

Impact of Quantitative Easing on Emerging Markets: A study on Indian Markets

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Declaration:

I declare that all the work in this dissertation is entirely my own unless the words have been placed in inverted commas and referenced with the original source. Furthermore, texts cited are referenced as such, and placed in the reference section. A full reference section is included within this thesis.

No part of this work has been previously submitted for assessment, in any form, either at Dublin Business School or any other institution.

Signed:.....

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And finally to my Paternal and Maternal Grandfathers – I write because of you.

Abstract

The Problem: *To understand and analyze the mechanisms, effects and consequences of conventional and unconventional monetary policy (UMP) on the Global Financial System and Emerging Markets in particular.* The recent financial crisis has changed the mechanism of monetary policy transmission in developed countries. The question that then arises is two-fold. First, has the quantitative easing (QE) policy that has been pursued by central banks affected output, employment and prices? And second, whether QE can continue to stimulate economic activity despite the presence of the zero lower bound and various other financial market frictions. Crockett (2001) notes that it is important to ensure that arrangements for the pursuit of price stability do not inadvertently endanger the stability of the financial system while at the same time the weaknesses of the financial system not impede the effective operation of monetary policy. The overall aim of the research is to then examine whether unconventional monetary policy serves the twin goals of monetary policy – that of price stability on one hand and financial stability on the other.

Methodology: A Vector Auto-Regression (VAR) model was used to build two models. The first model had Federal Funds Rate as a part of the exogenous variables and the second one had Quantitative Easing as a part of the exogenous variables. The research was conducted using longitudinal data from 2008 to 2013 and a quantitative overall design.

Conclusions and Recommendations: The results of the VAR models indicate significant relationships between Indian macroeconomic variables viz. Indian Repo Rate, Inflation and Rupee/Dollar Exchange Rate. Further, the research also displayed long run causality between the variables and short run causality in the currency and interest rate channels. The results of the VAR suggest that Monetary Policy in advanced and emerging economies must consider financial stability and external stability in their mandates.

CHAPTER 1 – INTRODUCTION

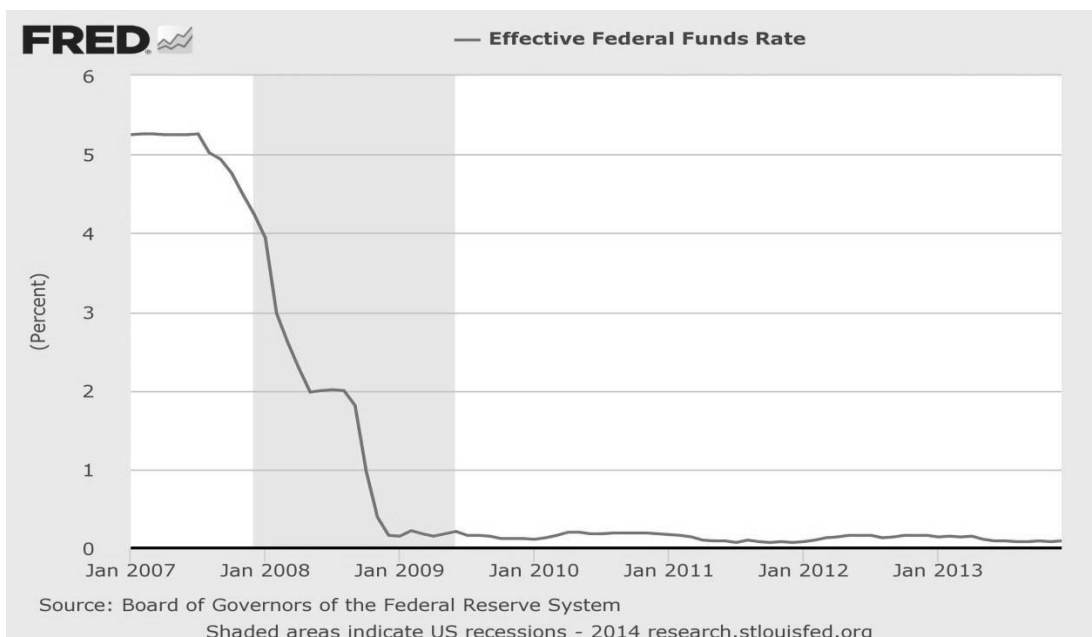
1. Introduction

“When the U.S. sneezes, emerging markets catch a cold”

The recent financial crisis of 2007 has had many ramifications. In addition to bringing about significant changes in the financial sector, it has also necessitated Monetary Policy Responses which one may be tempted to call as ‘out of the ordinary’. What differentiates this crisis from any other crises in the past is the integration of the global financial system. One ripple in one nation generates multiple ripples in many other nations. In addition to being integrated, the different features of different economies give this system a robust structure.

In an effort to control the onset of the crisis in 2007, the Federal Open Market Committee began an expansionary Monetary Policy cutting the Federal Funds Rate - which is the primary Monetary Policy tool – from 5.25% in 2007 to almost 2% in 2008.

Figure 1 - Effective Federal Funds Rate 2007-2013

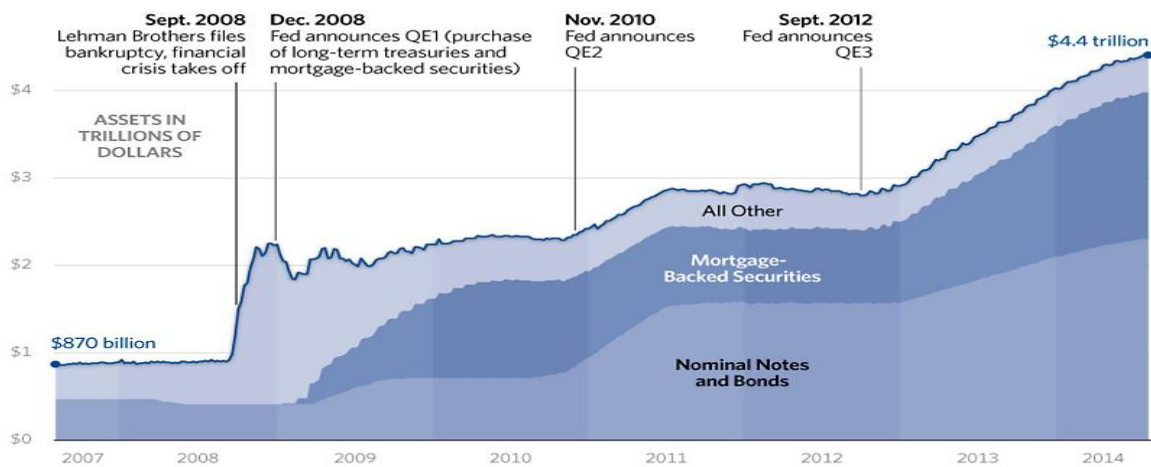


As interest rates approached zero, the Federal Reserve System was left with limiting options to ease out the liquidity crunch. Therefore, as a means of reviving the economy, the Federal Reserve began seeking out 'Unconventional Monetary Policies' in the form of Quantitative Easing (QE hereon). QE in its simplest form refers to the manipulation of the Federal Reserve's balance sheet by purchasing long term assets and in particular Treasury and agency securities and injecting liquidity into the system. Bernanke noted in a speech in 2012 that the large-scale asset purchases not only influence financial conditions but through other channels the broader economy as well. In 2010, he also noted that when the short term interest rates reach the zero-lower bound, Unconventional Monetary Policy essentially takes the form of conventional Monetary Policy and aims at changing longer term interest rates instead of having incremental policy impacts.

Since January 2009, the Federal Reserve's outright holdings of long term securities have increased significantly. Figure 2 illustrates the assets and liabilities held by the Federal Reserve. The first round of QE was undertaken in November 2008 involving a large scale purchase of mortgage-backed securities to the tune of \$1.7 trillion in debt purchases, mortgage-backed securities, government agency debt and Treasury bonds. The second round of QE began in November 2010 involves a purchase of \$600 billion in long-term Treasuries, in addition to the reinvestment of an additional \$250 billion to \$300 billion in Treasuries from earlier proceeds from mortgage-backed securities. The third round of QE involves a monthly purchase of \$40 billion mortgage backed securities.

Figure 2 - Federal Reserve Assets

Federal Reserve Assets: Key Dates



Source: Board of Governors of the Federal Reserve System, "Credit and Liquidity Programs and the Balance Sheet: Total Assets of the Federal Reserve," http://www.federalreserve.gov/monetarypolicy/bst_recenttrends.htm

In today's world of highly integrated economies, the impact of this QE program has been felt world-wide. This research therefore aims to identify this impact on emerging markets and in particular India.

The most direct transmission channel of QE on emerging markets has been through capital flows. The aim of QE has been to inject liquidity in the economy. While this effort was successful, confident channels, portfolio balancing channels also had impacts on the investors' decision to use this liquidity. Faced with less confidence and a natural desire to seek higher returns, US private investors started investing their capital in emerging economies which at that time had more attractive bonds than developed economies' bonds. As a result emerging economies experienced a surge in capital flows, and at times, more than they could handle and thereby leading to QE effects percolating to other factors in the economy as well.

This research seeks to highlight whether such a phenomena holds true for the Indian economy. The Indian market could be considered as a unique example of an emerging

economy. Unlike many South-East Asian counterparts, the initial shocks of the crisis were not felt by the Indian economy largely due to its banking and financial system which had little investments in the structured financial instruments like Mortgage backed securities which were the primary causes of the financial crisis. If anything, the effects of the crisis were positive in the beginning through increased foreign institutional investments and the general belief in emerging economies that they were 'the alternative engine of growth to the global economy'. For India, the challenges in the wake of the financial crisis are twofold – one, that of short term macroeconomic challenges of Monetary and Fiscal Policy and two, the medium term challenge of attaining and more importantly sustaining high rates of economic growth. Given this, it would be an interesting challenge to study whether Monetary Policy events in the US have had any impact on India.

The Research Problem – to study the effects of quantitative easing on India. The research looks at the period from 2008 to 2013 to study the impact of QE on Indian macroeconomic variables. The base model of the thesis is that done by Morgan (2012) who investigates the possible impacts of the US QE policy on a vast number of Asian economies. He does so by examining the inflationary impacts of the US Federal Reserve's large-scale asset purchases on the liquidity and inflation in emerging Asian economies through domestic liquidity, exchange rates and bond market yields. This research narrows the research aim of Morgan (2012) to India and focuses on studying the impact of US Monetary Policy in general from 2008 to 2013 on Indian Monetary Policy, Rupee/Dollar Exchange Rate and Inflation. By making use of Vector Auto-

regressions, the research looks how one variable reacts to changes in its own values and in the values of other variables. (See Chapter 3 and Chapter 4)

In the literature review (see Chapter 2), an attempt has been made to understand the evolution of Monetary Policy in general. It is important to study and analyze events in the past in order to understand how Monetary Policy has evolved since the Great Depression. One glaring observation after undertaking this exercise is that every time, world economies have faced a financial crisis or a recession; Monetary Policy has evolved to take into account this disturbance. As Monetary Policy evolved so did the theory surrounding it ,so much so , that every significant event in the history of Monetary Policy Economics mirrors the economic changes taking place such as Milton Friedman and Inflation Targeting , Rational Expectations Theory and so on. Thus, a strand of thought that emerges from this phenomenon is that QE in its current form in the US is but a natural development of Monetary Policy to address the current economic conditions. The question that then arises is that is it fair to evaluate QE as an 'Unconventional Monetary Policy Tool'?

The next section of the Literature Review attempts to study QE. The first section looks at the theoretical justification behind QE followed by a general discussion of Unconventional Monetary Policy and finally the transmission mechanisms of QE.

Eventually , the focus of the literature review goes to the impact of QE on emerging markets and a brief overview of the theoretical model based on which this research is conducted.

Taking into account the research methodologies applied which are discussed in Chapter 3 and the actual research findings in Chapter 4 , it is anticipated that this study will add to the slowly growing literature that is examining the effect of QE on emerging markets and in particular India . Throughout the research undertaken to carry out this research, it has been noted that while the literature for empirical evidence of QE on emerging markets is small, there has been no study conducted for the Indian economy. Therefore, this research is a small attempt to initiate studies that look at this facet of the repercussions of the Great Financial Crisis.

Finally, Chapter 5 looks at whether there exists a relationship between macroeconomic variables in India and the US Monetary Policy tools. It then further addresses the key theme that underlies this entire thesis – has Unconventional Monetary Policy changed the structure and the mechanism through which inflation and economic stability is achieved.

CHAPTER 2 – LITERATURE REVIEW

2. Literature Review

2.1 Traditional Monetary Policy Transmission Mechanism

In order to undertake a critical analysis of Unconventional monetary policies, it is imperative to first look at Monetary Policy itself. In its simplest form, Monetary Policy can be referred to the 'decisions about the nation's system of coin, currency and banking' (Mankiw, 2013). However, the contextual importance of Monetary Policy stems from the fact that it has evolved into both an important determinant as well as an important variable in the context of the entire economic system. Mishkin (2008) observes that the objectives of monetary policy revolve around formulating policies that stabilize inflation and economic activity.

Every financial and economic turmoil since the Great Depression has seen a different form of monetary policy being implemented. In conjunction with the appropriate fiscal policy, these set of economic policies have been deemed appropriate to address the situation at any particular point in time. However, fiscal and monetary policies have a strong impact on short-term stability and long-term viability. Therefore, the responses to these policies are of greater importance.

An overwhelmingly large amount of literature concerning Monetary Policy in the wake of the financial crisis centers around three main themes. They are –

1. What should the intermediate objectives of Monetary Policy be and in that context what the benefits and challenges are of cross country policy operations?

2. How should Monetary Policy be shaped during normal times to avoid hitting the ZLB and therefore what are the merits of using Unconventional policy tools during normal times?
3. What is the optimal governance structure for macro-prudential, micro-prudential policies and Monetary Policy?

Taylor (2013) observes that MP over the last thirty years can be largely looked at as either 'discretionary' or 'unpredictable'. He further notes of the existence of a positive relationship between a rules-based monetary policy and an improvement in the macro economy.

Keynes' argument that suggested that shortfalls in aggregate demands were the source of the recession in 1928 was contested by Milton Friedman's famous adage that 'inflation is always and everywhere a monetary phenomenon.' Bernanke (2004) observes 'Friedman's monetary framework has been so influential that, in its broad outlines at least, it has nearly become identical with modern monetary theory and practice.'

Up until two decades preceding the crisis, low and stable inflation was the primary mandate of MP. Further as Blanchard and Gali (2007) succinctly point out stable inflation kept output around its efficient level. New Keynesian models where nominal rigidities were the only friction provided the intellectual foundation for this approach (Woodford 2003).

The Federal Reserve in the United States of America describes its Monetary Policy mandate as 'to promote effectively the goals of maximum employment, stable prices

and moderate long term interest rates.’ Mishkin (2007) however argues that a stable macroeconomic environment is necessary for long term interest rates to remain low. Therefore, one can then conclude that any Central Bank would have a dual mandate – that of maximizing employment and price stability. Economic literature has argued over the apparent conflicting interests in pursuing these twin objectives in the short run. In the long run however as Mishkin (2008) points out, stabilizing economic activity and stabilizing inflation become mutually reinforcing.

Inflation targeting as a Monetary Policy objective became important in the 1970s as the costs of inflation became more apparent. This is further elucidated by research conducted by Andersen and Gruen (1995) in particular who examined wide ranging theoretical and empirical evidence on the effect of macroeconomic policies on economic growth. They concluded that growth in industrial countries is affected by higher inflation and the associated increased uncertainty about future inflation. Further they emphasized that gains from lower inflation appeared to exceed the initial costs of reducing inflation within a decade. The aspect of uncertainty is emphasized by Lucas (1992) and Briault (1995) as well who are of the opinion that economic efficiency is impacted by the uncertainty regarding relative prices and the future price level due that comes about due to high inflation. The costs of higher inflation is also illustrated by English (1996) who suggested that high inflation undermines the value of money as a medium of exchange and leads to an over-investment in the financial sector resulting in individuals and businesses escape some costs of inflation. Another facet to understanding inflation targeting as a Monetary Policy objective is the Phillips Curve. Introduced in 1958, the Phillips Curve suggests that there is a negative correlation

between unemployment and the rate of change of money wages in the UK. An extension of this research was the trade-off between unemployment and inflation available to policy makers – Central Banks could decide how much inflation it is willing to accept in order to attain a certain unemployment rate. The Phillips Curve thus perfectly captures the dichotomous nature of Monetary Policy objectives. Samuelson and Solow (1960) were the first to identify this trade-off between unemployment and inflation and the potential policy options of the same. Further research by Akerlof, Dickens and Perry (2000), Primiceri (2006) and Sargent, Williams and Zha (2005) for instance discussed the policy implications of this trade-off. In the long run however, the Phillips Curve relationship does not hold true. Friedman (1968) and Phelps (1968) independently argued the same and concluded that once the economy gravitates towards a natural unemployment rate, the Phillips curve would become vertical and any attempts to lower unemployment would only result in higher inflation. Friedman was of the opinion that ‘there is always a temporary tradeoff between inflation and unemployment; there is no permanent trade off’. He argues this by elucidating that a Monetary Policy which aims to lower unemployment by a monetary expansion can only achieve that goal temporarily. This is because lower interest rates stimulate spending and raise the marginal product of labor which in turn increases employment and output. According to Friedman, the demand for higher nominal wages will increase because prices rise before the wages as a result of which the real wages fall. As wage increases begin to match the price increases, the rising real wage rate will bring unemployment back to its ‘natural rate’ rendering inflation targeting as a Monetary Policy objective ineffective.

This gave rise to the famous rational expectation theory) Lucas, 1972, 1973 and 1976) who demonstrated that market expectations of policy actions have important effects on the economy. As a result, the importance of confidence channels was established – that is, the expectations of policy makers' actions are an important determinant of monetary policy effectiveness. Woodford (2003) elucidated this further by highlighting that a central element of monetary policy is the management of expectations of future policy. The Taylor Rule (1993) has been regarded by many as the seminal work that explains the relationship between monetary policy expectations and economic outcomes.

All this leads to final question of what is the optimal monetary policy. Mishkin argues that the theory of optimal monetary policy begins by specifying an objective function that represents economic welfare where economic welfare is the wellbeing of the economy which is maximized subject to the constraints provided by the model of the economy. Before the financial crisis the objective and the constraints were based on the new neoclassical synthesis. Svensson (1997) , Gertler et al (1999) and Woodford (2003) stat that the objective function is based on two components which reflects price stability by minimizing inflation from its optimal rate and the costs of underutilized resources in the economy which involves minimizing deviations of real economic activity from its natural rate level. Further, the importance of future expectations requires Central Banks to maximize objectives that are both for the present state and expected future paths an economy could take. Given this, Mishkin (2007) then postulates that short term interest rates are the best tool for maximizing the objective function.

How then has the financial crisis changed Monetary Policy transmission? Once again, this is best summarized by Mishkin (2007). He argues that there are five phenomena which has influenced monetary policy framework across the world.

- a. Developments in the financial sector have a far greater impact on economic activity
- b. The macro economy is highly nonlinear causing economic activity to transcend into a perverse cycle
- c. The zero lower bound is more problematic than we realized
- d. The costs of cleaning up after a financial crisis are very high. Deep recessions lead to very strong recoveries often in a V-shaped pattern
- e. And the most important of all , price and output stability do not ensure financial stability

Krugman (2009) argued that the flaws of monetary policy were highlighted in the wake of the financial crisis. He wrote, 'How did Economists get it so wrong? Does it mean that the science of monetary policy as we knew it before the crisis should be abandoned, and that policymakers and monetary economists should start all over?'

2.2 Theoretical justification of QE

The previous section highlighted the fact that the primary instrument used by monetary authorities for achieving their objectives is the short term interest rate (Mishkin 2007). However under the presence of zero lower bound (ZLB) interest rates, this methodology is not effective. This was proven during the Great Depression when fiscal spending took the primary place in achieving economic stimulus , the next event that

proved the same was Japan's experience between 1990-2006 and the most recent crisis was handled by monetary authorities through QE which is the focus of this research.

The alternate tools that could be available for monetary policy were identified by Blinder (2007) who suggested seven alternatives from longer maturity government securities purchases to depreciating the exchange rate through foreign securities purchase. These alternatives were narrowed down by Bernanke and Reinhart (2004) who drew inference from the Japanese experience to suggest three possible Monetary Policy actions to stimulate economic activity. These techniques were –“ (1) *using communications policies to shape public expectations about the future course of interest rates*; (2) *increasing the size of the Central Bank's balance sheet, or “quantitative easing”*; and (3) *changing the composition of the Central Bank's balance sheet through, for example, the targeted purchases of long-term bonds as a means of reducing the long-term interest rate* “ What is interesting to note is that while these actions can be mutually exclusive, they can also be used in tandem such as taking actions to expand the balance sheet so as to credibly signal future policy actions. Klyuev et al (2009) suggested four possible alternatives available to Central Banks in such an event. These were 1) Committing explicitly to low policy rates maintenance; 2) Additional liquidity provisions to financial intermediaries; 3) purchasing government securities to alter long term interest rates and 4) intervening in specific credit markets on purpose.

For QE to demonstrate a credible commitment to increase money supply permanently would lead to rising inflation expectations, lower real interest rates and aggregate demand stimulation (Auerbach and Obstfeld 2005). Auerbach and Obstfeld (2005) also argue that the effectiveness of QE is determined by the expectations of private sector

participants. Thus one can then reach the conclusion that theoretically QE can enable economic activity stimulation in the event of a zero lower bound. However, this argument is ambiguous because of the temporary use of QE each time it has been implemented.

Therefore, what is QE? Shiratsuka (2009) defines QE as a 'package of Unconventional policy measures designed to absorb the shocks hitting the economy by making use of both the asset and liability sides of the Central Bank balance sheet' This works by increasing money supply through large scale asset purchase by the Central Bank s and as a result providing banks with reserves to further lend.

The first evidence of QE was the monetary response of the United States in 1932 when the Federal Reserve System began \$1 million purchases of government treasuries from 1932 until 1936. The next instance of QE cited in literature is the Japanese experience in 1990s and 2001. In February 1999 when the Japanese official bank rate reached the zero-bound , the Bank of Japan initiated QE as a supplement to the zero-rate policy to avoid deflationary trends as well as a tool for further economic stimulus. The recent crisis led to Central Banks of major advanced economies to resort to Unconventional Monetary Policy measures. The focus of this research is the QE policies undertaken by the federal reserve of the United States. As of date, three rounds of QE have been undertaken. The first round of QE was undertaken in November 2008 involving a large scale purchase of mortgage-backed securities to the tune of \$1.7 trillion in debt purchases, mortgage –backed securities, government agency debt and Treasury bonds. The second round of QE began in November 2010 involves a purchase of \$600 billion in long-term Treasuries, in addition to the reinvestment of an additional \$250 billion to

\$300 billion in Treasuries from earlier proceeds from mortgage-backed securities . The third round of QE which involves a monthly purchase of \$40 billion mortgage backed securities.

There appears to be little consensus in literature regarding whether QE is effective due to the fact that each time QE has been used , it has been done for short periods of time. Bernanke, Reinhart and Sack (2004) discuss the ways in which QE works in the scenario of a 'liquidity trap'. They make two significant observations. One, that the statements made by monetary authorities must be credible to shape interest rate expectations by policy commitments. This could be achieved by temporarily increasing the size of the Central Bank's balance (Krugman 2000). Second the imperfection in financial markets assist QE to have a direct impact on interest rates. This view is countered by Reinhart and Sack (2000) , Eggertsson and Woodford (2003) who argue that increases in monetary base which does not signal a future change in the interest rate policy will 'neither stimulate real activity or halt deflation' when the nominal interest has reached the lower bound. They posit two arguments for their claims. One is that forward looking agents would adjust their economic decision according to their anticipation of policy reversal based on the Japanese experience in early 2000s. As a result, the general equilibrium of the model will become independent of bond and money supply at the zero lower bound because agents would respond to asset purchases by increasing their money holdings. Two, for portfolio balancing effects to take place, the financial imperfections which are required may begin to generate countervailing effects leading to an ambiguous stimulatory influence of the portfolio balancing effect.

However it is theoretically still unclear whether QE would have an unambiguously positive influence on economic activity. Curdia and Woodford (2011) demonstrated that a temporary use of QE will only stimulate aggregate demand if it enables the Central Bank to extend the optimal level of credit to the private sector. Given that the main objective of QE is to stimulate investment by lowering long term interest rates, their research does not help in answering the question. They found QE to not have any effect when the optimal level of credit was exceeded because the endogenous variable path would not have changed in the equilibrium setting. Gertler and Karadi (2011) reached the same conclusion by using a framework that included financial intermediaries as well.

Having discussed the effectiveness of QE, two facets seem to be the highlights in literature. The effectiveness of QE depends on the inherent degree of financial imperfections in the market and its ability to signal future courses of policy rates. The temporary use of QE as a tool to stimulate demand is aided and abetted by heterogeneous households, constraints on bank lending, constraints on the borrowing ability of households and the preference of habitats of the financial market participants. If these conditions seem to exist in an economy, Clouse et al (2003) suggest that QE would be an effective measure to stimulate demand by altering either the inflation or interest rate expectations. Therefore, to study the empirical effectiveness of QE, it is important to consider the presence (or not) of these frictions in the economy.

2.3 Empirical Analysis of QE's effectiveness

In order to understand and evaluate the empirical effectiveness of QE, two broad cases must be considered. The first one is the QE measures undertaken by Japan and

secondly, the QE measures undertaken by Western Economies in the wake of the recent financial crisis.

2.3.1 The Japanese Experience between 2001-2006

The vast amount of literature studying the Japanese experience focuses on the two QE programs that preceded the 2001 QE policy. The 2001 QE was used as an additional tool for providing stimulus to the economy and avoiding deflationary trends. Bowman et al (2011) identified three key elements of the Japanese QE in 2001. These were – (1) Changing the main operating target from uncollateralized overnight call rate to the outstanding current account balances held by financial institutions at the Bank of Japan to increase the current account balances more than the required reserves.; (2) increasing the purchases of government bonds to help achieve the targeted increases in the current account balances and (3) a commitment to maintain the QE until the core CPI stopped declining.

The relative strengths of the transmission channels were elucidated by Ugai (2006) who found QE to have moderate effects on interest rates through the portfolio balancing effect and more importantly by exhibiting a credible commitment to the monetary authority's low interest rate commitment. Shiratsuka (2009) adds to this by proving the effect of the policy on the short term interest rates and credit spreads. A general consensus apparent from the vast amount of literature examining the Japanese experience is that the QE undertaken by Japan was instrumental in stabilizing the financial system through sufficient liquidity provision to financial institutions. Oda and Ueda (2005) used a small macroeconomic model with no-arbitrage asset pricing components to further validate the aforementioned conclusions. They seem to be of

the opinion that while the policy did have marginal effects on interest rates and provided credibility to the zero-rate policy; it had uncertain effects on the risk premium of long term bond yields. However, further reading suggests that while their claims might be true, the methodology used by the authors such as not controlling for binding liquidity constraints meant that they refrained from many potentially confounding effects in their model.

The general consensus from the vast literature is that while QE had a definite impact on the interest rates, its effect on output and inflation remains ambiguous. Plausible reasons for this ambiguity is succinctly summarized by Kamada and Sugo (2006) who argue that this uncertainty rises from asset prices decline leading to significant deterioration of private sector balance sheets and disruption in traditional economic relationships due to the zero lower bound .

2.3.2 Current Experience of Quantitative Easing

Figure 3 QE Timeline

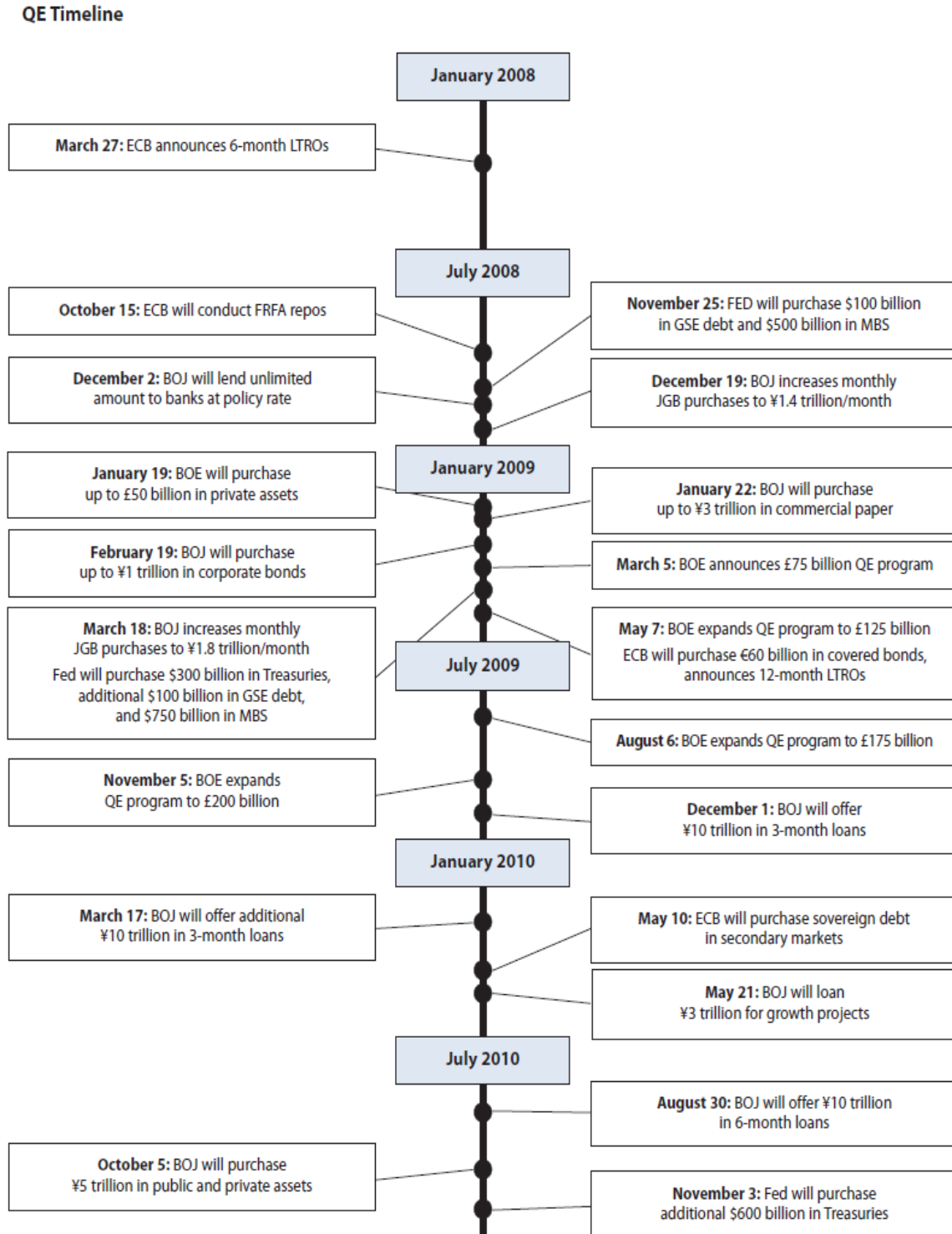
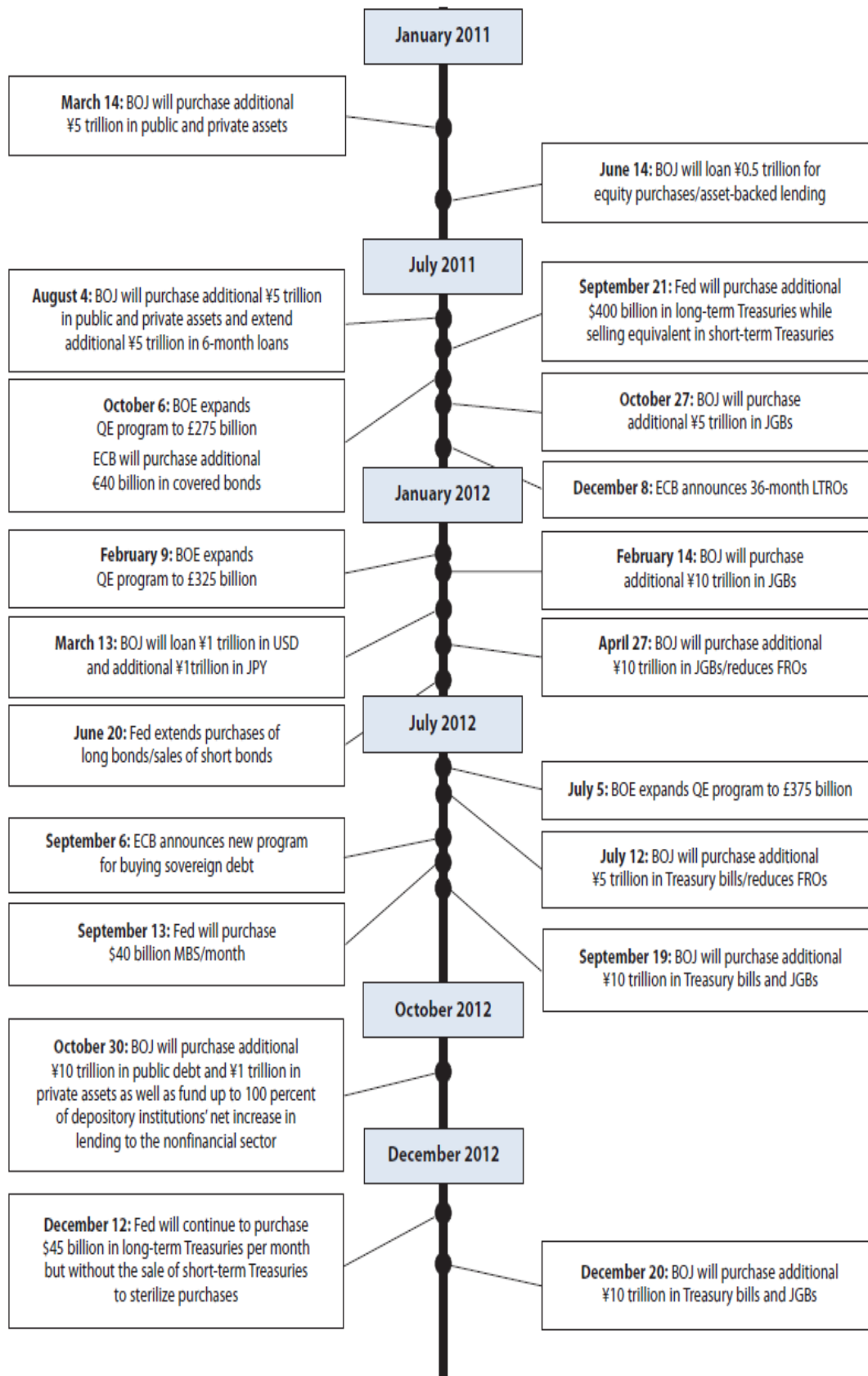


Figure 3 (continued)



NOTE: FROs, fixed-rate operations; JPY, Japanese yen; USD, U.S. dollars.

Source – Blinder (2007)

In the wake of the recent financial crisis, four countries took up to QE in the face of a zero lower bound. These were the four cases of QE that took place in the United States, the United Kingdom, the European Union and Japan.

These four cases have been widely studied in literature. Stoebel and Taylor (2009), Kohn (2009), Meyer and Bomfim (2010) and Gagnon et al (2011) are some of the major academicians who have studied the phenomenon of the American QE. The majority consensus was that the US QE program was successful in reducing the long term yields of the US bonds. Neely (2012) evaluated the effect of the Fed's 2008-09 QE. The main aim of the study was to evaluate the effect of this QE program on international long bond yields and exchange rates, the conclusion of which was that the QE program had similar effects on the given variables akin to a simple portfolio balance model and long run purchasing parity. For the Bank of England QE programs, Joyce et al (2011) is the seminal work that summarizes the effect of the QE. They find that the effects of the Bank of England QE were similar to that of the United States in affecting the bond yields.

Fawley (2013) was the first economist to draw a comparison between the four cases of QE. He finds that while the four cases of QE had a common primary aim of reducing financial stress, with time, the scope of these policies broadened to address issues such as stimulating the real economy, targeting a particular inflation level and in the case of the EU, to contain the sovereign debt. Further his studies conclude that a consistent facet of these four cases was their effect on the monetary base and in more particular the expansion of monetary base.

Empirical literature in this regard has used various methodologies to understand and analyze the effect of Unconventional Monetary Policy on real economic variables as well as financial market factors.

Meier (2009) and Joyce et al. (2010) analysed the QE by the bank of England to find that the large scale purchase of government bonds led to a decline in the yields between 40 – 100 and 55 – 120 basis points respectively over the 5 – 25 year segment of the yield curve. Joyce et al. (2010) furthered the research in identifying the significant movements in corporate bond yields; however, the research presented an ambiguous effect of the policy on equity prices and exchange rates. One element that emerges upon studying these literatures is that the fact that QE has been undertaken only for short periods of time renders any policy evaluation from giving adequate results on their effects on macroeconomic variables.

With respect to the US QE, Gagnon et al. (2010) identified the effect of the Federal Reserve's policy on the yields of bonds with different maturities. They find that the assets which were targeted by the policy experienced a decline in their yields by 120 basis points on an average. Krishnamurthy and Vissing – Jorgensen (2011) supported the claims of Gagnon and in addition showed that QE led to an increase in inflationary expectations therefore a sharper decrease in real interest rates and a sharp decrease in nominal rates for long-term safe assets. Lenza et al. (2010) used a Bayesian VAR to confirm similar findings. With regards to the impact of QE on MBS purchases, Hancock and Passmore (2010) argue that additional market liquidity bought about by the MBS purchases led to the elimination of risk premiums from mortgage rates. A wide array of methodologies has been used by empirical literature to analyze the effect of QE on

financial market conditions and interest rates. These studies corroborate the fact that the presence of sufficient financial market frictions facilitated QE in stimulating economic activity. Where these research fail are in providing conclusive evidence with regards to the direction and the magnitude of these effects.

2.4 Transmission Mechanism for Quantitative Easing

Eggertsson and Woodford (2003) in their paper illustrated the method of modeling Unconventional Monetary Policy by using a standard New Keynesian framework. Their analysis included the main elements of any economy viz. a representative household, monopolistic competition in the goods market, price adjustments (they used the price adjustment mechanism as mentioned by Calvo (1983) and non-separable real money balances. They assumed the utility function to take the form of –

$$U'_m \left(C_t, \frac{M_t}{P_t}, \varepsilon_t \right) > 0 \text{ for all } , \frac{M_t}{P_t} \leq m(Y_t, \varepsilon_t) \quad (1)$$

&

$$U'_m \left(C_t, \frac{M_t}{P_t}, \varepsilon_t \right) = 0 \text{ for all } , \frac{M_t}{P_t} > m(Y_t, \varepsilon_t) \quad (2)$$

Where C_t denotes the level of consumption, $\frac{M_t}{P_t}$ the real money balances held by households and ε_t the vector of exogenous disturbances. When there is household optimization, Eggertsson and Woodford (2003) suggest that at least one of the following two inequalities must hold with equality. These inequalities are $\frac{M_t}{P_t} > L(Y_t, i_t, \varepsilon_t)$ where the second term denotes the money demand function and $i_t \geq 0$ where i is the nominal interest rate.

The satiation level which is defined as 'the minimum level of money balances at which the marginal utility from holding real money balances is zero such that the nominal interest rate also equals zero' leads to the equilibrium becoming independent of the actual monetary base level. Eggertsson and Woodford (2003) use a choice of monetary base function to represent QE. This monetary base function denotes the condition where the Central Bank supplies liquidity more than what is required for the nominal interest rate to be zero.

By doing this, the authors concluded that for QE to have any effect on real macroeconomic variables, the policy must be executed such that it alters future policy rates expectations. While Eggertsson and Woodford (2003) highlighted the main condition for a QE policy to succeed, their work fails on three main grounds. First, the specification of the monetary base rule is not consistent with the current policy base. The current policies aims at influencing the yield curve through large scale asset purchases and not target the size of money supply in the economy. Second, the model is seriously limited by the lack of use of financial imperfections. This is illustrated by Doh (2011) who argues that the lack of financial imperfections such as preferred habitats of investors, credit rationing, and automatically creates an environment where the only transmission mechanism available becomes the communication channel. And finally, they fail to take into consideration external forces which may impact the relationships between financial markets and the real economy. Doing this, leads to a perception that the effects of the policy do not percolate to output and prices. Kamada and Sugo (2006) highlight this point by suggesting that relationships between financial

markets and the real economy may have led to severe unambiguous changes in interest rates and outputs.

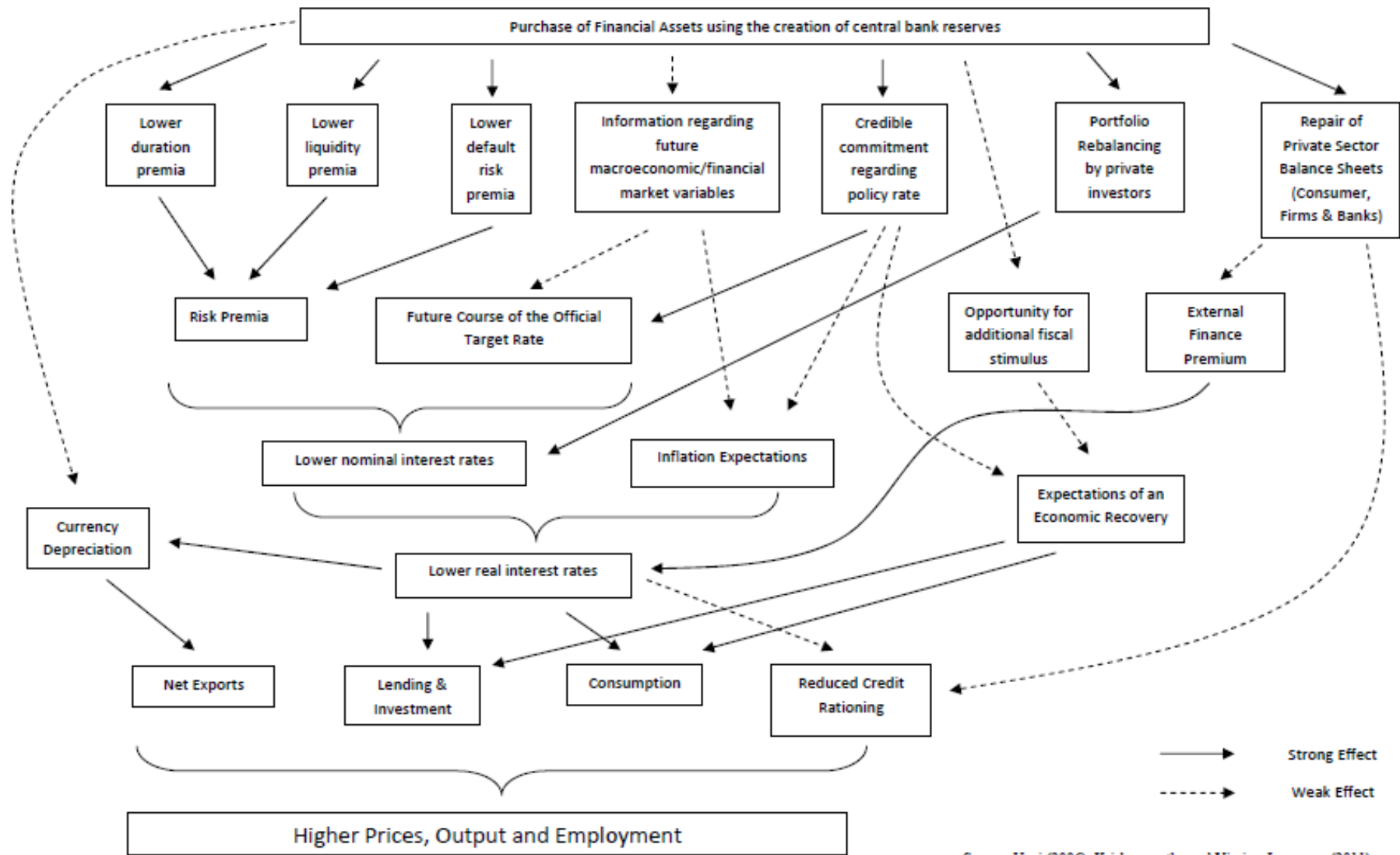
With regards to studying the effects of QE policies on the real economy, substantial research has been done. Smets and Wouters (2007) emphasize the effects of QE on financial market and other frictions in the New Keynesian Model framework. They extend Eggertsson and Woodford (2003)'s model to include adjustment lags and costs, technology shocks, wage and price shocks. However, they do not include the credit channel which has been identified by literature such as Mishkin (2007) to be an important Monetary Policy transmission channel. Bernanke et al. (1999) takes into account this aspect of the whole dynamics by introducing a 'financial accelerator' and laid stress on the microeconomic foundations and macroeconomic implications of this effect. The most comprehensive theoretical analysis of the impact of QE on the real economy is set by Gilchrist et al. (2009). Their model contains one of the broadest set of dynamics in literature from shocks to net worth and yield spreads. While the transmission mechanism of QE has been well discussed in literature, there has not been much discussion on the empirical identification of the long term effect of the policy on macroeconomic variables.

As discussed in earlier sections, traditionally, Monetary Policy has been viewed as the pre-eminent instrument for (1) counter-cyclical demand management to achieve stable inflation and (2) to ensure financial system stability. Goodhart (1987) , Lewis and Mizen (2000) illustrate that Monetary Policy has been expected by policy makers to use the short term interest rate in achieving these objectives. QE by changing the composition of the Central Bank's balance sheet has various effects. These are the impacts on

investment, consumption and net exports. An important point to remember when studying the transmission mechanism of QE is that this mechanism is located within the traditional Monetary Policy mechanisms because QE is seen as an additional instrument for changing interest rates in the wake of a zero lower bound constraint.

Ugai (2006), Krishnamurthy and Vissing – Jorgensen (2011) schematically represent the transmission mechanism for each identified channel. The figure below represents the same -

Figure 4- QE Transmission Mechanism



Source: Ugai (2006); Krishnamurthy and Vissing-Jorgensen (2011)

2.4.1 Long Term Interest Rates

Clouse et al. (2003) and Blinder (2010) prove that long term nominal interest rates are determined by the expected value of the risk-free rate which is primarily the policy rate.

They represent this as –

$$i_t^L = (1/N) \sum_{s=0}^{N-1} E_t (i_{t+s}) + \theta_t^L \quad (3)$$

Where i_t^L is the nominal interest rate, $\sum_{s=0}^{N-1} E_t (i_{t+s})$ is the expectations and θ_t^L is the risk premium

This transmission mechanism has been studied via two elements –

2.4.1.1 Future Course of the Policy Rate

Eggertsson and Woodford (2003) argue that in perfect financial markets, interest rates will have no effect on the markets unless it is accompanied by policies that alter the perceptions regarding the future course of the interest rates as well. Clouse et al. (2003) extends this further by demonstrating that a commitment to maintain interest rates at a very low level is given some sort of credibility when Central Bank's involve themselves in large – scale purchase of financial assets. Krishnamurthy and Vissing – Jorgensen (2011) additionally demonstrate that in addition to the purchase of large scale assets , the volume of these purchases also tend to act as signal for the federal reserve's policy actions.

For the effect of QE to reach investment and consumption it not has to have an effect on nominal interest rates but it should also successfully bring the real interest rate down. Lucas and Prescott (1971) and Boyle and Guthrie (2003) use the Fisher Equation as a means to demonstrate this and argue that when the inflation expectations are

constant , nominal and real interest rates would move one-for-one leading to a manipulation of expectations of QE . This would then lead to a decline in real interest rates as the real interest rate would then mirror the nominal rate. Feldstein (2010) presents the other side of the argument by stressing on the negative effect of controlling inflation through Monetary Policy. If inflationary expectations rise every time QE is used, it would render any effect on real interest rates to be nil. Therefore, as argued by Krishnamurthy and Vissing – Jorgensen (2011) QE has another channel of reducing real interest rates which is by influencing inflationary expectations.

2.4.1.2 Risk Premia

The risk premium in general depends on illiquidity, default risk and duration risk. Duration risk can be defined as the fluctuations on the asset price over the bond maturity due to changes in inflation and interest rates. When longer term securities are purchased on a large scale basis, this risk premia is reduced due to a fall in the duration risk. Juttner and Hawtrey (1997) define the ‘preferred habitat theory’ to be based upon investors who only trade in securities within certain maturity bands or classes resulting in very similar assets being substitutes for one another as a result of which there is limited arbitrage in the long term to the short term markets leading to different rates of return. Using this definition then, one could argue that large scale asset purchases would lead to a lower overall premium. Therefore if there is an existence of a credible signal regarding the future course of interest rates coupled with lower risk premia, the uncertainty regarding future changes in interest rates is reduced a little.

Another channel through this worth a mention is the fall in liquidity premiums due to the absence of default and liquidity premiums on government securities which has a

direct impact on reducing rates of MBS and corporate debt. Mishkin (2011), Kamin and DeMarco (2010) illustrate this fact by demonstrating the effect of realization of the losses on sub-prime mortgages on falling US house prices. They conclude that this effect led to a decline in household demand for housing and an increase in foreclosures. Hancock and Passmore (2011) further add to this by arguing that this led to a significant decline in liquidity in the MBS market leading to increasing risk aversion. When the Federal Reserve purchased \$1.25 trillion worth MBS and reinvested the interest payments, they acted a 'buyer of last resort'. As a result of this private investors became more confident and there was an increase in market liquidity due to the Central Bank support (Joyce et al., 2010). Hancock and Passmore (2011) provided substantial evidence that this channel of falling liquidity premiums and decreasing asset interest rates existed during the period of the first two rounds of QE.

2.4.2 Portfolio Rebalancing Effect

QE leads to a changing supply of various assets in the financial system. This leads to lower long-term nominal interest rates. Gagnon et al. (2010) showed that when investors have portfolio preferences, a fall in the supply of their preferred choice of bonds leads to an increase in the demand for other bonds such that the total composition of their portfolios remains unchanged. As a result, the increase in demand for these substitutes will lead to a decline in their yields. Therefore, the portfolio rebalancing effect refers to the broader fall in yields other than that of those specific bonds targeted by the purchases of the Federal Reserve.

2.4.3 Private Sector

One of the key effects of the recent financial crisis has been the massive deterioration of private sector firms' balance sheets in terms of liquidity. This culminated in having significant impacts on the lending and borrowing occurring in the economy at a global level. In addition, the large capital losses incurred by the firms led to a decrease in confidence to borrow and lend leading to a liquidity crunch. Research identifies this phenomenon as the 'credit crunch'. Much research has been undertaken to analyze this for the great depression and the Japanese experience between 1990 and 2006. Friedman and Schwartz (1963) identify the effect of this lack of liquidity in the banking sector during the great depression leading to a large decrease in the demand and supply of money aided and abetted by the lack of confidence. Bernanke (1983) brought about another insight of this effect in terms of the constrained credit flows due to lack of confidence in lender and borrower solvency. As a result of the events in the private sector, the largest sufferers turned out to be homeowners as illustrated by Bernanke (1983). Walsh (2003) , Stiglitz and Weiss (1981) threw light on the effect of moral hazards due to informational asymmetries in credit markets which led to lenders using credit rationing based on observable borrower characteristics.

In the context of these issues, QE has the effect of reducing credit rationing and external financial premium through a number of avenues. First, the Central Bank bypasses these effects of moral hazard and credit rationing and provides the liquidity required for firms to lend and borrow. Secondly, there is an increase in asset prices which again improves the liquidity and the health of private firms' balance sheets. This would lead to an improvement in the investment and employment in the economy. By

purchasing MBS, corporate debt and government debt, Central Banks act as a means of removing credit constraints of financial institutions and facilitate the ability to lend. Illiquidity concerns and access to capital for investment also improves as excess liquidity is injected into the market through large-scale asset purchases. Finally, demand for the assets purchased by the Federal Reserve is enhanced. Bernanke et al. (1999) show that the increase asset prices through excess demand and the corresponding sale by financial assets helps improve balance sheet liquidity. As a result of this, the state verification cost of lenders reduces leading to an increase in firms' net worth in terms of size and quality leading to lower borrowing costs.

These high asset prices bought about by QE would then percolate to the real economy by increasing consumption and improved equity and house process as illustrated by Hancock and Passmore (2011). Dvornak and Kohler (2003) quantify these improvements and suggest that QE would lead to a \$1 increase in housing and equity wealth and as a result \$0.04 – 0.08 increase in consumption.

QE by injecting substantial amount of reserves into the economy also improves individual households' access to credit which in the recent financial crisis was severely damaged. Federal Reserve in 2008 mentioned that the purchase of \$1.25 trillion worth of MBS was aimed at improving individual borrowing through improving the real estate market. A consequence of this is the improved access to credit for households bought about by significant increases in their net worth through higher asset prices.

2.4.4 Government Spending

QE policies pursued by the US and England have consisted a substantial purchase of government securities. A direct implication of this is that by purchasing and holding

government debt, the Central Banks are effectively monetizing government debt and as a result reducing the interest spending related to them. When there is lower government expenditure, it is possible for fiscal policy to reduce taxes and as a result increase private expenditure. Bernanke and Reinhart (2004) explicitly prove this by suggesting that QE creates expectations of lower government taxes in the future. The wealth effects arising from the inverse relationship between consumer wealth and taxation would then lead to an increase in consumption.

The alternative effect of this policy is the possibility of an increase in current government expenditure implying lesser reduction of future expenditure and as a result improving employment and increasing output and therefore ultimately increasing consumption as incomes increase.

2.4.5 Future Expectations

QE has the effect of improving the expectations of private agents in regards to the future. Krishnamurthy and Jorgensen (2011), Ugai (2006) present this facet and contemplate that the effect of QE on inflation expectations would lead to private sector alterations of future policy. An example of this would be that if forward looking households expect that the current QE policy would improve employment and output, they would spend more in the near-future and thereby reduce the illiquidity constraints in a zero lower bound set up.

2.4.6 Exchange Rates

Mishkin (2007) , Mishkin(1995) , Bernanke et al.(2004) and Bordon and Weber (2010) are just some examples of research which highlight the impact of global capital markets as a major channel for QE to affect output and prices. In the presence of open capital

markets, exchange rates are a significant channel through which QE operates. Theoretically, Krugman (2000) demonstrates that a nominal depreciation of exchange rates in the short run is akin to real exchange rate depreciation and as a result an improved net export. When currency depreciates, foreign investment becomes more expensive encouraging domestic firms to invest in the domestic market. The real exchange rate depreciation would lead to relatively expensive foreign capital and therefore an increase in domestic capital product purchases. This analysis is similar for households as well. As a result, economic activity is stimulated due to the nominal depreciation of currency bought about by QE policies.

However the contradictory effects of such a phenomena make this direct effect of QE on exchange rates ambiguous.

The first one is that QE leads to an increase in the supply of domestic currency in foreign exchange markets. Inherent in its mechanism is that QE involves a significant purchase of government securities and other financial assets in order to provide investors a zero – yielding asset in return for an asset with a low but positive yields. When investors come into the new cash, if they prefer return- maximization, it is natural for them to seek those assets which yield the highest returns. During the financial crisis, these assets were not available in the domestic markets in the United States. This is so because the crisis resulted in stagnating output growth and increasing unemployment. As a result, return-maximizing investors move their capital to those markets which offered the highest return.

2.5 Impact of QE on emerging markets

"This crisis started in the developed world. It will not be overcome ... through ... quantitative easing policies that have triggered ... a monetary tsunami, have led to a currency war and have introduced new and perverse forms of protectionism in the world." President Rousseff of Brazil (2012)

Most literature on QE focuses on its effect on US domestic markets and their underlying channels. The global effects of UMP have not been covered by literature extensively.

There is however a general consensus amongst various researches conducted that US Monetary Policy has an effect on the policies carried out in emerging markets. A good example of this is the research by Conover, Jensen and Johnson (2002) who analyzed the impact of adding equities from an emerging market economy to a developed market equity portfolio under a different Monetary Policy regime. They discovered that US Monetary Policy and an emerging market Monetary Policy moved in tandem such that a restrictive Monetary Policy adopted by the Federal Reserve would imply a restrictive Monetary Policy adopted by an emerging market economy as well. Thus one can then conclude that if the Federal Reserve were to change their Monetary Policy from a contractionary to an expansionary Monetary Policy, it would affect the risk premium of emerging market equity. Özatay, Özmen and Şahinbeyoğlu (2009) examine the determinants of emerging market risk premiums from 1998 to 2006 using a panel error-correction model. Their results show that a change in the Federal Funds Rate or even an announcement of a change of any macroeconomic variable in the US heavily influences the emerging market equity's risk premium.

Hayo, Kutan and Neuenkirch (2012) used a generalized autoregressive conditional heteroskedasticity (GARCH) model to analyze the impact of a Federal Reserve signal (such as speeches, Monetary Policy reports) on emerging market equity returns. Their research findings allude to the existence of a relationship between the announcements and equity returns. In particular, they find that an unexpected change in the target Federal Funds Rate has an impact on emerging markets.

Kaminsky and Reinhart (2004) were of the opinion that the capital flows in an emerging market are pro-cyclical in nature. Therefore, movements in capital flows mirror investor's view of a favorable market condition. These fluctuations then impact both domestic interest rates and the currency value. Hsing (2003) further adds to this by explicitly proving the influence of the Federal Funds Rate on the certificate of deposit, local Treasury – bill and the cost of funds rate in Mexico. Therefore, one can conclude that the Federal Funds Rate acts as an important influence on emerging market economies.

The exposure of the global risk appetite has in turn necessitated Responses in the form of Monetary Policy mechanisms on the part of emerging economies. One of them is the exchange rate regime. Frankel, Schmukler and Servén (2004) examined this facet by studying how international interest rates affect domestic rates under different exchange rate regimes for both developed and developing economies. Their results suggest that regardless of the interest rate regime, the impact of any interest rate shock fully transmit in the long run but experience a slower transition from the short run to the long run in the case of floating rates. Shambaugh (2004) contests this by suggesting that fixed exchange rate regimes gave economies more independence as compared to

those with floating rate regimes. The latter research finding is more consistent with the theory which states that open economies face the impossible trinity challenge between fixed exchange rates, monetary indolence and free capital flows. The importance of regime choice is a significant determinant. Hoffmann (2007) reinforces this fact in his paper where he conducted a panel vector autoregression on 42 developing economies and their ability to withstand external shocks to global economic indicators such as world GDP and world interest rates. His results seem to suggest that floating rate regimes were better prepared to absorb external shocks than fixed rate regimes. Di Giovanni and Shambaugh (2008) also show that interest rates in major developed nations have a direct impact on the interest rates of developing nations. A general consensus amongst various researches is that the Central Bank independence in a developing nation allows them to deal with external shocks better.

In general, the literature lacks clarity and robustness for the effect of Unconventional Monetary Policy on emerging markets. Fratzscher, Lo Duca, and Straub (2013) study the spillovers to 65 emerging markets and advanced economies by analyzing the channel of net inflows and prices. They find that QE1 triggered a portfolio rebalancing across countries out of emerging markets into the US while QE2 triggered the rebalancing in the opposite direction. Chen, Filardo, He, and Zhu (2012) used event studies and global VECM model and analysed the spillover effects through the real and financial variables channel and concluded that in the short run, the US QE stimulated the economy and boosted asset process globally. Chinn (2013) using VARs to study the impact of exchange rates and money base on the BRIC nations. Moore, Nam, Suh and Tepper (2013) used panel analysis to study the impact of foreign investment in EMEs,

government bond markets and bond yields and concluded that there was an increase in portfolio flows into many emerging market economies. Morgan (2010) classified Unconventional Monetary Policy tools into three categories – (1) commitment effects, (2) QE, (3) credit easing. He finds no clear impact of QE1 on the bond yields in emerging economies.

Given this, this research seeks to look at the impact of QE on emerging markets and in particular India. The reason for choosing India to study this impact is its rapidly growing economy and the high real GDP growth. In the situation that India is in, to be able to sustain this growth, there has to be equal concomitant growth in the monetary aggregates and as a natural extension, an expansion of the base money. While, the accretion of unsterilized foreign exchange into the economy helps towards the aforementioned aim, anything in excess to the required reserves necessitates more active monetary and macroeconomic management. Therefore if there is a large inflow of capital – more than what is required – a consequence of this would be high domestic credit, monetary growth, stock market boom, excess domestic demand and in general macroeconomic and financial instability. Another facet to consider is the abrupt withdrawal of these capital flows, however, the impact of that is outside the scope of this thesis.

2.6 Theoretical Model

The basic theoretical set up of the model is derived from studies conducted by Canova (2005) and Kandil (2009) who examined the effects of the spillover through the currency and trade channels. These studies highlight the currency channel to bear greater weight in quantifying the spillover effects. However, the latest quantitative

easing, led to considerable objections from emerging economies. They argued that the unfair intervention of the Federal Reserve in the foreign exchange markets gave rise to a backhanded trade policy in the form of increasing US exports and decreasing US imports through the depreciation of the US dollar. Therefore in the event that these concerns hold any validity, the research done in this thesis would indicate exchange rates and inflation in India to be a significant channel for spillover effects from QE shocks.

The basic exchange rate model has its foundations in the uncovered interest parity (UIP). The UIP is a model that explains the relationship between short term interest rates and exchange rates. In the presence of efficient market hypothesis , with no opportunities for arbitrage , the expected percentage change in exchange rates will equal the home interest rate minus the foreign interest rate i.e. –

$$\% \Delta e_{t+1}^e = R_H - R_F \quad (4)$$

Empirical studies have not confirmed the simple version of UIP however this model still provides the basis for macro-econometric models which attempt to analyze the effect of one variable in one country on the investment conditions in another country. The reason that UIP does not hold true is twofold. They are risk premiums and rational expectations. For home investors, the return on foreign assets must be more than the return on domestic assets to motivate them to invest in the same i.e. the foreign risk premium must be more than the domestic risk premium. Secondly, rational expectations theory posits that economic agents view the levels and term structure of interest rates to contain the best available information about future trends of the

interest rates therefore the only explanation that justifies wrong decisions by investors takes the form of random unexpected errors.

Therefore, if an expansionary Monetary Policy carried out by the federal reserve results in a dollar depreciation and there foreign Central Bank (in this case, India) does not respond to this decrease in the Federal Funds Rate, it would cost more for Indian economic agents to purchase \$1 and therefore lead to a decrease in the exchange rate. Alternatively, if the Indian Central Bank responds to this expansionary Monetary Policy, it would reduce its Repo Rate and thereby indulge in an effort to avoid Rupee appreciation.

The Federal Reserve views QE as a form of expansionary Monetary Policy. a devaluation of the dollar could arise through two channels – the purchase of longer term assets leading to a fall in long-term interest rates as well as short term interest rates and positive inflationary expectations because when the Central Bank signals its commitment to accept a higher inflation, the yield on American capital assets would decrease due to a fall in the value of the dollar denominated assets bought about by dollar depreciation. Again, there are two options available to the Indian Central Bank – it can either do nothing, or as in the case explained above, it could intervene and stop the Rupee appreciation.

Finally, this thesis looks to interpret the results of the regression analysis in the light of four theories. These are – the bilateral trade integration, business cycle synchronization, the gravity model and the exchange rate regime classification.

1. The bilateral trade integration

This refers to the intensity of trade between the US and India. In theory, high volumes of trade between two countries would lead to a more responsive foreign Central Bank in the face of exchange rate fluctuations. If the trade between the US and India is substantial, a dollar depreciation would lead to a Rupee devaluation so as to conserve the trade relations.

2. Business Cycle Synchronization

This theory examines the synchronization between the growth rates between the two countries examined i.e. the US and India. The more growth rates are in tandem, the magnitude of the spillovers and responses will be larger. This is illustrated by a scenario that if both countries require an expansionary Monetary Policy, a decline in the US Federal Funds Rate would lead to an appreciation of the Indian rupee. If the Indian Central Bank does not respond to this expansionary Monetary Policy, it would lead to an appreciation of the Rupee. As a result, the Indian Central Bank would have to increase the magnitude of the of its Monetary Policy expansion to avoid extreme rupee appreciation.

3. The Gravity Model

The Gravity Model is an alternate approach to the Heckscher – Ohlin model of trade. It argues that if the economic size of two countries is similar, the trade relations between them would follow the same pattern. If this theory is extended to Monetary Policy relationships between two countries, it would lead to an explanation of the reactions to Monetary Policy actions in one country to another.

4. The Exchange Rate Regime

The last model refers to the reactions of Central Banks to currency fluctuations. If the Central Bank maintains significant control over its currency value, any appreciation of the domestic currency would render a reaction from the Central Bank in an effort to maintain the current value of its currency in respect of the other currency. The closer the country is to a fixed regime; larger will be the magnitude of the response.

Given these four theories, this research expects the following trends to hold true –

1. An increase in inflation
2. An increase in monetary policy instrument I.e. the interest rate
3. An appreciation of the rupee vis-à-vis the dollar

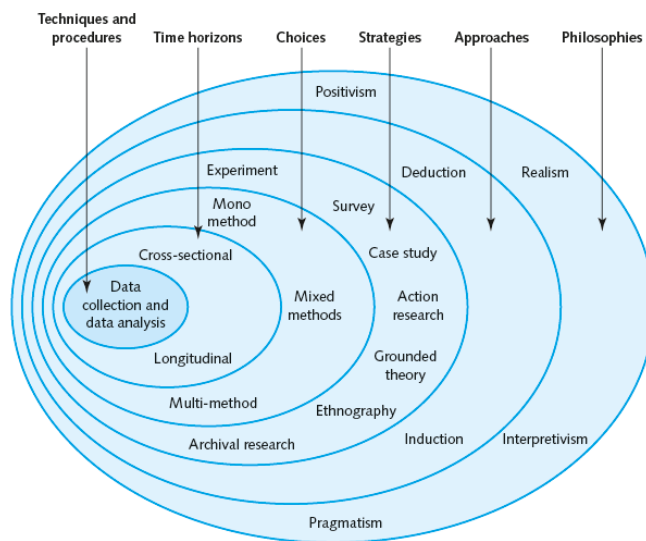
CHAPTER 3 – METHODOLOGY

3. Research Methodology

3.1 Research Paradigm

Weaver and Olson (2006) refer to the research paradigm as ‘ patterns of beliefs and practices that regulate inquiry within a discipline by providing lenses , frames and processes through which investigation is accomplished’ . A research paradigm therefore can be looked at as a structure consisting of accepted theories and methods which enable a researcher to conduct their research. The most common method to look at a research paradigm and its contents is the ‘Research Onion’ developed by Saunders et al in 1997. The research onion presents the various decisions a researcher must take in establishing the course of their research.

Figure 5 - Research Paradigm



Source – Saunders (2009)

Given this, the research paradigm for this thesis is as follows –

Research Philosophy	Positivism, Critical Realism and Post Positivism
Research Approach	Deductive and Inductive

Research Strategy	Explanatory Research using Longitudinal Time Series
Research Choice	Quantitative Study
Time Horizon	Longitudinal Study (October 2008 to September 2013)
Techniques and Procedures	Vector Auto-Regression Model

Table 1- Research Paradigm (Source - Own)

3.2 Research Philosophy

Remenyi et al. (1998) suggested that while there are different significant considerations as to why one must do a research , choosing a research methodology that is , the ‘how’ of research involves something that is much deeper than the practicality aspects of a research – it necessitates a ‘philosophical’ solution to the question of ‘*why research*’ . Levin (1988) observes that a research philosophy is a belief about the way data about a phenomenon should be collected and analyzed. Thus, for a theoretical model to explain anything there must be an appropriate relationship between the statements made the methods used to make such statements and the philosophical perspective deployed to inform the methods as opinionated by Abbott (1998)

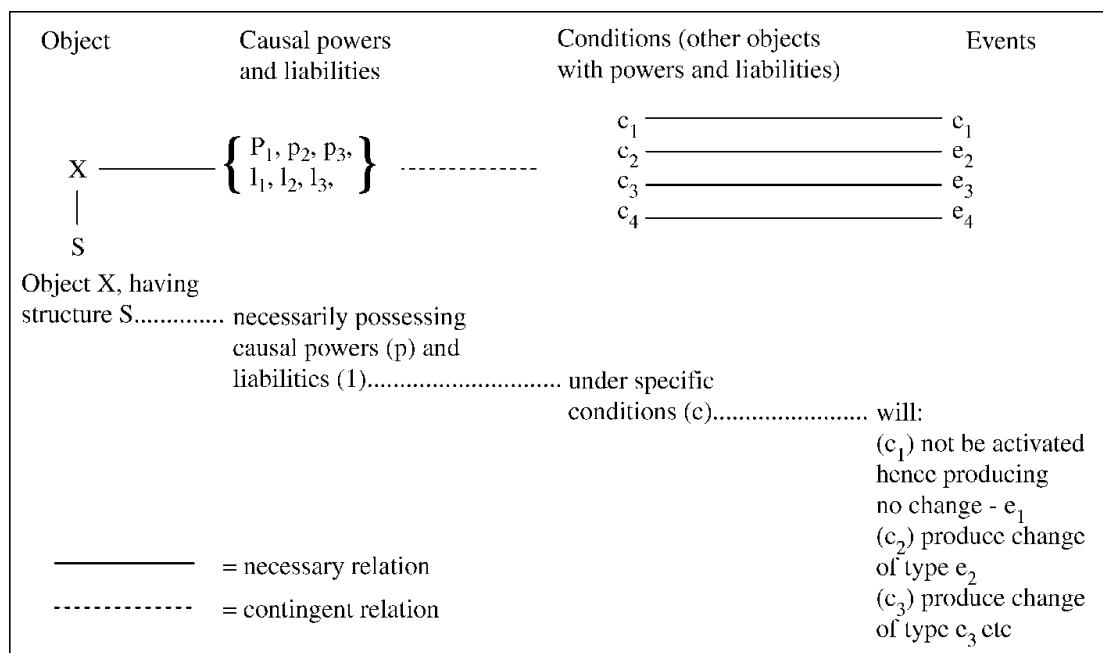
Given this then, the desired research posits three research philosophies relevant to the research viz. Positivism, Critical Realism and Post Positivism.

Positivism The main aim of the positivistic researcher is to generalise the results to the larger population (Limpanitgul 2009). In simple terms, positivism refers to the philosophy where the researcher assumes that human behaviours can be explained and predicted in terms of cause and effect. The appropriateness of this philosophy to this research is derived from Schiffman and Kanuk (1997) who argue that this philosophy is

most applicable to methodologies consisting observations, experiments and survey techniques and often involve complicated statistical analysis in order to generate the findings and test hypothesis empirically. Further, as this research will be deductive in nature of establishing a theory and testing it with empirical observations, as a positivistic research, this will then conform to the same. This is because the aim of a positivistic researcher is to generalise the results to the larger population.

Critical Realism This research paradigm requires the researcher to view the world in three components: the reality, the actual and the empirical. Sayer (2000) argues that reality concerns that which exists regardless of whether we understand it or whether we have to experience it. The actual on the other hand refers to the outcome when the structure and powers of the real are activated. The following diagram better explains the appropriateness of this philosophy to this research. The attempt to distinguish between the actual and the real is an essential component of this research

Figure 6 - Critical Realism



Source: Sayer (1992)

Post Positivism The term ‘post positivism’ refers to the thinking after positivism, challenging the traditional notion of the absolute truth of knowledge (Phillips & Burbules, 2000). It acknowledges the fact that a researcher cannot always be ‘positive’ about the claims of knowledge when studying the behavior and actions of humans. It is a deterministic philosophy in which causes probably determine effects or outcomes. The appropriateness of this philosophy for this research comes from the idea that as a post positivist the researcher intends to reduce ideas into a ‘small discrete set of ideas’ to test in the form of hypotheses which contain these ideas as variables. Creswell (2003) summarizes a post positivist best by arguing that a postpositivist begins with a theory , collects data that either supports or refutes the theory and then makes necessary revisions before additional tests are conducted.

3.3 Research Approach

Given the scope and aims of the research, the research approaches employed are both deductive and inductive. The analysis conducted in this thesis is purely quantitative in nature. Therefore, the research findings would largely consist of using a Vector Auto Regression (VAR) model to highlight the patterns and compare existing literature and theory to them.

Saunders (2009) defines deduction as ‘a research approach which involves the testing of a theoretical proposition by using a research strategy specifically designed for the purpose of its testing’. He further lays down five sequential stages in a deductive approach as –

- I. *Defining the research questions from the general theory that exists*

As mentioned before , the research question of this thesis in its broadest sense is whether there is an effect of Unconventional monetary policy on the economic policies of emerging markets and in particular of India.

II. Specifying the method in which these questions may be answered

In order to answer these questions, the researcher employs VAR models to test the relationship between key macroeconomic variables in India and the tools of Monetary Policy in the US.

Two VAR models shall be run. The first model comprises of the Federal Funds Rate , the Rupee/Dollar exchange rate, Indian Repo Rate and Wholesale Price Index in India. The second model then uses the same Indian macroeconomic variables viz. the Rupee/Dollar exchange rate, Indian Repo Rate and Wholesale Price Index but tests the relationship between them and the QE purchases made by the US Monetary Policy authority.

III. Seeking answers to the questions

The results of the VAR tests shall be analysed by generate Impulse Response Functions to the key Indian macroeconomic variables from a shock by the Federal Funds Rate and QE purchases.

IV. Analyzing the results of the inquiry to confirm that it relates to the theory or alternatively providing a modification to the existing underlying theory

These results will then be analysed to check whether they confirm to the theoretical model explained in Chapter 2.

V. Finally, confirming the initial general theory. Where the research analysis modifies existing theory, these five steps are repeated to test the resulting new theory.

As opposed to a deductive research approach, an inductive approach is ‘the development of a theory resulting from analyzing data’ (Saunders, 2009). Thus, one might also argue that this thesis is also inductive in nature in the sense that the proposed methodology has not been applied to Indian markets before. Therefore, while certain theoretical findings might hold true which are derived from existing literature, the research findings may adopt an inductive nature since it will develop new general conclusions and theories

3.4 Research Strategy & Choice

The research strategy employed is an explanatory research using longitudinal data.

Saunders (2009) refers to longitudinal studies as ‘the study of a particular topic over an extended period of time’. A longitudinal design is chosen to be able to measure the behavior of the variables over a period of time. The time period chosen is from October 2008 to September 2013. This time period corresponds to the Federal Reserve’s decision to employ Unconventional Monetary Policies to stimulate the economy.

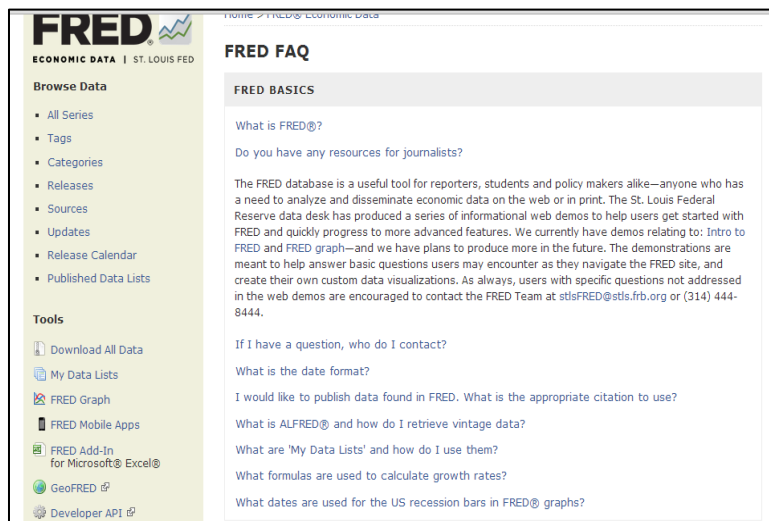
The research is explanatory owing to the fact that the thesis aims to look at an explanation of the relationship between the chosen variables. Saunders (2009) defines an explanatory study as that which focuses on studying a situation to explain the relationship between the variables. The use of a VAR model enables the researcher to do this. In its simplest form, a VAR can be described as a system of equations in which each variable is a function of its own lags and that of the other remaining variables. All variables are treated as endogenous to the system and can thus be explained by the VAR itself.

Two models of VAR will be run. The first one looks at the relationship between Federal Funds Rate and Indian macroeconomic variables. The second VAR model will look at the relationship between QE and Indian macroeconomic variables.

3.5 Ethical Issues and procedure

The proposed research will be conducted using a longitudinal quantitative analysis and a quantitative overall design. The data analyzed is secondary in nature and available on public domain for anyone to use. The following screenshots of the Federal Reserve website and the Reserve Bank of India are further proofs for the same. Federal Reserve Use of Published Data (<https://research.stlouisfed.org/fred2/help-faq/>) -

Figure 7 -Use of Federal Reserve Data



Reserve Bank of India use of Published Data available at - <http://dbie.rbi.org.in/DBIE/dbie.rbi?site=home>

Figure 8 - Use of Data Published by the Reserve Bank of India



3.6 Population and Sample

In order to examine the effects of US Quantitative Easing on emerging economies, the researcher performed a vector auto-regression looking at trade, currency and interest rate channels. The researcher collected data on US Federal Funds Rate, QE purchases, Indian Repo Rate, Indian Wholesale Price Index (WPI) and the Dollar/Rupee Exchange Rate. The time period of the study is from October 2008 to September 2013 with monthly frequencies.

3.6.1 Federal Reserve Monetary Policy

In order to bring in the effect of QE into the regression model, the research will use the Federal Funds Rate. The Federal Open Market Committee has used two primary avenues for controlling US Monetary Policy, these are, the Federal Funds Rate and quantitative easing purchases.

The researcher collected Federal Funds Rate data on a monthly frequency from the Economic Research and Data section of the Federal Reserve Board. In order to make the data stationary, log differences of the Federal Funds Rate were calculated and used.

In order to analyze the effects of QE, the researcher collected Federal Agency Debt Securities and Mortgage Backed securities weekly data from the Federal Reserve Board's archives pertaining to 'Factors Affecting Reserve Balance'. The researcher then aggregated the weekly purchases into monthly data and took the total of both the purchases to reflect the effect of QE on macroeconomic variables.

3.6.2 Indian Interest Rate

Since the aim of this research is to evaluate the effect of US Monetary Policy on the Indian Monetary Policy, it is only logical to use the Reserve Bank of India's Monetary Policy tool which is the Repo Rate. For the purpose of this research, monthly Repo Rates were obtained from the 'Database on the Indian Economy' available on the website of the Reserve Bank of India.

To make the data stationary, the log differences of the Repo Rates were taken.

3.6.3 Exchange Rate

For Exchange Rates, the monthly data is obtained from 'The Board of Governors of the Federal Reserve System' Series ID DEXINUS. The sample selected is based on the Noon buying rates in New York City for cable transfers payable in foreign currencies.

The exchange rates were made stationary by first calculating the percentage change in exchange rates measured as the log difference of observations between two consecutive periods.

3.6.4 Inflation

Inflation in India is measured based on certain indices. Five major national indices are used for measuring inflation. The Wholesale Price Index (base 1993-94) is the headline inflation indicator. Four different consumer price indices are used to assess the inflation for different sections of the labor force.

For the purpose of this research, the Wholesale Price Index (WPI) shall be used. This is because the WPI best captures price movements and is the basis for important fiscal and monetary policy changes. The recent WPI series uses 2004-05 as the base year.

As with other variables, the growth rate of WPI was calculated by taking the log differences of two consecutive values.

3.7 Data collection, editing and coding

3.7.1 Vector Auto-Regression Model

In his paper "Macroeconomics and Reality" (1980), Sims argued that a VAR can be used for three purposes in macroeconomics – (1) to forecast economic time series, (2) to design and evaluate economic models and (3) to evaluate the consequences of alternative policy actions. VAR has been widely used in economic literature to study the impact of policy shocks on different variables. There are two reasons why this methodology is chosen over a host of other options. First, a VAR allows the researcher to test the basic hypothesis underlying this research viz. whether Unconventional Monetary Policy have different spillover effects than that from conventional Monetary Policy. Second, as demonstrated by Sims (1980), the goal of a VAR process is to determine the interrelationships among its variables and thus enabling the researcher to capture the rich dynamics between the endogenous variables.

The first research that employed the VAR methodology to investigate the external effects of Monetary Policy was conducted by Sims (1980). In his seminal work, he compared the external effects of Monetary Policy of the United States and Germany in the interwar (1920-1941) and postwar (1948-1978) time periods. The results of his study were twofold. First, by exploring the impulse responses of exogenous shocks to interest rates, money supply, wholesale price index and industrial production similar

dynamic responses were found in the interwar and postwar business cycles. Secondly, he found that a large percentage of variance in production in both the time periods were due to money supply.

Mackowiak (2007) then used Sims' VAR methodology to study the extent of external shocks on macroeconomic fluctuations in emerging economies. His results showed that external shocks account for half of the variation in both exchange rate and price level, 40% of variation in real output and a third of the variation in the short term interest rate in eight emerging economies in Latin America and east Asia between 1986 and 2000. The model used by Mackowiak contained two vectors with the macroeconomic variables in emerging markets and macroeconomic variables external to emerging markets. Further, the model included measures of shocks with domestic and external origins respectively. These shocks were taken to be as short term interest rate, exchange rate, real aggregate output and aggregate price level for shocks with domestic origins and the Federal Funds Rate, world commodity prices, money stock, real aggregate output and aggregate price level of the US for shocks external to emerging markets. One of the key highlights of his work was the use of the assumption that each emerging economy represents a small open economy enabling him to better assess the effects of external shocks from the US on these economies. This assumption has been used in various other studies to ensure that small economies have no effect on the interest rates of large economies either with lags or contemporaneously but the interest rates of large economies can affect interest rates in smaller economies.

Canova (2005) applied similar methodology to study the features of transmissions of US shocks to selected Latin American countries. He modeled bilateral relationships with each of his selected Latin American countries and the US as a bivariate block VAR

model. He concluded that US monetary disturbances i.e. the interest rate channel resulted in large and significant responses in macroeconomic variables in Latin America whereas real demand and supply shocks viz. the trade channel in the US had insignificant fluctuations.

Sato, Zhang and McAleer (2011) used a structural VAR model with block exogeneity to investigate if external shocks originating from US policies play a dominant role in influencing macroeconomic fluctuations in East Asia. The main research question was to determine whether external shocks played a more dominant role in explaining macroeconomic fluctuations as compared to internal economic developments. The model developed was similar to that of Mackowiak specifying macroeconomic variables in the domestic sector, structural shocks of foreign origin and domestic origin respectively in the form of vectors and concluded that US shocks were an important source of fluctuations in the sample of the countries selected.

Mattoo, Mishra and Subramaniam (2012) examined the spillover effect of movements in the Chinese exchange rate on exports of other developing countries. By using VAR techniques, they regressed log of exports against exchange rates and an index of competition developed by them.

These are just some of the various literatures that have used VAR methodology to analyze effects similar to the aim of this research. Over time, the VAR methodology has been used in various settings to analyze effects, conduct counterfactual analyses over a range of factors in both developed and developing countries.

In its simplest form, a VAR can be viewed as a form of univariate autoregression which is a single-equation, single-variable linear model where the current value of a variable is explained by its own lagged values. Thus, a VAR is an n-equation, n-variable linear

model in which each variable is explained by its own lagged values, plus current and past values of the remaining $n-1$ values.

Christiano et al (1998a, b), Bernanke and Blinder (1992) and Ford et al (2003) demonstrate a representative VAR as

$$By_t = C(L)y_t + D(L)x_t + \epsilon_t \quad (5)$$

Where y_t is a $(m \times 1)$ vector of endogenous variables, x_t is an n vector of exogenous variables B, C and D are matrices of the estimated coefficients, L is the lag operator and i is the number of lag or the order of the VAR. The error term ϵ_t is a vector of innovations which are independent and identically distributed.

A better definition of a VAR model is given by Lutkepohl (2004) who illustrates that for a set of K time series variables $y_t = (y_{1t}, \dots, y_{kt})$, a VAR model captures their dynamic interactions and the basic model of order p has the form

$$Y_t = A_1 Y_{t-1} + \dots + A_p Y_{t-p} + U_t \quad (6)$$

U_t is the unobservable error term which is independent stochastic vectors with a zero-mean independent white noise process.

For a VAR model to be stable, Lutkepohl argues that the polynomial defined by the determinant of the autoregressive operator has no roots in and on the complex unit circle.

The process of setting up a VAR model involves two steps.

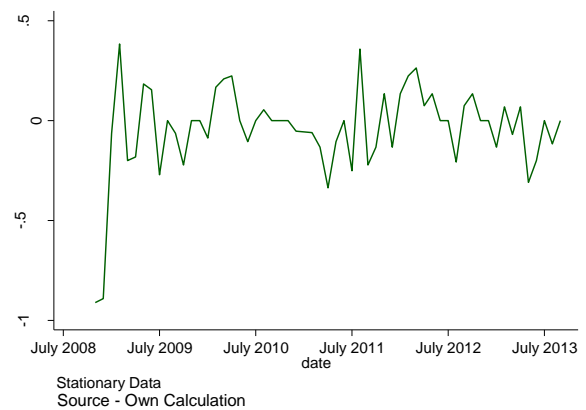
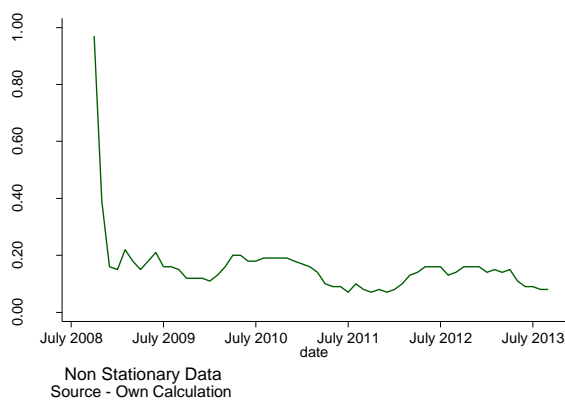
3.7.2 Dickey-Fuller Test for Unit Roots

The first step of a VAR model is to establish that the data used is stationary. Lutkepohl (2004) identifies a variable y_t to be stationary if it satisfies the following two conditions

–

1. $E(y_t) = \mu_y$ for all $t \in T$ i.e. variable is a stationary stochastic process with the same constant mean
2. $E[(y_t - \mu_y)(y_{t-h} - \mu_y)] = \gamma_h$ for all $t \in T$ and all integers h such that $t-h \in T$ i.e. the variances and the covariances of the variable are also time-independent.

In order to check the stationarity of the variables used, the research employs the Augmented Dickey-Fuller test. (ADF Test)



The Augmented Dickey – Fuller test is a procedure used to test whether a variable follows a random walk. The model fits a model of the form –

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta_t + \zeta_1 \Delta y_{t-1} + \zeta_2 \Delta y_{t-2} + \dots + \zeta_k \Delta y_{t-k} + \epsilon_t \quad (7)$$

The null hypothesis to be tested is that the variable is not stationary and has a unit root while the alternate hypothesis specifies that the variable is stationary. Another test that can be performed to check for the stationarity of the variables is the Phillips Perron test. This test corrects for serial correlation and heteroskedasticity in the error terms by modifying the Dickey Fuller test statistics. At the most basic level , the difference between the Augmented Dickey – Fuller Test and the Phillips-Perron test is that while the former uses additional lags of the first differenced variables , the latter the Newey-

West(1987) heteroskedasticity and auto correlational consistent covariance matrix estimator.

The ADF test indicates a variable to have no unit roots if the absolute value of the test statistic is more than its critical value. Therefore, the null hypothesis will be rejected if the test statistics value is more than the critical value at a particular confidence level.

The following are the results of the ADF test run for the chosen variables at a 95% confidence interval-

Variable	Test-Statistics	5%-critical value
Federal Funds Rate	-18.970	-2.923
Quantitative Easing	-3.063	-2.923
WPI	1.878	-2.923
Repo Rate	-1.018	-2.923
Exchange Rate	1.472	-2.923

Table 2 - ADF Test Statistic (Source – Own Calculation)

The above table shows the results of the ADF tests for the selected variables without any transformation .Except Federal Funds Rate and QE, all the other variables demonstrate that they have a relationship with time. As mentioned above, in order to make the variables stationary, the log difference of the values were taken.

The following are the test results of the ADF test run for the transformed variables at a 95% confidence interval -

Variable	Test-Statistics	5%-critical value
Federal Funds Rate	-6.661	-2.924
Quantitative Easing	-3.063	-2.923

WPI	-5.773	-2.924
Repo Rate	-6.227	-2.924
Exchange Rate	-5.331	-2.924

Table 3 - ADF Test Statistic for transformed variables (Source - Own Calculation)

The details of the test results are available in the appendices 1 & 2.

3.7.3. Lag Selection

The next step in estimating a VAR model is to establish the number of lags that must be used. This is an important part of estimating a VAR model as in its very definition, a VAR estimates variables based on its own lags and that of the other variables. Kilian & Ivanov (2005) illustrate that the empirical studies select lag –orders based on some pre-specified criterion. In the absence of any structural break in the time series, the method of selecting the number of lags include minimizing certain information criteria. Literature uses six common tests to choose lag-length. These are Schwarz Information Criterion (SIC) , Hannan- Quinn Criterion (HQC) , the Akaike Information Criterion (AIC) , the general-to-specific sequential Likelihood Ratio test (LR) , a small sample correction to that test (SLR) proposed by Sims (1980) and the Portmanteau test. The most commonly used tests from these six include the SIC, HQC and AIC. For the purpose of this research, the lag order selection criterion that shall be used is the AIC criterion for lag selection since it works better for models with small samples as is the case with this VAR.

The AIC information criterion minimizes the log likelihood function used by Hamilton (1994) which is defined as –

$$LL = \left(\frac{T}{2}\right)\{\ln(|\Sigma^{\wedge} - 1|) - K \ln(2\pi) - K\} \quad (8)$$

Therefore the AIC Criterion for a VAR (p) can be defined as –

$$AIC(p) = 2 \frac{LL}{T} + 2 \frac{tp}{T} \quad (9)$$

Where *LL* stands for the log likelihood for a VAR (*p*) with *T* number of observations and *p* number of lags

The software used to run the VAR models was Stata and it gives all the six criteria for lag selection and the results for both the models are as given below –

For the first model, 3 lags are chosen -

```
. varsoc fedfunds_d er_d repo_d wpi_d
```

Selection-order criteria
Sample: March 2009 - September 2013 Number of obs = 55

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	479.24				3.7e-13	-17.2815	-17.225*	-17.1355*
1	493.984	29.488	16	0.021	3.9e-13	-17.2358	-16.9535	-16.5059
2	517.869	47.769	16	0.000	2.9e-13	-17.5225	-17.0144	-16.2086
3	537.448	39.158	16	0.001	2.6e-13*	-17.6526*	-16.9187	-15.7548
4	551.957	29.018*	16	0.024	2.9e-13	-17.5984	-16.6387	-15.1166

Endogenous: fedfunds_d er_d repo_d wpi_d
Exogenous: _cons

Table 4 - Lag Selection Criteria Pre-Estimation Model 1 (Source - Own Calculation)

For the second model 3 lags are chosen as well –

```
. varsoc qe er_d repo_d wpi_d
```

Selection-order criteria
Sample: March 2009 - September 2013 Number of obs = 55

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-382.072				14.6946	14.039	14.0954	14.185*
1	-350.687	62.769	16	0.000	8.41523	13.4795	13.7618	14.2095
2	-328.171	45.033	16	0.000	6.70558	13.2426	13.7507	14.5565
3	-297.772	60.797*	16	0.000	4.07113*	12.719*	13.4529*	14.6168
4	-287.267	21.01	16	0.178	5.21165	12.9188	13.8785	15.4006

Endogenous: qe er_d repo_d wpi_d
Exogenous: _cons

Table 5 - Lag Selection Criteria Pre-Estimation Model 2 (Source - Own Calculation)

3.8 Limitation to the research

The limitations of this research can be described at two levels. At the very basic level, macroeconomic modeling is effective subject to some constraints that arise due to the assumptions and restrictions imposed by the modeler. These assumptions and restrictions, such as the assumption that there is no short term relationship between variables, may not hold true in the real world scenario. As a result, the results of this research may be limited in that sense.

Secondly, the use of VAR itself lends some limitations to the study. While VAR has been used to best capture the dynamics of macroeconomic variables without the need to impose exogenous constraints, this model has many limitations on its own. The first limitation is from the use of ADF tests to check for data stationarity. As illustrated above, the ADF tests have limitations of their own in that inherent in their definition, unit root tests may lead to misrepresentation of the true behavior of the variables and information may be lost due to the resulting reduced form of these values. Secondly, it is important to point out that VARs are limited only by the inventiveness of the researcher as illustrated by Stock and Watson (2001). These models require identifying assumptions that allow correlations to be interpreted casually permitting contemporaneous links estimated by using only instrumental variables as defined by the researcher themselves.

Finally, the main limitation of this research is the limited time period at which the variables are studied. While the results may hold true for the selected time period, it is important to look at exogenous factors such as fiscal policy, domestic economic policy and other politico-economic factors which may affect the behavior of the chosen macroeconomic variables.

CHAPTER 4 – RESEARCH FINDINGS

4. Research Findings

Zhu et al (2013) demonstrate there are three channels of impact of QE on emerging markets. These are international trade, international capital flow and international balance of payments; these three channels in turn have an impact on the real economy. Therefore it is natural to assume that these channels have a long run complex relationship. The empirical analysis of QE on India can therefore be decomposed by looking at its impact on India's inflation, Repo Rate and exchange rate.

The first step in establishing this relationship is to check whether there is a long run association between the given set of variables. In order to do so the following methodology was employed in setting up the VAR model –

4.1 Unit Root Test

As mentioned in Chapter 3, the variables were checked for their non-stationarity in order to run the VAR. This was done to avoid false regression of non-stationary time series. The ADF test was employed to do the same.

Inherent in its definition, a non-stationary time series variable displays no clear tendency to return to a constant value or a linear trend. This leads to problems in estimating a regression line between two or more non-stationary variables. Therefore, the first step in establishing a VAR model was to derive stationary variables from the chosen variables. In order to do so, the Augmented Dickey-Fuller Test was used.

The ADF test indicates a variable to have no unit roots if the absolute value of the test statistic is more than its critical value. Therefore, the null hypothesis will be rejected if the test statistics value is more than the critical value at a particular confidence level.

The following are the results of the ADF test run for the chosen variables -

Variable	ADF test statistic	Critical Values		
		1%	5%	10%
Federal Funds Rate	-18.970	-3.567	-2.923	-2.596
QE	-3.063	-3.567	-2.923	-2.596
Repo Rate	-1.018	-3.567	-2.923	-2.596
Exchange Rate	1.472	-3.567	-2.923	-2.596
WPI	1.878	-3.567	-2.923	-2.596

Table 6 – ADF Test Statistic (Source – Own Calculation)

The above table shows the results of the ADF tests for the selected variables without any transformation. Except Federal Funds Rate and QE, all the other variables demonstrate that they have a relationship with time. As mentioned above, in order to make the variables stationary, the log difference of the values were taken.

Table 7 shows the test results of the ADF test run for the first difference log variables –

Variable	ADF test statistic	Critical Values		
		1%	5%	10%
Federal Funds Rate	-6.661	-3.569	-2.924	-2.597
QE	-3.063	-3.567	-2.923	-2.596
Repo Rate	-6.227	-3.569	-2.924	-2.597
Exchange Rate	-5.331	-3.569	-2.924	-2.597
WPI	-5.773	-3.569	-2.924	-2.597

Table 7 - ADF test statistic for first difference log variables (Source - Own Calculation)

Tables 8 and 9 contain a set of figures representing the stationarity and non stationarity of the variables. As is visible from the graphs, non-stationary variables seem to exhibit a trend over time while stationary variables as visible from the next figure seem to assume a 'random walk'

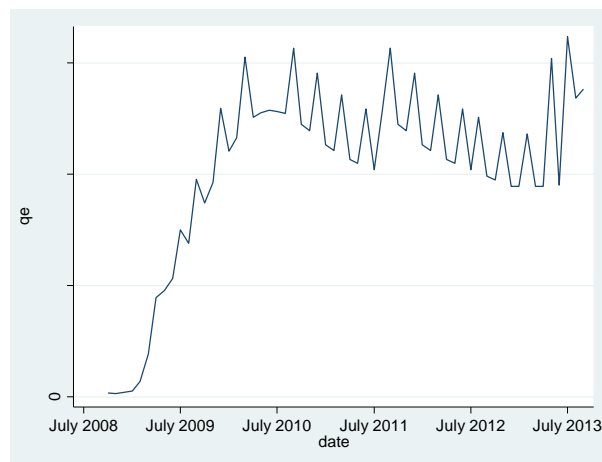
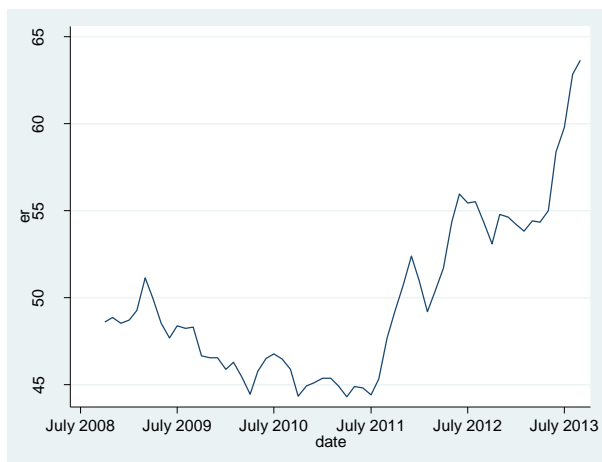
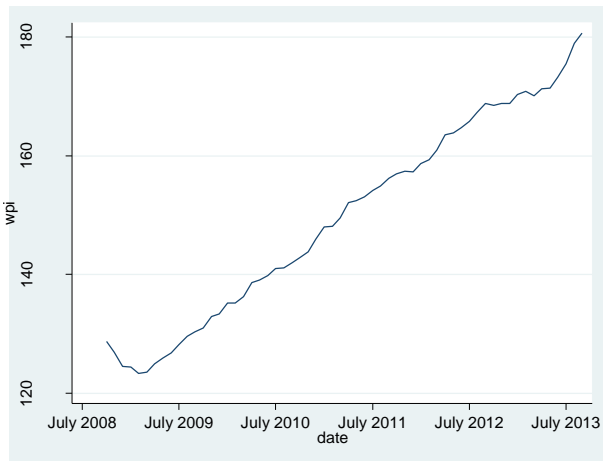


Table 8 - Non Stationary Time Series (Source – Own Calculation)

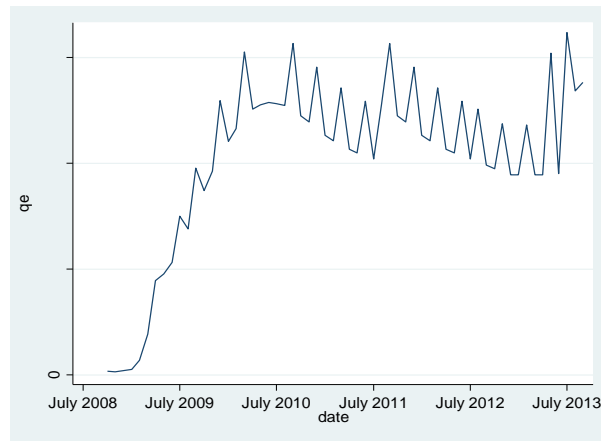
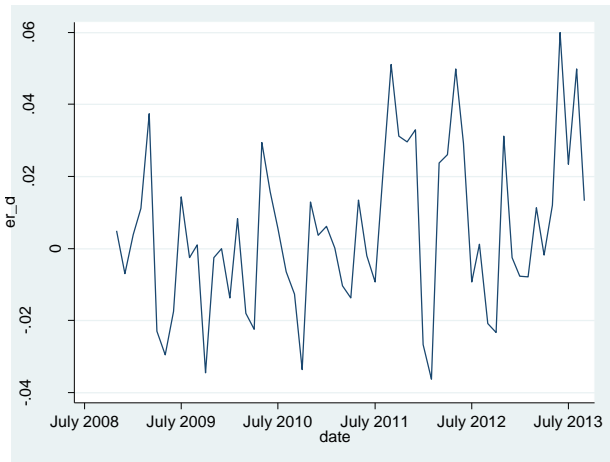
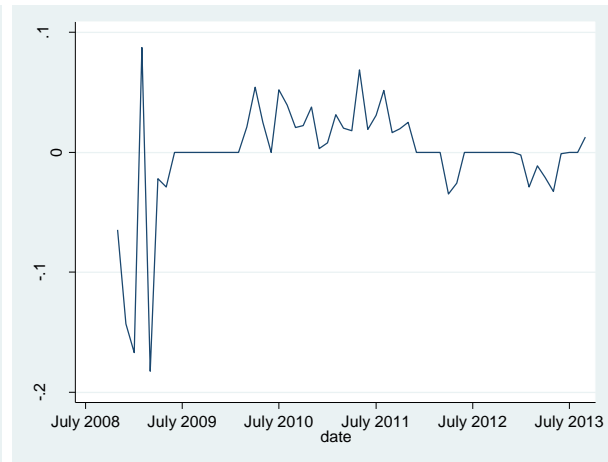
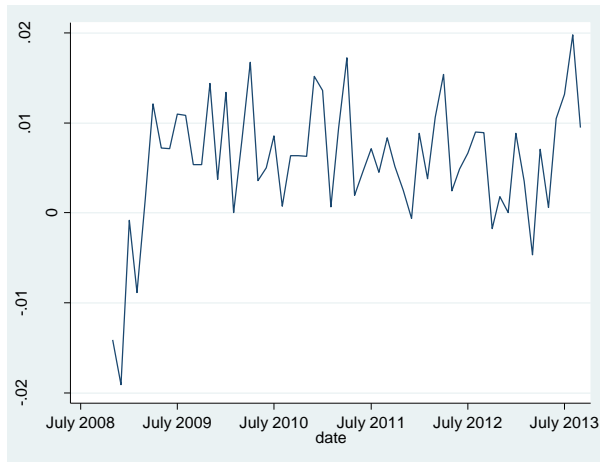
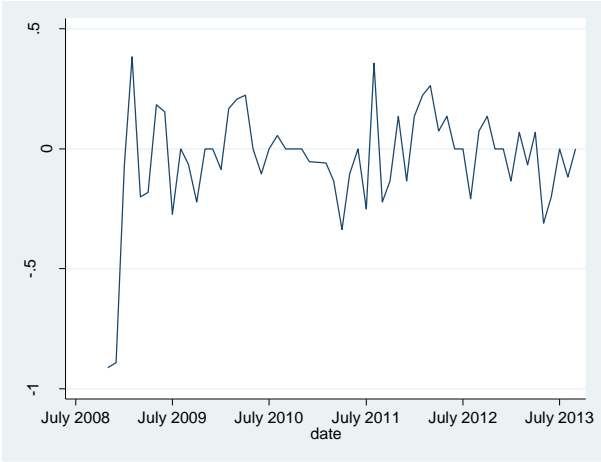


Table 9 - Stationary Time Series (Source – Own Calculation)

4.2 Cointegration Test

The next step was to check for Cointegration among the variables. This was done in order to establish whether there is a long run relationship between them. Granger (1981) defined an 'integrated series' as one which has no deterministic component with a stationary, invertible auto-regressive moving average representation after it is differenced d times. In the previous section, the economic variables were tested for stationarity and like majority of economic time series; it was proven that while the time series in themselves were not stationary, the first difference of these variables was. Granger (1981) showed that first-differenced stationary processes were also known to be integrated processes of order 1 or I (1) processes. Nelson and Plosser (1982) illustrated that if the linear combinations of two or more unit root non stationary variables do not contain stochastic trends, they are cointegrated i.e. while the time series variables are non-stationary; a linear combination of these variables may be stationary. Cointegration then allows the researcher to examine the correlation between the non-stationary time series variables.

Therefore, the next step was to establish the order of integration to find out the number of lags needed to make the time series stationary. In order to do so, Johansen's Test of Cointegration was used. The null hypothesis that was tested is that the number of cointegrating relationships is equal to r which is the maximum rank column of the output. The alternative hypothesis is that there are more than r cointegrating relationships. When the trace statistic is greater than the critical value, the null is rejected. That is, when the trace statistic is less than the critical value, the associated maximum rank is the number of cointegrated relationships in the proposed

VAR. The results showed that a maximum of six lags generated an I (1) cointegrated process for both the models.

Table 10 - Johanssen's Test of Cointegration for Model 2 (Source - Own Calculation)

```
. vecrank qe er_d repo_d wpi_d, trend(rtrend) lags(6) ic
```

Johansen tests for cointegration

Trend: rtrend Number of obs = 53
Sample: May 2009 - September 2013 Lags = 6

maximum				trace	5%
rank	parms	LL	eigenvalue	statistic	critical value
0	84	-268.49823	.	49.1519*	62.99
1	92	-257.54573	0.33854	27.2469	42.44
2	98	-250.14444	0.24368	12.4443	25.32
3	102	-245.2463	0.16876	2.6480	12.25
4	104	-243.92228	0.04874		

maximum				SBIC	HQIC	AIC
rank	parms	LL	eigenvalue			
0	84	-268.49823		16.42455*	14.50267*	13.30182
1	92	-257.54573	0.33854	16.61053	14.50562	13.1904
2	98	-250.14444	0.24368	16.78071	14.53852	13.13753
3	102	-245.2463	0.16876	16.89552	14.56181	13.10363
4	104	-243.92228	0.04874	16.99538	14.61591	13.12914

Table 11 - - Johanssen's Test of Cointegration for Model 2 (Source - Own Calculation)

```
. vecrank fedfunds_d er_d repo_d wpi_d, trend(rtrend) lags(6) ic
```

Johansen tests for cointegration

Trend: rtrend Number of obs = 53
Sample: May 2009 - September 2013 Lags = 6

maximum				trace	5%
rank	parms	LL	eigenvalue	statistic	critical value
0	84	545.39553	.	41.8566*	62.99
1	92	553.92257	0.27514	24.8025	42.44
2	98	560.08555	0.20750	12.4766	25.32
3	102	564.63438	0.15773	3.3789	12.25
4	104	566.32383	0.06176		

maximum				SBIC	HQIC	AIC
rank	parms	LL	eigenvalue			
0	84	545.39553		-14.28843*	-16.2103*	-17.41115
1	92	553.92257	0.27514	-14.01091	-16.11582	-17.43104
2	98	560.08555	0.20750	-13.79401	-16.0362	-17.43719
3	102	564.63438	0.15773	-13.66602	-15.99973	-17.4579
4	104	566.32383	0.06176	-13.57995	-15.95942	-17.44618

4.3 VAR Model

Having established the Cointegration among variables, the next step was to run a special case of VAR – Vector Error Correction Model (VECM)

As demonstrated before, one of the primary conditions in establishing a VAR is that all variables in the system be stationary. When the variables in the VAR are cointegrated, a special case of VAR known as VECM is used. The VECM contains first difference terms and the cointegrating relationships between them and can be written as –

$$\Delta Y_t = \Pi Y_{t-k} + \Gamma_1 Y_{t-1} + \Gamma_2 Y_{t-2} + \dots + \Gamma_k \Delta Y_{t-k-1} + u_t \quad (10)$$

Where $\Pi = \sum_{i=1}^k \beta_i - I_n$ and $\Gamma = \sum_{i=1}^j \beta_i - I_n$

The VECM is then developed to measure the dynamic adjustments between the first differences of the variables. Therefore, it is safe to conclude that a VECM is a VAR in its first difference form and a vector of cointegrating residuals. The equation that is then derived to estimate the VECM with 3 lags is as follows –

For the first model -

$$\Delta ff_t = \alpha_0 + \alpha_1 \Delta ff_{t-1} + \alpha_2 \Delta er_{t-1} + \alpha_3 \Delta r_{t-1} + \alpha_4 \Delta wpi_{t-1} + \alpha_5 ECT_{t-1} + u_{t1}$$

$$\Delta er_t = \alpha_0 + \alpha_1 \Delta er_{t-1} + \alpha_2 \Delta ff_{t-1} + \alpha_3 \Delta r_{t-1} + \alpha_4 \Delta wpi_{t-1} + \beta_5 ECT_{t-1} + u_{t2}$$

$$\Delta r_t = \alpha_0 + \alpha_1 \Delta r_{t-1} + \alpha_2 \Delta er_{t-1} + \alpha_3 \Delta ff_{t-1} + \alpha_4 \Delta wpi_{t-1} + \gamma_5 ECT_{t-1} + u_{t3}$$

$$\Delta wpi_t = \alpha_0 + \alpha_1 \Delta wpi_{t-1} + \alpha_2 \Delta er_{t-1} + \alpha_3 \Delta ff_{t-1} + \alpha_4 \Delta r_{t-1} + \delta_5 ECT_{t-1} + u_{t3}$$

Where ff = Federal Funds Rate, er = Rupee/Dollar exchange rate r = Repo Rate (India)
 wpi = Inflation and u is the error term. The term ECT_{t-1} is the lagged error correction
term derived from the long run cointegrating relations between the four variables.

For the second model –

$$\Delta qe_t = \alpha_0 + \alpha_1 \Delta qe_{t-1} + \alpha_2 \Delta er_{t-1} + \alpha_3 \Delta r_{t-1} + \alpha_4 \Delta wpi_{t-1} + \alpha_5 ECT_{t-1} + u_{t1}$$

$$\Delta er_t = \alpha_0 + \alpha_1 \Delta er_{t-1} + \alpha_2 \Delta qe_{t-1} + \alpha_3 \Delta r_{t-1} + \alpha_4 \Delta wpi_{t-1} + \beta_5 ECT_{t-1} + u_{t2}$$

$$\Delta r_t = \alpha_0 + \alpha_1 \Delta r_{t-1} + \alpha_2 \Delta er_{t-1} + \alpha_3 \Delta qe_{t-1} + \alpha_4 \Delta wpi_{t-1} + \gamma_5 ECT_{t-1} + u_{t3}$$

$$\Delta wpi_t = \alpha_0 + \alpha_1 \Delta wpi_{t-1} + \alpha_2 \Delta er_{t-1} + \alpha_3 \Delta qe_{t-1} + \alpha_4 \Delta r_{t-1} + \delta_5 ECT_{t-1} + u_{t3}$$

Where qe = quantitative easing, er = Rupee/Dollar exchange rate r = Repo Rate (India)
 wpi = Inflation and u is the error term. The term ECT_{t-1} is the lagged error correction
term derived from the long run cointegrating relations between the four variables.

The first step in interpreting the results was to check for the significance of the
variables in the VECM.

For the first model with the Federal Funds Rate, the following were the results of the
test-

Endogenous Variable	Error correction term	Standard Error	z-value	P>|z|
Federal Funds Rate	-.0153023	.0339083	-0.45	0.652
Exchange Rate	.013762	.005122	2.69	0.007
Repo Rate	.009087	.0047496	1.91	0.056
WPI	-.0035705	.0012653	-2.82	0.005

Table 12 - Results of First LAG from VECM Model 1 (Source - Own Calculation)

The second model with QE had the following results -

Endogenous Variable	Error correction term	Standard Error	z-value	P>|z|
QE	.0028371	.024142	0.12	0.906
Exchange Rate	-9.27e-10	8.55e-10	-1.08	0.279
Repo Rate	-1.76e-09	7.06e-10	-2.49	0.013
WPI	6.81e-10	1.82e-10	3.74	0.000

Table 13 - Result of First Lag from VECM Model 2 (Source - Own Calculation)

The error correction term is also known as the coefficient estimates of the first lag of the variables. For the first model, the Exchange Rate and Interest Rates were significant at the 0.05 level. When looking at the model with QE, Interest Rate and Inflation were found to be significant. This seems to be indicative of the importance of the currency and the trade channel of spill over effects on emerging economies.

Further when the exchange rate was the dependent variable, the Federal Funds Rate was significant in period 1 only. When the interest rate was the dependent variable, it was significant in the 2nd period. And when inflation was the dependent variable it was significant in period 1.

The QE model showed QE was not significant in any period when exchange rate was the dependent variable. However it was significant in periods 0, 1 and 2 with the interest rate as the dependent variable. When inflation was the dependent variable, QE was found to be significant in period 0 and 1.

Further, when looking at long run causality (For long run causality, the coefficient must be significant and negative) it was present for the interest rate channel in both models. It was also present in the inflation channel for model 1.

Model 1 with Federal Funds Rate -

<i>Federal Funds Rate Lags</i>	<i>Exchange Rate as Dependent</i>				<i>Interest Rate as Dependent</i>				<i>Inflation as dependent</i>			
	<i>Coefficient</i>	<i>St. Error</i>	<i>Z-Score</i>	<i>P>|z|</i>	<i>Coefficient</i>	<i>St. Error</i>	<i>Z-Score</i>	<i>P>|z|</i>	<i>Coefficient</i>	<i>St. Error</i>	<i>Z-Score</i>	<i>P>|z|</i>
0	.0237662	.0216694	1.10	0.273	-.0391016	.0200936	-1.95	0.052	-.0026089	.005353	-0.49	0.626
1	.013762	.005122	2.69	0.007	.009087	.0047496	1.91	0.056	-.0035705	.0012653	-2.82	0.005
2	.0340528	.0200196	1.70	0.089	-.0386423	.0185637	-2.08	0.037	.0022501	.0049454	0.45	0.649
3	.0099444	.0172773	0.58	0.565	-.0123943	.0160209	-0.77	0.439	.0012616	.004268	0.30	0.768

Table 14 - VECM Model 1 results (Source - Own Calculation)

Model 2 with Quantitative Easing Purchases –

<i>Quantitative Easing Lags</i>	<i>Exchange Rate as Dependent</i>				<i>Interest Rate as Dependent</i>				<i>Inflation as dependent</i>			
	<i>Coefficient</i>	<i>St. Error</i>	<i>Z-Score</i>	<i>P>|z|</i>	<i>Coefficient</i>	<i>St. Error</i>	<i>Z-Score</i>	<i>P>|z|</i>	<i>Coefficient</i>	<i>St. Error</i>	<i>Z-Score</i>	<i>P>|z|</i>
0	-2.57e-09	5.10e-09	-0.51	0.613	9.80e-09	4.21e-09	2.33	0.020	2.22e-09	1.08e-09	2.04	0.041
1	-9.27e-10	8.55e-10	-1.08	0.279	-1.76e-09	7.06e-10	-2.49	0.013	6.81e-10	1.82e-10	3.74	0.000
2	-2.64e-09	6.75e-09	-0.39	0.695	1.41e-08	5.57e-09	2.54	0.011	1.28e-09	1.44e-09	0.89	0.374
3	3.62e-09	5.93e-09	0.61	0.542	7.13e-09	4.90e-09	1.46	0.145	1.28e-09	1.26e-09	1.01	0.311

Table 15 - VECM Model 2 results (Source - Own Calculation)

To test for short run causality, the Granger Causality method was used. Granger (1969) proposed that variable x would 'Granger – cause' a variable y if, the past values of y and past values of x are useful to predict y . Therefore, the Granger Causality method regresses y on its own lagged values and on the lagged values of x .

The null hypothesis tested is that the estimated coefficients on the lagged values of x are jointly zero. In Stata, the Granger Causality test, tests the hypothesis that each of the other endogenous variables do not Granger-cause the dependent variable in that equation.

Model 1 – Federal Funds Rate	Chi-square statistic	Prob > chi square
Inflation	2.47	0.4808
Interest Rate	8.97	0.0297
Exchange Rate	4.83	0.1846

Table 16 - Granger Causality for Model 1 (Source - Own Calculation)

Model 2 – Quantitative Easing	Chi-square statistic	Prob > chi square
Inflation	1.79	0.6169
Interest Rate	2.29	0.5135
Exchange Rate	1.07	0.7835

Table 17 - Granger Causality for Model 2 (Source - Own Calculation)

From the Granger Causality test, there was a short run causality running between Federal Funds Rate and Interest Rate. However it was not the same in Model 2. This seems to indicate some sort of multi-period adjustment processes for both changes in the interest rate, inflation and exchange rate channels as well as the Monetary Policy response of the Indian Central Bank.

4.4 Post – estimation Tests

As a part of post estimation testing, three tests were carried out. These were –

1. Predicting the cointegrating relationships
2. Testing for residual autocorrelation
3. Testing for normally distributed variances

4.4.1 Predicting the cointegrating relationships

The cointegrating relationship seems to have come from the Federal Funds Rate and QE respectively to other variables. As is visible from the table below –

For Model 1 -

Cointegrating equations

Equation	Parms	chi2	P>chi2
_cel	3	24.97123	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
_cel						
fedfunds_d	1	.	.	.	.	.
er_d	-26.42433	9.718598	-2.72	0.007	-45.47243	-7.376226
repo_d	-10.03352	6.32435	-1.59	0.113	-22.42902	2.361975
wpi_d	165.9704	46.08904	3.60	0.000	75.63753	256.3032
_cons	-.9743345	.	.	.	.	.

Table 18 - Cointegrating Equation for Model 1 (Source – Own Calculation)

For Model 2 –

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	3	33.27146	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]
_ce1					
qe	1	.	.	.	.
er_d	6.09e+07	5.95e+07	1.02	0.306	-5.57e+07 1.77e+08
repo_d	5.04e+07	3.88e+07	1.30	0.193	-2.55e+07 1.26e+08
wpi_d	-1.30e+09	2.50e+08	-5.18	0.000	-1.79e+09 -8.05e+08
_cons	4.57e+07	.	.	.	.

Table 19 - Cointegrating Equation for Model 2 (Source - Own Calculation)

Further, since the inference in the parameters of α depends on the stationarity of the cointegrating equation, the equation was predicted and graphed over time to check for the presence of unit roots.

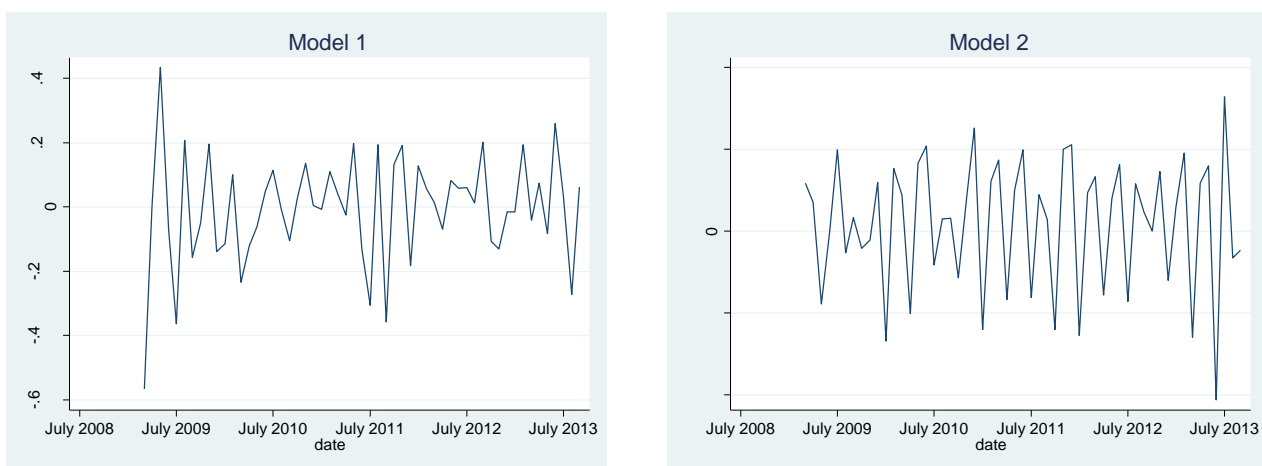


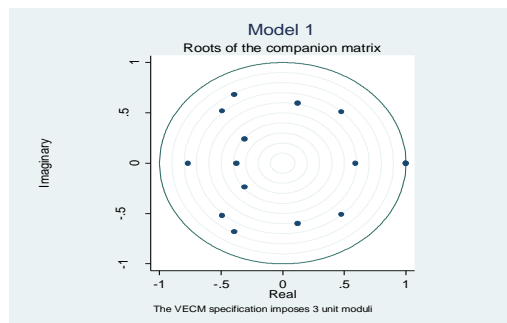
Table 20 - Unit Root Test for constant terms in both models (Source - Own Calculation)

From the above graph it is obvious that while large shocks were instrumental in the predictions from the cointegrating equations, the almost negative shocks were a

concern to the researcher. To further confirm whether the correct number of cointegrating equations was specified the stability of the VECM model was checked. If the process of VECM is stable, the companion matrix of a VECM with K endogenous variables and r cointegrating equations with $K-r$ unit eigenvalues has the moduli of the remaining r eigenvalues as strictly less than 1. Both the models were tested for their stability and the results indicated the remaining eigenvalues with moduli less than 1. The graph indicates that none of the remaining eigenvalues appear close to the unit circle.

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
1	1
-.3955206 + .6809904i	.787518
-.3955206 - .6809904i	.787518
-.7683642	.768364
-.4892396 + .5177213i	.712314
-.4892396 - .5177213i	.712314
.4750128 + .508198i	.695631
.4750128 - .508198i	.695631
.1224352 + .5971285i	.609551
.1224352 - .5971285i	.609551
.5914789	.591479
-.3120654 + .2393542i	.393288
-.3120654 - .2393542i	.393288
-.3753676	.375368

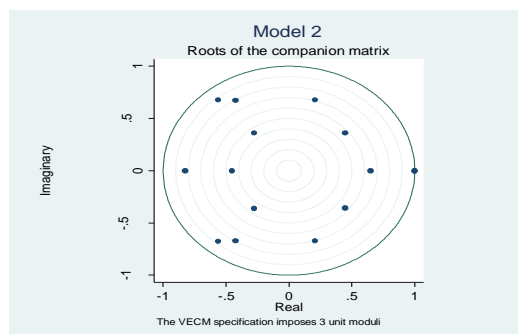


The VECM specification imposes 3 unit moduli.

. vecstable , graph

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
1	1
-.5588862 + .6769754i	.877866
-.5588862 - .6769754i	.877866
-.8226636	.822664
-.4226474 + .6711925i	.793177
-.4226474 - .6711925i	.793177
.2063261 + .674608i	.705455
.2063261 - .674608i	.705455
.6483865	.648386
.4472797 + .358658i	.573319
.4472797 - .358658i	.573319
-.2739 + .3616195i	.453641
-.2739 - .3616195i	.453641
-.4504495	.450449



The VECM specification imposes 3 unit moduli.

Table 21- VECM Stability Test for Model 1 & 2 respectively (Source - Own Calculation)

4.4.2 Testing for residual autocorrelation

Since the estimation, inference and post estimation analysis of VECM is dependent on the errors not being auto correlated, the Lagrange – multiplier test was used to test for autocorrelation in the residuals. The p-value for both the models was significant and the null hypothesis for both models were not rejected.

Table 22 shows the Lagrange Multiplier Test for Model 1 and Table 23 shows the Lagrange Multiplier Test for Model 2.

Table 22 - Test for Autocorrelation for Model 1 (Source - Own Calculation)

```
Lagrange-multiplier test
```

lag	chi2	df	Prob > chi2
1	19.0820	16	0.26443
2	15.6407	16	0.47830

H0: no autocorrelation at lag order

Table 23 - Test for Autocorrelation for Model 2 (Source - Own Calculation)

```
. veclmar
```

```
Lagrange-multiplier test
```

lag	chi2	df	Prob > chi2
1	16.6486	16	0.40868
2	8.6944	16	0.92546

H0: no autocorrelation at lag order

4.4.3 Testing for normally distributed variances

Johansen (1995) stated that the log likelihood for a VECM is derived from the assumption that the errors are independently and identically distributed and therefore assume a normal distribution. Therefore, to check the validity of the model, it is important to check for the normality of the model. Stata gives three test statistics to

check for the normality of the differences. These are – the Jarque – Bera Statistic, Skewness Statistic and the Kurtosis Statistic. For this model, only the Jarque – Bera Statistic will

The Jarque – Bera statistic tests each equation in the VECM and all equations jointly for normal disturbances. The null hypothesis tested is that the disturbance term in each equation has a univariate normal distribution. When it runs the test for all equations jointly, the null hypothesis tested is that the K disturbances present in the model come from a K dimensional normal distribution.

A drawback of the Jarque – Bera statistic however works well for large datasets and might not give the best results, therefore the Skewness and the kurtosis tests are also conducted. The Skewness test runs the null hypothesis that the disturbance term in each equation has zero Skewness and in general, for the null hypothesis to be accepted, if the Skewness is between -1 and 1, the disturbances are assumed to be symmetrical. The kurtosis of a normally distributed variable is 3 and therefore for the kurtosis to be consistent with normality it must be greater or equal to 3.

Tables 24 and 25 illustrate the normality tests for Models 1 and 2 respectively. For the Jarque-Bera statistic, the single equations and the joint equations are significant and therefore the null of normality is not rejected. For the Skewness test, the row marked 'ALL' shows that the results for a test that the disturbances jointly have zero Skewness indicates that the Skewness is indeed zero and therefore the null hypothesis is not rejected. The same results hold true for the kurtosis test as well.

. vecnorm, jbera skewness kurtosis

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_fedfunds_d	2.321	2	0.31328
D_er_d	0.122	2	0.94066
D_repo_d	0.288	2	0.86604
D_wpi_d	0.428	2	0.80751
ALL	3.159	8	0.92399

Skewness test

Equation	Skewness	chi2	df	Prob > chi2
D_fedfunds_d	.3953	1.432	1	0.23137
D_er_d	.05973	0.033	1	0.85648
D_repo_d	.16309	0.244	1	0.62147
D_wpi_d	-.00328	0.000	1	0.99208
ALL		1.709	4	0.78908

Kurtosis test

Equation	Kurtosis	chi2	df	Prob > chi2
D_fedfunds_d	3.6228	0.889	1	0.34578
D_er_d	2.8022	0.090	1	0.76462
D_repo_d	2.8617	0.044	1	0.83414
D_wpi_d	2.5681	0.427	1	0.51322
ALL		1.450	4	0.83548

Table 24 - Normality tests for Model 1 (Source - Own Calculation)

. vecnorm, jbera skewness kurtosis

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_qe	0.948	2	0.62239
D_er_d	1.032	2	0.59702
D_repo_d	2.039	2	0.36081
D_wpi_d	0.021	2	0.98948
ALL	4.040	8	0.85350

Skewness test

Equation	Skewness	chi2	df	Prob > chi2
D_qe	.29154	0.779	1	0.37741
D_er_d	.32175	0.949	1	0.32998
D_repo_d	.3971	1.446	1	0.22925
D_wpi_d	.04235	0.016	1	0.89796
ALL		3.190	4	0.52654

Kurtosis test

Equation	Kurtosis	chi2	df	Prob > chi2
D_qe	2.7282	0.169	1	0.68077
D_er_d	3.1899	0.083	1	0.77379
D_repo_d	2.4912	0.593	1	0.44116
D_wpi_d	2.9546	0.005	1	0.94525
ALL		0.850	4	0.93164

Table 25 - Normality Tests for Model 2 (Source - Own Calculation)

4.5 Impulse Response Function

The final part of the research findings was to generate impulse response functions to better understand the power of the relationships between the variables. While Granger Causality tests help determine the predictive power of the variables, it does not say much about the sign or the power of the relationship. An impulse response function (IRF) helps to identify the effect of a unit shock to one variable on the other variables in the model. In a VECM model, the presence of cointegrating equations helps identify whether the effect of a shock is permanent or transitory.

Lutkepohl (2005) defines an IRF as a measure to describe the effect of a shock to an endogenous variable on itself or on other endogenous variables. More generally, it refers to the reaction of any dynamic system in response to some external change.

Algebraically, it is represented as $\frac{\partial y_i(t+s)}{\partial \varepsilon_{jt}^i}$ as a function of s . It describes the response of $y_i(t+s)$ to a one time one standard deviation impulse in y_{jt} with all the other variables in the time series t .

For Model 1, the impulse given was the Federal Funds Rate and response of Repo Rates, Exchange Rates and Inflation in India were observed. From Table 26, it is clear that one standard deviation shock of the Federal Funds Rate increases exchange rate by 0.04 standard deviations, decreases interest rates by 0.03 standard deviations and decreases inflation by 0.06 standard deviations. While the impact on inflation is unexpected, it could be attributed to the increase in capital flows due to the excess capital spillover due to QE policies.

```
. irf table irf , irf(vec1) impulse(fedfunds_d) response(er_d repo_d wpi_d) individual
```

Results from vec1

step	(1) irf	(2) irf	(3) irf
0	0	0	0
1	.037528	-.030015	-.006179

- (1) irfname = vec1, impulse = fedfunds_d, and response = er_d
- (2) irfname = vec1, impulse = fedfunds_d, and response = repo_d
- (3) irfname = vec1, impulse = fedfunds_d, and response = wpi_d

Table 26 - Impulse Response Function Values for Model 1 (Source – Own Calculation)

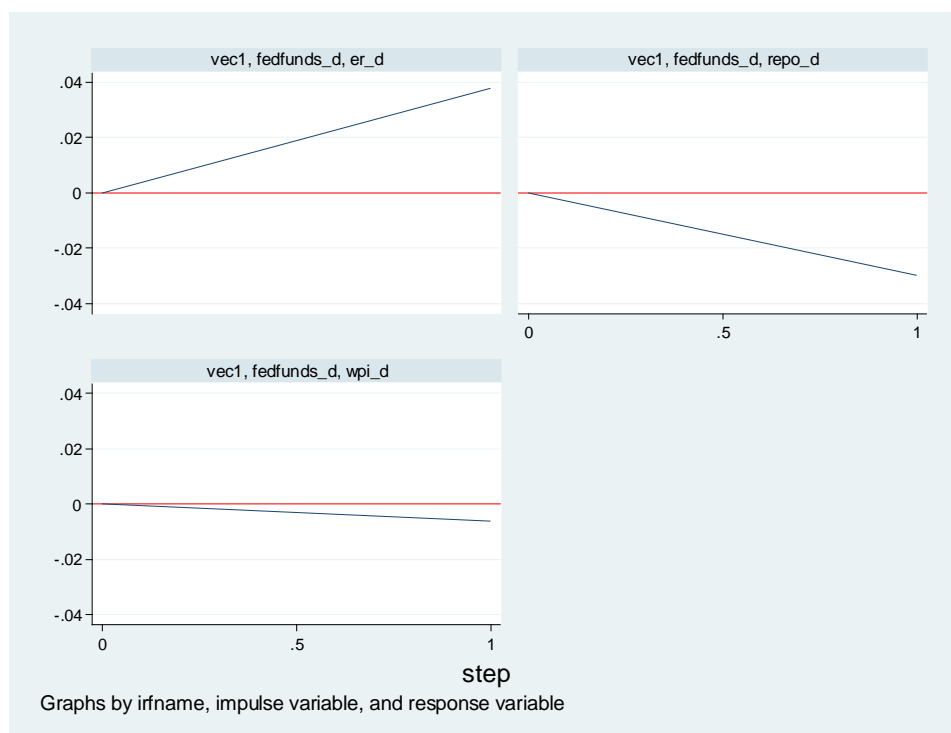


Table 27 - Impulse Response Function for Model 1 (Source - Own Calculation)

For model 2 , the direction of the effect is completely opposite to the first model indicative of the fact that QE purchases of long-term assets might have a negative impact on the exchange rate , a positive impact on interest rates and an increase in inflation albeit only marginally. Once again, it is stressed here, that given the small

sample size used in the VECM, the effect of an external shock may not be a true reflection.

```
. irf table irf, irf(vec2) impulse(qe) response(er_d repo_d wpi_d) individual step(4)
```

Results from vec2

step	(1) irf	(2) irf	(3) irf
0	0	0	0
1	-3.5e-09	8.0e-09	2.9e-09

- (1) irfname = vec2, impulse = qe, and response = er_d
- (2) irfname = vec2, impulse = qe, and response = repo_d
- (3) irfname = vec2, impulse = qe, and response = wpi_d

Table 28 - Impulse Response Function Values for Model 2 (Source - Own Calculation)

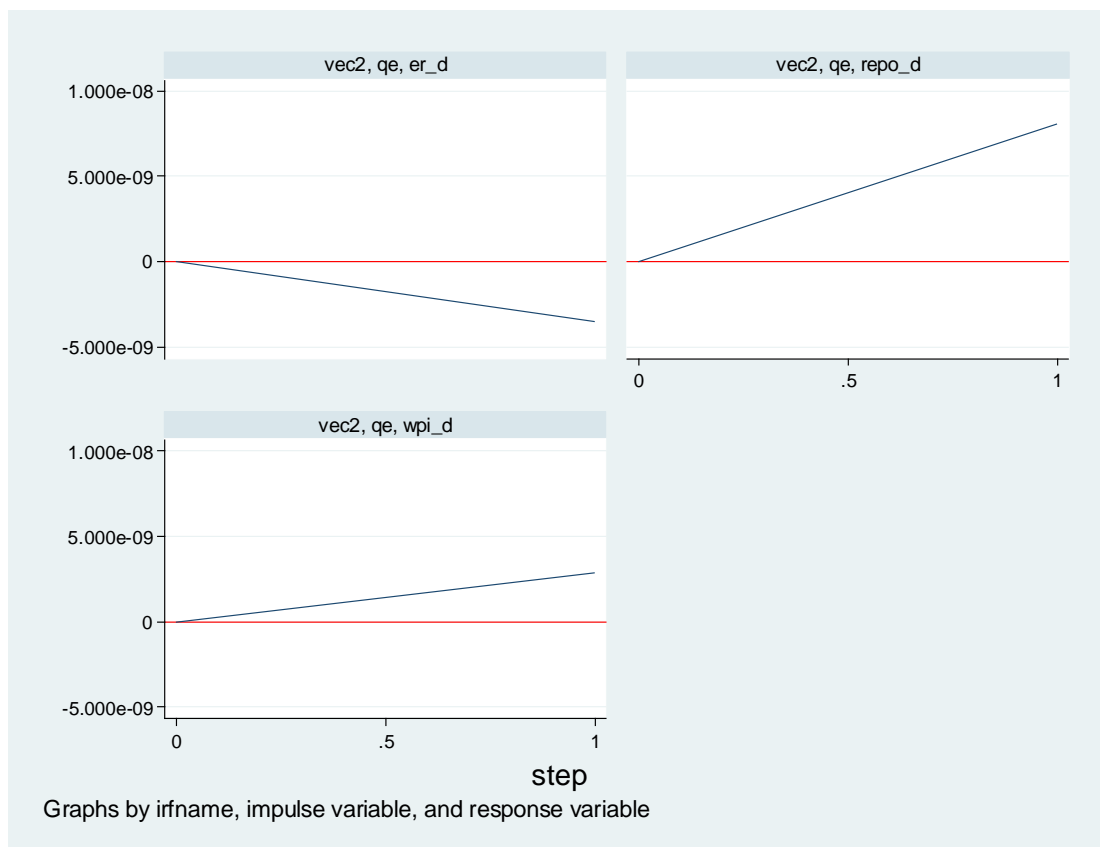


Table 29 - Impulse Response Function for Model 2 (Source - Own Calculation)

CHAPTER 5 – CONCLUSION

5. Conclusion

Having conducted a VAR analysis to examine the relationship between US Monetary Policy variables and Indian macroeconomic variables, as stated before, it might be useful to go back to the theories stated in the Theoretical Model in Chapter 2 and reflect on whether these hold true.

The US-India bilateral trade has been significant. The following table lists the trade in goods with India for the US. Each year, the value of good imported from India is more than that exported to India, signifying an intense trade relationship between the two countries.

<i>Year</i>	<i>Exports</i>	<i>Imports</i>
2008	17,682.1	25,704.4
2009	16,441.4	21,166.0
2010	19,248.9	29,532.9
2011	21,542.2	36,154.5
2012	22,105.7	40,512.6
2013	21,842.3	41,845.3

Table 30 - US Trade in goods with India (\$) (Source -United States Census Bureau)

Given this, the bilateral trade theory suggests that a monetary expansion in the US would lead to a Rupee appreciation or alternatively, an inverse relationship between US Monetary Policy and Indian exchange rates and also interest rates to a certain degree in the event that the Indian Central Bank responds to movements in American interest rates. From the results in Chapter 4, it is visible that exchange rates were significant for both the models indicating an impact of QE on Indian exchange rates.

When investigating whether economic events in India paralleled that of the US during the time period observed. It is to note that India is one of the few emerging countries where the impact of the financial crisis was slower in its reach. This could be attributed to domestic policies at play in India. As illustrated by Mohanty (2009) Indian financial markets were largely unaffected during the first phase of the crisis due to less exposure of Indian banks to the toxic assets which were the cause of the crisis. Further, as the growth process in India was largely 'domestic driven' the impact of the crisis was eventually felt through trade, finance and confidence channels. In addition, the international capital flow surge exposed India to significant capital boom and this is evident from the results where the excess spillover had an impact on all three variables. Alluding to the business cycle synchronization theory, the Indian Central Bank itself resorted to expansionary Monetary Policy tactics thereby suggesting that US Monetary Policy led to similar responses on behalf of Indian Monetary Policy as well.

Mohanty (2009) notes *'While fiscal stimulus cushioned the deficiency in demand, monetary policy augmented both domestic and foreign exchange liquidity. The expansionary policy stance of the Reserve Bank was manifested in significant reduction in CRR as well as the policy rates.'*

For both the models tested, each variable has been significant in some lag over the time period studied. It was evident that the currency channel was the first variable to be impacted. The effect of Federal Funds Rate and QE purchases themselves on the Indian Repo Rate seem to suggest that Unconventional Monetary Policies have an impact on India and it is possible that they have an effect on other emerging markets too. Table 31 below summarizes the significant lags in the VAR model illustrated in Chapter 4.

	Significant Lag	
Variable	Model 1 – Federal Funds Rate	Model 2 – Quantitative Easing
Interest Rate	2	0 , 1 , 2
Exchange Rate	1	Nil
Inflation	1	0 , 1

Table 31 -Summary of results (Source - Own Calculation)

When the impulse response functions were investigated, the variation in the results seemed to indicate a counter-cyclical adjustment process to changes in US Monetary Policy with alternating positive and negative responses. These responses seem to suggest some sort of overshooting in Indian Central Bank's response to changes in the US Monetary Policy.

Overall, the results of this research are consistent with literature in establishing that external shocks do have an impact on the domestic variables of an emerging economy.

CHAPTER 6 – RECOMMENDATIONS AND FUTURE

INTENTIONS

6. Recommendations and future intentions

The first obvious conclusion that is derived from conducting a VAR methodology is that there is a relationship between US Monetary Policy and Indian Macroeconomic Variables.

By using VAR, the researcher was able to isolate the effect of (1) Federal Funds Rate and (2) Quantitative Easing thereby equating QE as a tool of conventional Monetary Policy. The presence of cointegrating relationships meant that there was a long run relationship running between the chosen variables. When analysed further, it became apparent that this relationship ran from the Federal Funds Rate to the other variables in Model 1 and from QE to the other variables in Model 2. Thus, this research is consistent with existing literature on the conclusion that there is an impact of QE on macroeconomic variables in emerging economies.

A major limitation that was faced in this research was the inability of the VAR methodology to isolate the effects of QE1, QE2 and QE3 respectively. This is because each round of QE has been carried out for small time periods which give rise to residual autocorrelation when a VAR is done. Alternative Econometrics methods are available to isolate these effects such as Panel Data analysis used by Morgan (2012) however, such a method would then limit the researcher's ability to test for significant relationships between the variables.

Overall, this research was an attempt in showing the effect of Unconventional Monetary Policy on India. It is imperative here to note that while other emerging economies have had deeper and significant impacts of QE and the general actions of advanced economies in the wake of the financial crisis, India as an economy has had strong fundamentals through its policies. A question that may then arise is, is it right for an emerging economy to be 'protectionist' to a certain degree in its policy?

Another important fact to note is the evolution of QE itself. History as illustrated in the Literature Review of this thesis has highlighted how every response to every crisis has seemed 'but natural' at that point in time. Is it then right for advanced economies to continue to

operate on near-zero interest rates? And more importantly, is it time for macroeconomic policy to take on a more comprehensive approach in its implementation and consider factors that are external to the economy in it? The second argument holds true for both advanced economies and emerging economies.

And the final point that seemed obvious through the conduct of this research is the aim of Monetary Policy in itself. 'When is it right for Monetary Policy to target financial stability?' and also , if it does have to include financial stability in its mandate , should Central Banks in advanced and developing economies include it only to the extent where it threatens price stability or should it introduce additional independent targets to monitor the same ?

CHAPTER 7 – SELF REFLECTION ON OWN LEARNING
AND PERFORMANCE

7. Self-Reflection on own learning and performance

For understanding one's learning and performance over the course of this thesis, the researcher shall use Kolb's learning style in conjunction with a Learning Inventory Questionnaire and Honey and Mumford's Learning Styles.

Kolb's Learning Style

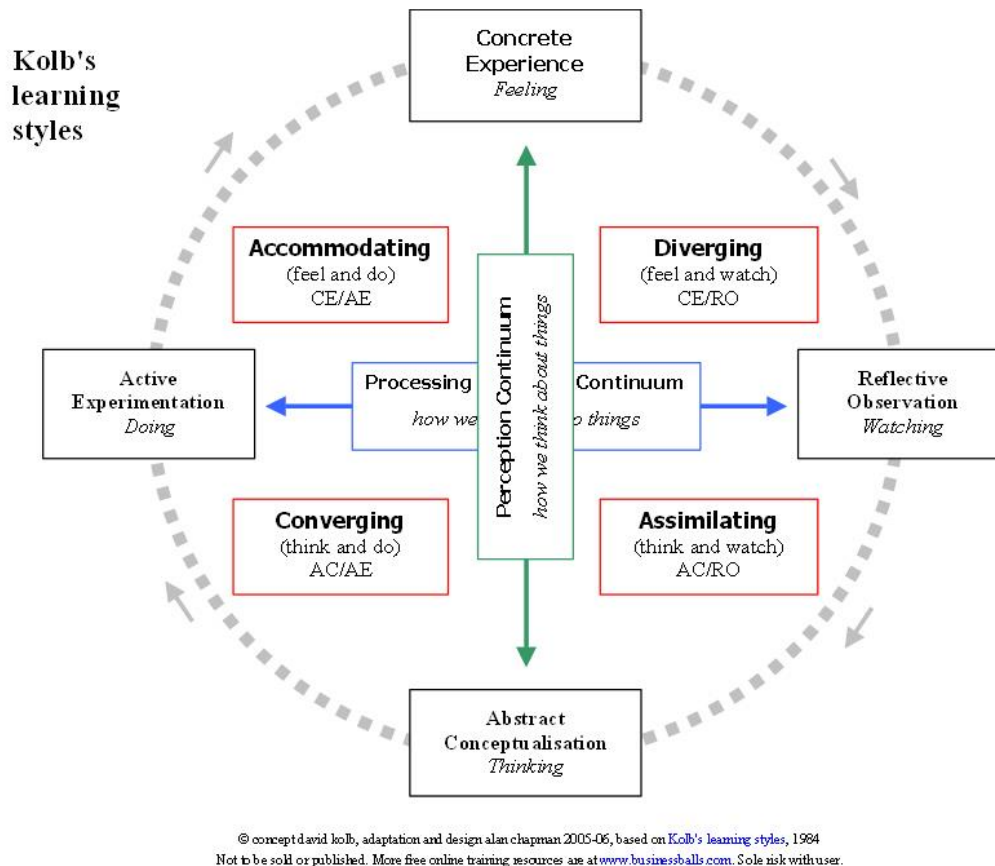


Figure 9 - Kolb's Learning Styles (Source - <http://www.businessballs.com/kolblearningstyles.htm>)

Kolb's learning style essentially explains four distinct styles of learning which are based on a four-stage learning cycle. It is a useful tool to understand different learning styles while appreciating the underlying experiential learning that applies to every individual. The Experiential Learning Theory, developed by Kolb is useful in understanding the 'cycle of learning' every individual goes through and through this cycle, experience

concrete events which in turn have an effect on the reflection and observations gained during the experience. According to Kolb, every individual, at some point in the learning cycle, touches each of the four styles through active experience, reflection, thinking and acting. These activities then have a bearing on the observations and reflections which then set the framework for the next round of learning experiences.

His model, works on two levels –

1. A four-stage cycle
2. Four-type definition of learning styles.

The four stage cycle includes the following -

1. Concrete Experience (feeling)
2. Reflective Observation (thinking)
3. Abstract Conceptualization (doing)
4. Active Experimentation (watching)

These stages in the cycle are aided by the learning styles which according to Kolb work as a combination of two preferred styles. These learning styles are –

1. Diverging – use concrete experiences and reflective observations to watch and gather information and use their imagination to implement the knowledge. They are aware of the existence of various opinions and accommodate differences in people and experiences in their learning approach.
2. Assimilating – Use reflective observations and abstract conceptualizations to apply concise logic in their learning. These people are more aware of abstract logic and ideas than they are of the people around them.

3. Converging – Use abstract conceptualization and active experimentation to solve practical problems. They are more technical than personal.
4. Accommodating – use active experimentation to apply to hands-on activities and practical skills, they are generally more impulsive and respond well to learning that requires a challenge of them.

Reflecting on the learning experience of this thesis and applying Kolb's learning styles on the observations, the researcher believes, that she is assimilating, converging and accommodating and adopts the learning styles of reflective observations, abstract conceptualizations and active experimentation to the best of her ability.

Having taken on the task of this thesis, the researcher felt the need to study in deep econometric methods she had only been aware of through her Bachelor Degree in Economics. She self-taught herself the concepts and with the help of her supervisor, was able to successfully implement the knowledge acquired.

These observations are further validated through the Learning Inventory questionnaire which suggested that the researcher is a VISUAL LEARNER. The figure below is a screenshot of the results of the questionnaire taken

- | | | | |
|--|----------------------------------|----------------------------------|----------------------------------|
| 18. I would rather listen to a good lecture or speech than read about the same material in a textbook. | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> |
| 19. I am good at working and solving jigsaw puzzles and mazes. | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| 20. I play with objects in hands during learning period. | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 21. I remember more by listening to the news on the radio rather than reading about it in the newspaper. | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> |
| 22. I obtain information on an interesting subject by reading relevant materials. | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| 23. I feel very comfortable touching others, hugging, handshaking, etc. | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| 24. I follow oral directions better than written ones. | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> |

After answering each question, click on the button below.

Your Learning Styles Inventory Results

Based on your input, you are a(n): Visual learner.

If you are a VISUAL learner, then by all means be sure that you look at all study materials. Use charts, maps, filmstrips, notes and flashcards. Practice visualizing or picturing words/concepts in your head. Write out everything for frequent and quick visual review.



Learning Styles Inventory by [Brett Bixler](#) is licensed under a [Creative Commons Attribution-NonCommercial-Share Alike 3.0 United States License](#).

Figure 10 - Learning Inventory Questionnaire (Source - <http://www.personal.psu.edu/bxb11/LSI/LSI.htm#ShowResults>)

Finally, to completely understand the learning process, the researcher used the Honey and Mumford's Learning Style Questionnaire which is a direct development of Kolb's Experiential Learning Styles. The model is similar to that of Kolb's but differs in the types of personalities analysed. The model seeks to identify whether a person is a reflector, a theorist, a pragmatist or an activist.

Applying one's own experience to the learning styles of Honey and Mumford, the researcher is led to the conclusion that she is a Pragmatist.

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CHAPTER 8 –APPENDICES

Appendix 2 – Augmented Dickey-Fuller Test for transformed data

```
. dfuller fedfunds_d , regress lags(0)
```

Dickey-Fuller test for unit root Number of obs = 58

Test Statistic	Interpolated Dickey-Fuller		
	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.569	-2.924	-2.597

MacKinnon approximate p-value for Z(t) = 0.0000

D.fedfunds_d	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
fedfunds_d L1.	-.7240865	.1087057	-6.66	0.000	-.9418501	-.5063229
_cons	-.0154421	.0248463	-0.62	0.537	-.0652153	.0343311

```
. dfuller wpi_d , regress lags(0)
```

Dickey-Fuller test for unit root Number of obs = 58

Test Statistic	Interpolated Dickey-Fuller		
	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.569	-2.924	-2.597

MacKinnon approximate p-value for Z(t) = 0.0000

D.wpi_d	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
wpi_d L1.	-.6696554	.1159958	-5.77	0.000	-.9020229	-.437288
_cons	.0042148	.0010429	4.04	0.000	.0021256	.006304

D_er_d						
_cel						
L1.	.013762	.005122	2.69	0.007	.003723	.023801
fedfunds_d						
LD.	.0237662	.0216694	1.10	0.273	-.0187051	.0662375
L2D.	.0340528	.0200196	1.70	0.089	-.0051848	.0732905
L3D.	.0099444	.0172773	0.58	0.565	-.0239185	.0438073
er_d						
LD.	-.0273595	.1703987	-0.16	0.872	-.3613347	.3066158
L2D.	-.0258648	.1521853	-0.17	0.865	-.3241425	.2724129
L3D.	-.0726621	.146302	-0.50	0.619	-.3594088	.2140846
repo_d						
LD.	.0321058	.1279449	0.25	0.802	-.2186617	.2828732
L2D.	-.0668478	.1620789	-0.41	0.680	-.3845165	.250821
L3D.	-.0591572	.1094963	-0.54	0.589	-.273766	.1554515
wpi_d						
LD.	-1.346748	.8630973	-1.56	0.119	-3.038387	.3448918
L2D.	-.1421809	.7041147	-0.20	0.840	-1.52222	1.237859
L3D.	-1.207817	.5791199	-2.09	0.037	-2.342871	-.0727629
_cons	.0015899	.0032689	0.49	0.627	-.0048171	.0079969
D_repo_d						
_cel						
L1.	.009087	.0047496	1.91	0.056	-.000222	.0183959
fedfunds_d						
LD.	-.0391016	.0200936	-1.95	0.052	-.0784843	.0002811
L2D.	-.0386423	.0185637	-2.08	0.037	-.0750265	-.0022581
L3D.	-.0123943	.0160209	-0.77	0.439	-.0437946	.019006
er_d						
LD.	-.1130464	.1580068	-0.72	0.474	-.4227342	.1966413
L2D.	-.0379114	.141118	-0.27	0.788	-.3144975	.2386747
L3D.	.1460414	.1356626	1.08	0.282	-.1198523	.4119352
repo_d						
LD.	-.6976326	.1186404	-5.88	0.000	-.9301635	-.4651016
L2D.	-.1820181	.1502921	-1.21	0.226	-.4765852	.1125489
L3D.	.0168333	.1015334	0.17	0.868	-.1821685	.2158352
wpi_d						
LD.	-.8978944	.8003306	-1.12	0.262	-2.466514	.6707247
L2D.	-.3549489	.6529096	-0.54	0.587	-1.634628	.9247305
L3D.	.2952885	.5370048	0.55	0.582	-.7572216	1.347799
_cons	.0028931	.0030312	0.95	0.340	-.003048	.0088342

D_wpi_d							
_cel							
L1.	-.0035705	.0012653	-2.82	0.005	-.0060504	-.0010905	
fedfunds_d							
LD.	-.0026089	.005353	-0.49	0.626	-.0131005	.0078827	
L2D.	.0022501	.0049454	0.45	0.649	-.0074427	.0119429	
L3D.	.0012616	.004268	0.30	0.768	-.0071035	.0096267	
er_d							
LD.	-.0986025	.0420933	-2.34	0.019	-.1811039	-.0161012	
L2D.	-.0336918	.0375941	-0.90	0.370	-.1073748	.0399913	
L3D.	-.0820974	.0361407	-2.27	0.023	-.1529319	-.0112628	
repo_d							
LD.	.0100426	.031606	0.32	0.751	-.0519041	.0719893	
L2D.	.0354496	.0400381	0.89	0.376	-.0430236	.1139228	
L3D.	.0116212	.0270487	0.43	0.667	-.0413932	.0646357	
wpi_d							
LD.	-.176039	.2132095	-0.83	0.409	-.5939219	.2418439	
L2D.	-.0663929	.1739363	-0.38	0.703	-.4073018	.2745159	
L3D.	.0957631	.143059	0.67	0.503	-.1846275	.3761536	
_cons	.0001718	.0008075	0.21	0.832	-.0014109	.0017545	

Cointegrating equations

Equation	Parms	chi2	P>chi2
_cel	3	24.97123	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]
_cel					
fedfunds_d	1	.	.	.	.
er_d	-26.42433	9.718598	-2.72	0.007	-45.47243 -7.376226
repo_d	-10.03352	6.32435	-1.59	0.113	-22.42902 2.361975
wpi_d	165.9704	46.08904	3.60	0.000	75.63753 256.3032
_cons	-.9743345	.	.	.	.

Appendix 4 – VECM Model full results for Model 2

```
. vec qe er_d repo_d wpi_d, trend(constant) lags(4)
```

Vector error-correction model

```
Sample: March 2009 - September 2013           No. of obs   =           55
                                                AIC          = 13.35248
Log likelihood = -308.1931                    HQIC         = 14.18518
Det(Sigma_ml) = .8654663                     SBIC         = 15.5058
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_qe	14	695589	0.6444	74.28972	0.0000
D_er_d	14	.024642	0.3729	24.34493	0.0416
D_repo_d	14	.020329	0.8579	244.7455	0.0000
D_wpi_d	14	.005242	0.6200	63.96884	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
D_qe						
_ce1						
L1.	.0028371	.024142	0.12	0.906	-.0444804	.0501545
qe						
LD.	-.7032482	.1438818	-4.89	0.000	-.9852514	-.421245
L2D.	-.2456117	.1904856	-1.29	0.197	-.6189566	.1277333
L3D.	.407333	.1675126	2.43	0.015	.0790144	.7356516
er_d						
LD.	3798384	4319354	0.88	0.379	-4667394	1.23e+07
L2D.	-56859.46	4176268	-0.01	0.989	-8242194	8128476
L3D.	2395493	4268680	0.56	0.575	-5970966	1.08e+07
repo_d						
LD.	4735003	3249907	1.46	0.145	-1634697	1.11e+07
L2D.	5831166	4165621	1.40	0.162	-2333301	1.40e+07
L3D.	3271067	2938893	1.11	0.266	-2489058	9031193
wpi_d						
LD.	1.31e+07	2.82e+07	0.47	0.642	-4.21e+07	6.83e+07
L2D.	-6812334	2.28e+07	-0.30	0.765	-5.14e+07	3.78e+07
L3D.	1.01e+07	1.79e+07	0.56	0.573	-2.50e+07	4.51e+07
_cons	6.03e-08	1038931	0.00	1.000	-2036268	2036268

<hr/>						
D_er_d						
_cel						
L1.	-9.27e-10	8.55e-10	-1.08	0.279	-2.60e-09	7.49e-10
qe						
LD.	-2.57e-09	5.10e-09	-0.51	0.613	-1.26e-08	7.42e-09
L2D.	-2.64e-09	6.75e-09	-0.39	0.695	-1.59e-08	1.06e-08
L3D.	3.62e-09	5.93e-09	0.61	0.542	-8.01e-09	1.53e-08
er_d						
LD.	-.2536129	.1530149	-1.66	0.097	-.5535167	.0462908
L2D.	-.1751586	.1479461	-1.18	0.236	-.4651275	.1148104
L3D.	-.2640119	.1512198	-1.75	0.081	-.5603972	.0323735
repo_d						
LD.	.0838323	.1151293	0.73	0.467	-.141817	.3094816
L2D.	.0315037	.1475689	0.21	0.831	-.257726	.3207334
L3D.	-.0442322	.1041115	-0.42	0.671	-.2482871	.1598226
wpi_d						
LD.	-.406886	.9982434	-0.41	0.684	-2.363407	1.549635
L2D.	.2523433	.8064623	0.31	0.754	-1.328294	1.83298
L3D.	-1.004807	.6337097	-1.59	0.113	-2.246855	.237241
_cons	.0400579	.0368046	1.09	0.276	-.0320777	.1121936
<hr/>						
D_repo_d						
_cel						
L1.	-1.76e-09	7.06e-10	-2.49	0.013	-3.14e-09	-3.74e-10
qe						
LD.	9.80e-09	4.21e-09	2.33	0.020	1.56e-09	1.80e-08
L2D.	1.41e-08	5.57e-09	2.54	0.011	3.21e-09	2.50e-08
L3D.	7.13e-09	4.90e-09	1.46	0.145	-2.46e-09	1.67e-08
er_d						
LD.	-.1528662	.126236	-1.21	0.226	-.4002842	.0945518
L2D.	-.1290144	.1220542	-1.06	0.290	-.3682363	.1102075
L3D.	.1023331	.124755	0.82	0.412	-.1421823	.3468484
repo_d						
LD.	-.8891945	.0949807	-9.36	0.000	-1.075353	-.7030358
L2D.	-.4153439	.1217431	-3.41	0.001	-.6539559	-.1767319
L3D.	-.0769341	.0858911	-0.90	0.370	-.2452776	.0914095
wpi_d						
LD.	-1.841176	.8235423	-2.24	0.025	-3.455289	-.2270625
L2D.	-1.115963	.6653245	-1.68	0.093	-2.419976	.1880486
L3D.	-.1599873	.5228051	-0.31	0.760	-1.184666	.8646919
_cons	.0748384	.0303635	2.46	0.014	.0153271	.1343497

D_wpi_d							
_cel							
L1.	6.81e-10	1.82e-10	3.74	0.000	3.24e-10	1.04e-09	
qe							
LD.	2.22e-09	1.08e-09	2.04	0.041	9.10e-11	4.34e-09	
L2D.	1.28e-09	1.44e-09	0.89	0.374	-1.54e-09	4.09e-09	
L3D.	1.28e-09	1.26e-09	1.01	0.311	-1.20e-09	3.75e-09	
er_d							
LD.	-.0485673	.0325487	-1.49	0.136	-.1123615	.0152269	
L2D.	-.0085242	.0314704	-0.27	0.786	-.0702051	.0531567	
L3D.	-.0452427	.0321668	-1.41	0.160	-.1082885	.0178031	
repo_d							
LD.	.0026236	.0244898	0.11	0.915	-.0453755	.0506227	
L2D.	.0350201	.0313902	1.12	0.265	-.0265036	.0965437	
L3D.	.0196706	.0221461	0.89	0.374	-.0237351	.0630762	
wpi_d							
LD.	.0420325	.2123419	0.20	0.843	-.37415	.4582151	
L2D.	.0181252	.1715471	0.11	0.916	-.3181009	.3543513	
L3D.	.1417266	.1347999	1.05	0.293	-.1224764	.4059296	
_cons	-.0288774	.0078289	-3.69	0.000	-.0442218	-.013533	

Cointegrating equations

Equation	Parms	chi2	P>chi2
_cel	3	33.27146	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]
_cel					
qe	1	.	.	.	.
er_d	6.09e+07	5.95e+07	1.02	0.306	-5.57e+07 1.77e+08
repo_d	5.04e+07	3.88e+07	1.30	0.193	-2.55e+07 1.26e+08
wpi_d	-1.30e+09	2.50e+08	-5.18	0.000	-1.79e+09 -8.05e+08
_cons	4.57e+07	.	.	.	.