30	3	20	2	0.91	0.09	0.91	0.09
Colombia	17	4	29	5	0.81	0.19	0.85	0.15
Congo, Dem. Rep.	8	3	41	3	0.73	0.27	0.93	0.07
Costa Rica	19	6	25	5	0.76	0.24	0.83	0.17
Cote d'Ivoire	24	8	16	7	0.75	0.25	0.70	0.30
Denmark	29	2	23	1	0.94	0.06	0.96	0.04
Dominican Republic	11	8	28	8	0.58	0.42	0.78	0.22
Ecuador	7	4	40	4	0.64	0.36	0.91	0.09
Egypt, Arab Rep.	21	6	22	6	0.78	0.22	0.79	0.21
El Salvador	17	8	22	8	0.68	0.32	0.73	0.27
Ethiopia	17	9	19	10	0.65	0.35	0.66	0.34
Gabon	25	7	17	6	0.78	0.22	0.74	0.26
Gambia, The	23	11	9	12	0.68	0.32	0.43	0.57
Ghana	18	1	34	2	0.95	0.05	0.94	0.06
Guatemala	23	6	19	7	0.79	0.21	0.73	0.27
Haiti	17	7	24	7	0.71	0.29	0.77	0.23
Honduras	26	3	23	3	0.90	0.10	0.88	0.12
Iceland	15	5	30	5	0.75	0.25	0.86	0.14
India	36	8	3	8	0.82	0.18	0.27	0.73
Iran, Islamic Rep.	19	1	33	2	0.95	0.05	0.94	0.06
Israel	15	3	34	3	0.83	0.17	0.92	0.08

Jamaica	20	3	29	3	0.87	0.13	0.91	0.09
Japan	26	2	26	1	0.93	0.07	0.96	0.04
Kenya	17	5	28	5	0.77	0.23	0.85	0.15
Korea, Rep.	26	8	13	8	0.76	0.24	0.62	0.38
Libya	29	7	12	7	0.81	0.19	0.63	0.37
Madagascar	15	5	29	6	0.75	0.25	0.83	0.17
Malaysia	20	6	22	7	0.77	0.23	0.76	0.24
Mauritius	33	8	7	7	0.80	0.20	0.50	0.50
Mexico	20	3	28	4	0.87	0.13	0.88	0.13
Morocco	29	4	19	3	0.88	0.12	0.86	0.14
Myanmar	10	5	34	6	0.67	0.33	0.85	0.15
Nepal	26	12	4	13	0.68	0.32	0.24	0.76
New Zealand	29	2	23	1	0.94	0.06	0.96	0.04
Niger	20	9	17	9	0.69	0.31	0.65	0.35
Nigeria	17	3	31	4	0.85	0.15	0.89	0.11
Norway	30	2	21	2	0.94	0.06	0.91	0.09
Pakistan	31	5	14	5	0.86	0.14	0.74	0.26
Panama	23	4	25	3	0.85	0.15	0.89	0.11
Paraguay	24	4	23	4	0.86	0.14	0.85	0.15
Peru	12	2	38	3	0.86	0.14	0.93	0.07
Philippines	30	10	6	9	0.75	0.25	0.40	0.60
Rwanda	16	8	22	9	0.67	0.33	0.71	0.29
Samoa	26	10	9	10	0.72	0.28	0.47	0.53
Saudi Arabia	17	8	22	8	0.68	0.32	0.73	0.27
Senegal	16	6	27	6	0.73	0.27	0.82	0.18
Singapore	20	6	24	5	0.77	0.23	0.83	0.17
South Africa	40	5	5	5	0.89	0.11	0.50	0.50
Sri Lanka	24	11	9	11	0.69	0.31	0.45	0.55
Sudan	18	2	33	2	0.90	0.10	0.94	0.06
Sweden	30	2	22	1	0.94	0.06	0.96	0.04
Switzerland	30	2	22	1	0.94	0.06	0.96	0.04
Syrian Arab Republic	19	12	13	11	0.61	0.39	0.54	0.46

Thailand	29	5	17	4	0.85	0.15	0.81	0.19
Togo	16	9	21	9	0.64	0.36	0.70	0.30
Trinidad and Tobago	43	4	4	4	0.91	0.09	0.50	0.50
Turkey	18	0	36	1	1.00	-	0.97	0.03
United States	32	2	20	1	0.94	0.06	0.95	0.05
Uruguay	17	3	31	4	0.85	0.15	0.89	0.11

Table II: Transition economies with respect to M2

Country	LL	LH	HH	HL	p(LL)	p(LH)	p(HH)	p(HL)
Algeria	56	0	0	0	1.00	0.00	0.00	0.00
Australia	56	0	0	0	1.00	0.00	0.00	0.00
Bahrain	0	0	56	0	0.00	0.00	1.00	0.00
Bolivia	0	0	56	0	0.00	0.00	1.00	0.00
Burkina Faso	50	2	2	2	0.96	0.04	0.50	0.50
Burundi	5	2	48	1	0.71	0.29	0.98	0.02
Cameroon	56	0	0	0	1.00	0.00	0.00	0.00
Canada	56	0	0	0	1.00	0.00	0.00	0.00
Colombia	56	0	0	0	1.00	0.00	0.00	0.00
Congo, Dem. Rep.	8	0	47	1	1.00	0.00	0.98	0.02
Costa Rica	38	1	15	2	0.97	0.03	0.88	0.12
Cote d'Ivoire	56	0	0	0	1.00	0.00	0.00	0.00
Denmark	50	1	5	0	0.98	0.02	1.00	0.00
Dominican Republic	0	0	56	0	0.00	0.00	1.00	0.00
Ecuador	0	0	56	0	0.00	0.00	1.00	0.00
Egypt, Arab Rep.	2	0	53	1	1.00	0.00	0.98	0.02
El Salvador	0	0	56	0	0.00	0.00	1.00	0.00
Ethiopia	0	0	56	0	0.00	0.00	1.00	0.00
Gabon	56	0	0	0	1.00	0.00	0.00	0.00
Gambia, The	0	0	56	0	0.00	0.00	1.00	0.00
Ghana	0	0	56	0	0.00	0.00	1.00	0.00
Guatemala	0	0	56	0	0.00	0.00	1.00	0.00
Haiti	0	0	56	0	0.00	0.00	1.00	0.00
Honduras	0	0	56	0	0.00	0.00	1.00	0.00
Iceland	22	1	31	2	0.96	0.04	0.94	0.06
India	56	0	0	0	1.00	0.00	0.00	0.00

Iran, Islamic Rep.	56	0	0	0	1.00	0.00	0.00	0.00
Israel	19	1	35	1	0.95	0.05	0.97	0.03
Jamaica	0	0	56	0	0.00	0.00	1.00	0.00
Japan	56	0	0	0	1.00	0.00	0.00	0.00
kenya	0	0	56	0	0.00	0.00	1.00	0.00
Korea, Rep.	56	0	0	0	1.00	0.00	0.00	0.00
Libya	0	0	56	0	0.00	0.00	1.00	0.00
Madagascar	56	0	0	0	1.00	0.00	0.00	0.00
Malaysia	46	3	5	2	0.94	0.06	0.71	0.29
Mauritius	0	0	56	0	0.00	0.00	1.00	0.00
Mexico	27	0	28	1	1.00	0.00	0.97	0.03
Morocco	35	2	18	1	0.95	0.05	0.95	0.05
Myanmar	30	3	20	3	0.91	0.09	0.87	0.13
Nepal	3	0	52	1	1.00	0.00	0.98	0.02
New Zealand	0	0	56	0	0.00	0.00	1.00	0.00
Niger	31	1	24	0	0.97	0.03	1.00	0.00
Nigeria	23	0	32	1	1.00	0.00	0.97	0.03
Norway	56	0	0	0	1.00	0.00	0.00	0.00
Pakistan	56	0	0	0	1.00	0.00	0.00	0.00
Panama	0	0	56	0	0.00	0.00	1.00	0.00
Paraguay	56	0	0	0	1.00	0.00	0.00	0.00
Peru	0	0	56	0	0.00	0.00	1.00	0.00
Philippines	56	0	0	0	1.00	0.00	0.00	0.00
Rwanda	9	4	40	3	0.69	0.31	0.93	0.07
Samoa	0	0	56	0	0.00	0.00	1.00	0.00
Saudi Arabia	48	1	5	2	0.98	0.02	0.71	0.29
Senegal	56	0	0	0	1.00	0.00	0.00	0.00
Singapore	21	2	32	1	0.91	0.09	0.97	0.03

South Africa	56	0	0	0	1.00	0.00	0.00	0.00
Sri Lanka	51	2	1	2	0.96	0.04	0.33	0.67
Sudan	0	0	56	0	0.00	0.00	1.00	0.00
Sweden	56	0	0	0	1.00	0.00	0.00	0.00
Switzerland	47	1	8	0	0.98	0.02	1.00	0.00
Syrian Arab Republic	45	1	8	2	0.98	0.02	0.80	0.20
Thailand	56	0	0	0	1.00	0.00	0.00	0.00
Togo	32	2	21	1	0.94	0.06	0.95	0.05
Trinidad and Tobago	0	0	56	0	0.00	0.00	1.00	0.00
Turkey	0	0	56	0	0.00	0.00	1.00	0.00
United States	56	0	0	0	1.00	0.00	0.00	0.00
Uruguay	0	0	56	0	0.00	0.00	1.00	0.00

APPENDIX FOR ΔM2

Table I: Transition Counts and their Respective Probabilities for ΔM2 from 1961-2016

Country Name	LL	LH	HH	HL	p(LL)	p(LH)	p(HH)	p(HL)
Algeria	11	17	10	10	0.39	0.61	0.50	0.50
Australia	11	17	10	17	0.39	0.61	0.37	0.63
Bahrain	9	18	10	18	0.33	0.67	0.36	0.64
Bolivia	11	17	10	17	0.39	0.61	0.37	0.63
Burkina Faso	9	18	10	18	0.33	0.67	0.36	0.64
Burundi	10	18	9	18	0.36	0.64	0.33	0.67
Cameroon	10	19	7	19	0.34	0.66	0.27	0.73
Canada	9	19	8	19	0.32	0.68	0.30	0.70
Colombia	11	19	6	19	0.37	0.63	0.24	0.76
Congo, Dem. Rep.	10	19	7	19	0.34	0.66	0.27	0.73
Costa Rica	9	19	8	19	0.32	0.68	0.30	0.70
Cote d'Ivoire	10	19	7	19	0.34	0.66	0.27	0.73
Denmark	10	19	7	19	0.34	0.66	0.27	0.73
Dominican Republic	10	18	9	18	0.36	0.64	0.33	0.67
Ecuador	10	18	9	18	0.36	0.64	0.33	0.67
Egypt, Arab Rep.	9	18	10	18	0.33	0.67	0.36	0.64
El Salvador	8	18	11	18	0.31	0.69	0.38	0.62
Ethiopia	10	18	9	18	0.36	0.64	0.33	0.67
Gabon	7	19	10	19	0.27	0.73	0.34	0.66
Gambia, The	8	19	9	19	0.30	0.70	0.32	0.68
Ghana	9	18	10	18	0.33	0.67	0.36	0.64
Guatemala	6	19	11	19	0.24	0.76	0.37	0.63
Haiti	8	19	9	19	0.30	0.70	0.32	0.68
Honduras	3	20	12	20	0.13	0.87	0.38	0.63
Iceland	8	19	9	19	0.30	0.70	0.32	0.68
India	7	18	12	18	0.28	0.72	0.40	0.60
Iran, Islamic Rep.	8	18	11	18	0.31	0.69	0.38	0.62

Israel	10	18	9	18	0.36	0.64	0.33	0.67
Jamaica	10	18	9	18	0.36	0.64	0.33	0.67
Japan	10	18	9	18	0.36	0.64	0.33	0.67
Kenya	9	18	10	18	0.33	0.67	0.36	0.64
Korea, Rep.	8	18	11	18	0.31	0.69	0.38	0.62
Libya	11	17	10	17	0.39	0.61	0.37	0.63
Madagascar	9	17	12	17	0.35	0.65	0.41	0.59
Malaysia	9	17	12	17	0.35	0.65	0.41	0.59
Mauritius	9	17	12	17	0.35	0.65	0.41	0.59
Mexico	11	17	10	17	0.39	0.61	0.37	0.63
Morocco	9	18	10	18	0.33	0.67	0.36	0.64
Myanmar	9	18	10	18	0.33	0.67	0.36	0.64
Nepal	7	19	10	19	0.27	0.73	0.34	0.66
New Zealand	7	19	10	19	0.27	0.73	0.34	0.66
Niger	9	18	10	18	0.33	0.67	0.36	0.64
Nigeria	8	18	11	18	0.31	0.69	0.38	0.62
Norway	9	18	10	18	0.33	0.67	0.36	0.64
Pakistan	9	18	10	18	0.33	0.67	0.36	0.64
Panama	9	18	10	18	0.33	0.67	0.36	0.64
Paraguay	9	18	10	18	0.33	0.67	0.36	0.64
Peru	9	18	10	18	0.33	0.67	0.36	0.64
Philippines	9	18	10	18	0.33	0.67	0.36	0.64
Rwanda	7	19	10	19	0.27	0.73	0.34	0.66
Samoa	9	19	8	19	0.32	0.68	0.30	0.70
Saudi Arabia	9	19	8	19	0.32	0.68	0.30	0.70
Senegal	9	19	8	19	0.32	0.68	0.30	0.70
Singapore	9	19	8	19	0.32	0.68	0.30	0.70
South Africa	9	19	8	19	0.32	0.68	0.30	0.70
Sri Lanka	10	19	7	19	0.34	0.66	0.27	0.73
Sudan	12	19	5	19	0.39	0.61	0.21	0.79
Sweden	12	18	7	18	0.40	0.60	0.28	0.72
Switzerland	12	18	7	18	0.40	0.60	0.28	0.72

Syrian Arab Republic	10	17	11	17	0.37	0.63	0.39	0.61
Thailand	11	18	8	18	0.38	0.62	0.31	0.69
Togo	10	18	9	18	0.36	0.64	0.33	0.67
Trinidad and Tobago	11	18	8	18	0.38	0.62	0.31	0.69
Turkey	10	18	9	18	0.36	0.64	0.33	0.67
United States	11	18	8	18	0.38	0.62	0.31	0.69
Uruguay	11	18	8	18	0.38	0.62	0.31	0.69

Table 1: Cross Markov Transitions and their probabilities of M2 led to CPI during 1961-2016

Country Name	**LL**	**LH**	**HH**	**HL**	**p(LL)**	**p(LH)**	**p(HH)**	**p(HL)**
Algeria	32	24	31	24	0.57	0.43	0.56	0.44
Australia	29	32	19	31	0.48	0.52	0.38	0.62
Bahrain	22	27	35	27	0.45	0.55	0.56	0.44
Bolivia	30	24	33	24	0.56	0.44	0.58	0.42
Burkina Faso	25	31	25	30	0.45	0.55	0.45	0.55
Burundi	24	28	31	28	0.46	0.54	0.53	0.47
Cameroon	29	28	27	27	0.51	0.49	0.50	0.50
Canada	34	28	22	27	0.55	0.45	0.45	0.55
Colombia	26	26	33	26	0.50	0.50	0.56	0.44
Congo, Dem. Rep.	9	32	39	31	0.22	0.78	0.56	0.44
Costa Rica	28	26	32	25	0.52	0.48	0.56	0.44
Cote d'Ivoire	33	29	21	28	0.53	0.47	0.43	0.57
Denmark	35	26	25	25	0.57	0.43	0.50	0.50
Dominican Republic	16	32	32	31	0.33	0.67	0.51	0.49
Ecuador	13	27	45	26	0.33	0.68	0.63	0.37
Egypt, Arab Rep.	26	29	27	29	0.47	0.53	0.48	0.52

El Salvador	21	31	29	30	0.40	0.60	0.49	0.51
Ethiopia	27	28	28	28	0.49	0.51	0.50	0.50
Gabon	26	33	20	32	0.44	0.56	0.38	0.62
Gambia, The	34	28	21	28	0.55	0.45	0.43	0.57
Ghana	21	26	38	26	0.45	0.55	0.59	0.41
Guatemala	29	26	30	26	0.53	0.47	0.54	0.46
Haiti	26	26	33	26	0.50	0.50	0.56	0.44
Honduras	26	27	31	27	0.49	0.51	0.53	0.47
Iceland	22	25	39	25	0.47	0.53	0.61	0.39
India	40	29	12	30	0.58	0.42	0.29	0.71
Iran, Islamic Rep.	19	27	37	28	0.41	0.59	0.57	0.43
Israel	21	25	40	25	0.46	0.54	0.62	0.38
Jamaica	24	27	32	28	0.47	0.53	0.53	0.47
Japan	30	26	29	26	0.54	0.46	0.53	0.47
Kenya	19	30	31	31	0.39	0.61	0.50	0.50
Korea, Rep.	30	30	21	30	0.50	0.50	0.41	0.59
Libya	35	29	18	29	0.55	0.45	0.38	0.62
Madagascar	16	30	34	31	0.35	0.65	0.52	0.48
Malaysia	24	28	30	29	0.46	0.54	0.51	0.49
Mauritius	40	27	17	27	0.60	0.40	0.39	0.61
Mexico	20	31	28	32	0.39	0.61	0.47	0.53
Morocco	34	26	25	26	0.57	0.43	0.49	0.51
Myanmar	16	26	42	27	0.38	0.62	0.61	0.39
Nepal	38	26	20	27	0.59	0.41	0.43	0.57
New Zealand	31	26	28	26	0.54	0.46	0.52	0.48
Niger	29	27	28	27	0.52	0.48	0.51	0.49
Nigeria	17	29	35	30	0.37	0.63	0.54	0.46
Norway	32	27	24	28	0.54	0.46	0.46	0.54
Pakistan	33	30	17	31	0.52	0.48	0.35	0.65
Panama	28	26	31	26	0.52	0.48	0.54	0.46
Paraguay	25	30	25	31	0.45	0.55	0.45	0.55

Peru	11	30	39	31	0.27	0.73	0.56	0.44
Philippines	38	29	15	29	0.57	0.43	0.34	0.66
Rwanda	23	27	33	28	0.46	0.54	0.54	0.46
Samoa	37	27	20	27	0.58	0.42	0.43	0.57
Saudi Arabia	23	30	27	31	0.43	0.57	0.47	0.53
Senegal	24	26	35	26	0.48	0.52	0.57	0.43
Singapore	27	27	30	27	0.50	0.50	0.53	0.47
South Africa	44	29	8	30	0.60	0.40	0.21	0.79
Sri Lanka	39	25	21	26	0.61	0.39	0.45	0.55
Sudan	20	31	29	31	0.39	0.61	0.48	0.52
Sweden	35	28	21	27	0.56	0.44	0.44	0.56
Switzerland	35	28	21	27	0.56	0.44	0.44	0.56
Syrian Arab Republic	33	26	27	25	0.56	0.44	0.52	0.48
Thailand	39	25	23	24	0.61	0.39	0.49	0.51
Togo	29	25	33	24	0.54	0.46	0.58	0.42
Trinidad and Tobago	52	25	9	25	0.68	0.32	0.26	0.74
Turkey	23	24	40	24	0.49	0.51	0.63	0.38
United States	34	30	18	29	0.53	0.47	0.38	0.62
Uruguay	26	24	37	24	0.52	0.48	0.61	0.39

Table 2: Cross Markov Transitions and their probabilities of CPI led to M2 during 1961-2016

Country Name	**LL**	**LH**	**HH**	**HL**	**p(LL)**	**p(LH)**	**p(HH)**	**p(HL)**
Algeria	26	30	24	31	0.46	0.54	0.44	0.56
Australia	30	30	21	30	0.50	0.50	0.41	0.59
Bahrain	23	26	36	26	0.47	0.53	0.58	0.42
Bolivia	27	27	29	28	0.50	0.50	0.51	0.49
Burkina Faso	25	31	25	30	0.45	0.55	0.45	0.55

Burundi	22	30	28	31	0.42	0.58	0.47	0.53
Cameroon	26	30	24	31	0.46	0.54	0.44	0.56
Canada	35	26	24	26	0.57	0.43	0.48	0.52
Colombia	24	28	30	29	0.46	0.54	0.51	0.49
Congo, Dem. Rep.	11	29	41	30	0.28	0.73	0.58	0.42
Costa Rica	25	28	30	28	0.47	0.53	0.52	0.48
Cote d'Ivoire	32	29	21	29	0.52	0.48	0.42	0.58
Denmark	35	25	26	25	0.58	0.42	0.51	0.49
Dominican Republic	22	25	38	26	0.47	0.53	0.59	0.41
Ecuador	10	29	42	30	0.26	0.74	0.58	0.42
Egypt, Arab Rep.	25	30	26	30	0.45	0.55	0.46	0.54
El Salvador	21	30	29	31	0.41	0.59	0.48	0.52
Ethiopia	25	30	25	31	0.45	0.55	0.45	0.55
Gabon	26	32	21	32	0.45	0.55	0.40	0.60
Gambia, The	32	30	18	31	0.52	0.48	0.37	0.63
Ghana	21	26	37	27	0.45	0.55	0.58	0.42
Guatemala	29	26	29	27	0.53	0.47	0.52	0.48
Haiti	25	27	32	27	0.48	0.52	0.54	0.46
Honduras	26	27	31	27	0.49	0.51	0.53	0.47
Iceland	23	24	40	24	0.49	0.51	0.63	0.38
India	37	33	9	32	0.53	0.47	0.22	0.78
Iran, Islamic Rep.	19	28	36	28	0.40	0.60	0.56	0.44
Israel	21	25	40	25	0.46	0.54	0.62	0.38
Jamaica	24	28	32	27	0.46	0.54	0.54	0.46
Japan	28	28	28	27	0.50	0.50	0.51	0.49
Kenya	18	32	30	31	0.36	0.64	0.49	0.51
Korea, Rep.	34	26	25	26	0.57	0.43	0.49	0.51
Libya	32	32	15	32	0.50	0.50	0.32	0.68

Madagascar	16	31	33	31	0.34	0.66	0.52	0.48
Malaysia	20	33	25	33	0.38	0.62	0.43	0.57
Mauritius	37	30	15	29	0.55	0.45	0.34	0.66
Mexico	22	30	29	30	0.42	0.58	0.49	0.51
Morocco	33	27	25	26	0.55	0.45	0.49	0.51
Myanmar	14	29	39	29	0.33	0.67	0.57	0.43
Nepal	36	29	17	29	0.55	0.45	0.37	0.63
New Zealand	30	27	28	26	0.53	0.47	0.52	0.48
Niger	27	29	26	29	0.48	0.52	0.47	0.53
Nigeria	18	29	35	29	0.38	0.62	0.55	0.45
Norway	31	29	23	28	0.52	0.48	0.45	0.55
Pakistan	32	32	16	31	0.50	0.50	0.34	0.66
Panama	27	27	31	26	0.50	0.50	0.54	0.46
Paraguay	24	32	24	31	0.43	0.57	0.44	0.56
Peru	12	30	39	30	0.29	0.71	0.57	0.43
Philippines	36	31	14	30	0.54	0.46	0.32	0.68
Rwanda	24	27	33	27	0.47	0.53	0.55	0.45
Samoa	37	27	20	27	0.58	0.42	0.43	0.57
Saudi Arabia	21	33	25	32	0.39	0.61	0.44	0.56
Senegal	23	27	34	27	0.46	0.54	0.56	0.44
Singapore	26	28	30	27	0.48	0.52	0.53	0.47
South Africa	47	27	11	26	0.64	0.36	0.30	0.70
Sri Lanka	37	28	19	27	0.57	0.43	0.41	0.59
Sudan	20	31	29	31	0.39	0.61	0.48	0.52
Sweden	35	27	22	27	0.56	0.44	0.45	0.55
Switzerland	36	26	23	26	0.58	0.42	0.47	0.53
Syrian Arab Republic	30	28	25	28	0.52	0.48	0.47	0.53
Thailand	39	24	24	24	0.62	0.38	0.50	0.50

Togo	27	26	31	27	0.51	0.49	0.53	0.47
Trinidad and Tobago	50	27	7	27	0.65	0.35	0.21	0.79
Turkey	23	24	39	25	0.49	0.51	0.61	0.39
United States	35	28	20	28	0.56	0.44	0.42	0.58
Uruguay	25	25	35	26	0.50	0.50	0.57	0.43