

International commodity prices – volatility and global liquidity

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1. Introduction

Recent years have witnessed large fluctuations in international commodity prices. A boom in commodity prices until 2008 was followed by a sharp decline during the peak of the financial crisis. Since early 2009, prices of major groups of commodities rose to levels close to or even above the peak reached in 2008. For some commodities, the speed and amplitude of the recent price swings have been large by historical standards. There has been a persisting concern about the high and volatile behaviour of commodity prices in view of its likely impact on macroeconomic situation. The most prolonged global financial crisis since the *Great Depression* is not yet over and the loose monetary policy with very low interest rates and monetary easing through injection of liquidity by major advanced economy central banks continue. In this scenario, the subject of analyzing the impact of global liquidity on the commodity, consumer and asset prices has been receiving considerable attention.

It is argued that monetary policy can affect commodity prices by changing the expectations of commodity market participants about future growth and inflation. This expectation channel works through both changes in monetary policy and central bank communication about the macroeconomic outlook and possible future policy actions. In this channel, commodity prices may change faster than the prices of manufactured goods or services do, due to their less sticky properties. Accommodative global monetary conditions can also affect commodity prices through changes in the behavior of commodity market participants independent of actual or expected changes in aggregate demand and inflation. Lower return on safe assets may encourage financial investors to shift their portfolios into riskier assets. Moreover, excessively low funding costs may create incentives to generate extra returns by borrowing short-term at low interest rates and investing in higher-yielding assets, which could include commodity markets as well.

The G20 Study Group on Commodities (April 2011) noted the existing debate on the drivers of the commodity price developments. While one view attributed the fundamental demand-supply factors behind the commodity price trends, the other view was that financialization of commodities has had significant price impact. The financialization argument points to the impact of loose monetary policy for prolonged periods by way of large global liquidity in search of yields finding its way into the commodity markets and thereby influencing the commodity prices.

In this background, this paper examines the impact of global liquidity, excess monetary liquidity to be more precise, on the trends and volatility in international commodity prices. Several issues have to be reckoned in this regard. First, adjustments in investors' portfolio allocation in response to monetary policy actions will often reflect a combination of changes in macroeconomic expectations and risk appetite. Second, lower policy interest rates may

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lead to higher commodity prices, but central banks in turn would be required to take into account changes in commodity prices in their monetary policy. Third, an appropriate formulation of the dynamic interactions of different variables is required so as to control for the more fundamental demand-supply factors in order to capture the impact of the monetary factors.

In recent years, a number of studies have sought to establish the existence of significant positive impact of excess global liquidity on commodity and asset prices. These studies, by and large, examined the relationship between various measures of global liquidity and excess global liquidity and international commodity / asset price indices in a VAR framework and usually depended upon constant coefficient models. It is, however, pertinent to ask whether the magnitude of such impact can vary over time and, probing further, whether the impact during the pre-crisis period could be different from that in the crisis or post-crisis period. In this paper, these issues are examined initially based on conventional SVAR models followed by the application of time-varying coefficient SVAR modelling approach proposed by Primiceri (2005). The latter framework allows one to investigate the variable impact of the shock in global liquidity imparted at different points of time on international commodity prices.

The rest of the paper is organised as follows. Section 2 presents a brief literature review. A brief description about the TVP-VAR methodology is described in Section 3. Section 4 provides a description of the variables and data used for modelling. Section 5 provides the basic statistical properties of the variables and Section 6 presents the empirical analyses. Finally, Section 7 concludes.

2. Select literature survey

The literature on the relationship between liquidity and prices can be broadly classified into two categories, viz., investigations at national level and at international level. In keeping with the objective, our attention is focused on the studies on liquidity and prices at international level. At the outset, such studies have to contend with the development of suitable indicators of global liquidity and also consider appropriate price indices. It is also necessary to incorporate in the model appropriate output and other price variables at the global level for arriving at desirable specifications. Once suitable indicators are constructed, the next step is to look for suitable modeling and estimation techniques. In this section, we first provide a snapshot of various approaches used in the literature for construction of these variables and then present the findings of a few select studies.

2.1 Variables used in literature

Price variables

Among the various relevant variables used in these studies, international commodity, consumer and asset prices are most common. Many international agencies such as the IMF, World Bank, Commodity Research Bureau compile data on the international commodity price indices. These are based on spot or future prices of commodities obtained from different international markets, which are then aggregated using suitable weights such as traded volume, size of the spot/future contracts, etc. The behavior of such price data series can vary depending on the choice of the basket, nature of the markets, types of prices and their weights. Similarly, a number of asset price indices, mainly equity prices at international level are also compiled by international agencies.

Global liquidity

Although the term global liquidity is not very precisely defined, IMF, WEO October 2007³ provided two broad classifications of global liquidity, which are associated with (a) the global monetary policy stance (involving a range of monetary aggregates and policy interest rates) and (b) financial market liquidity. Along similar lines, Stark (2007)⁴ noted that monetary liquidity defined is in quantitative terms on the basis of monetary and financial aggregates. In another approach, following Domanski *et. al.* (2011) global liquidity may be defined as the overall “ease of financing” in the international financial system. The BIS Committee on the Global Financial System (CGFS) in its Report on Global liquidity (2011) argued that, from a global perspective, the “ease of financing” depends on the both official liquidity (those created by the public sector) and private sector liquidity. Private sector liquidity is created by international banks, institutional investors, non-bank financial institutions etc. by lending in the inter-bank market, buying commercial papers issued by corporate by the money market mutual funds, etc. Official liquidity is defined as the funding that is unconditionally available to settle through monetary authorities. Another major issue pertaining to the assessment of global liquidity is measuring the global “excess liquidity”. According to Stark *op. cit.* a qualitative definition of excess monetary liquidity is that poses a medium or long-term threat to price stability or starts to boost asset prices to levels not justified by economic fundamentals.

Agostino and Surico (2009) defined a baseline global liquidity as the simple average of the growth rates of broad money in the G7 economies. Sousa and Zaghini (2007) defined global liquidity as the sum of the monetary aggregates for the USA, the Euro area, Japan, the UK and Canada using exchange rates vis-à-vis the euro based on purchasing power parity. IMF (2010) defined two alternative measures of global liquidity based on monetary aggregates (M2) and reserve money for G-4 countries (the USA, the UK, Japan and the Euro area). Artus and Virard (2010) defined global liquidity as the “*money created by the central banks around the world*”, i.e. the base money of all the countries around the world. Darius and Radde (2010) measured global liquidity as the total of international reserves and the USA base money.

The CGFS (*op. cit.*) questioned the absence of an agreed equilibrium concept against which the actual development can be assessed. Ruffer and Stracca (2006) defined the “Excess Money” indicator for 15 countries as a ratio between broad (narrow money) and nominal GDP. The global liquidity was defined as the aggregate of money supply for the USA, the Euro area, Japan, Canada and the UK, using fixed real GDP weights at PPP exchange rate. IMF (*op. cit.*) defined excess liquidity as the difference between broad money growth and estimates for money demand in the G-4. De Nicolo and Wiegand (2007) defined global excess liquidity as the deviation of the short-term nominal interest rate from the interest rate based on the Taylor rule.

Global output

Generally, two different indicators of output are commonly used. In studies based on quarterly data, GDP of a group of countries, mainly advanced economies, are aggregated. One natural candidate is the aggregate GDP compiled by OECD for different groups of OECD economies.

³ IMF, World Economic Outlook, October 2007, Box 1.4 on Global liquidity.

⁴ Speech by Jürgen Stark, ECB workshop on “The external dimension of monetary analysis”, December 2007.

2.2 Modeling approaches and findings

Browne and Cronin (2007) used the Commodity Research Bureau Spot Index (CRBSI), the CRB Raw Industrials (CRBRI) and Conference Board's Sensitive Materials Index (SENSI) to represent the commodity price indices for their empirical analysis. They found that in the long run, the US money supply drives both commodity prices and in turn US consumer prices, under the cointegration framework.

Sousa and Zaghini (2007) examined the impact of global liquidity, estimated based on monetary aggregates of five industrial economies, on global output and prices through a Structural VAR model. Empirical analysis suggested that an increase in the global liquidity had a positive impact on real GDP in the short-run that disappeared in the medium to long term, while the impact on prices was found to be insignificant in the first two quarters, but become positive and permanent thereafter.

Belke *et al.* (2009) investigated the relationship between money (global liquidity), consumer prices, commodity prices and output from 1970 to 2008. Global liquidity was proxied by broad monetary aggregate in major OECD countries. The Johansen cointegration technique suggested existence of long-run equilibrium relationship between the variables. According to their empirical findings, global liquidity could be considered as a useful indicator of commodity price inflation and of a more generally defined inflationary pressure at a global level. They used the CRB index and the CRB Raw Industrials index for the commodity price indices.

Darius and Radde (2010) examined the impact of global liquidity on various asset prices *viz.*, the extent to which the rise in asset prices was influenced by developments in global liquidity using a VAR model. The model included various measures of assets – the housing price, the equity price and the commodity price. It found that global liquidity had a significant impact on the buildup in house prices, while the impact on equity prices was limited.

Anzuinet *et al.* (2010) investigated the relationship between the US money supply and commodity prices, using a Structural VAR framework, and found that a shock to the US money supply leads to an increase in the commodity prices.

3. Brief description of the methodology of Time Varying Vector Autoregression with Stochastic Volatility (TVP-VAR) Model

Let y_t be a $k \times 1$ vector of variables with a lag length of "s". The VAR(s) model with time-invariant parameters and variance may be written as,

$$AY_t = F_1 y_{t-1} + \dots + F_s y_{t-s} + u_t$$

where A is the matrix of cotemporaneous coefficients, while F_1, F_2, \dots, F_s are the matrices of coefficients. u_t is assumed to have mean 0 and fixed variance-covariance matrix S . The structure of the matrix A is as follows:

$$A = \begin{pmatrix} 1 & 0 & \dots & 0 \\ a_{21} & 1 & \dots & 0 \\ \dots & \dots & \dots & \dots \\ a_{k1} & a_{k2} & \dots & 1 \end{pmatrix}$$

The above referred equation can be rewritten in reduced form as

$$Y_t = X_t' b + e_t$$

In case one allows the matrices A , F_1 , F_2, \dots , F_s or the variance-covariance matrix S to vary over time, the model requires to incorporate some unobserved components as state variables. For estimation of the unobserved components, the state transition equation is required to be distinguished from a measurement equation under a state space model.

The structural changes in the macroeconomic indicators can be captured through a Time Varying Parameter VAR with stochastic volatility. Following Primiceri (2005), the time varying parameter VAR with stochastic volatility can be formulated as:

$$\begin{aligned} Y_t &= X_t' b_t + e_t, e_t \sim N(0, A^{-1} H_t A^{-1'}) \\ b_t &= b_{t-1} + v_t, v_t \sim N(0, S_u) \\ \log(H_{it}) &= \log(H_{it-1}) + u_{it}, u_{it} \sim N(0, Q_i) \\ \text{with } S_t &= \text{diag}(\sqrt{H_{it}}) \end{aligned}$$

The elements of the vector b_t are modelled as random walks. The standard deviations are assumed to evolve as geometric random walks, belonging to the class of models known as stochastic volatility. All the innovations in the model are assumed to be jointly normally distributed and uncorrelated.

The prior distribution for the variance-covariance matrix is assumed to follow Inverse-Wishart. The prior distribution for the initial states of the time varying coefficients is assumed to be normally distributed. This is estimated using Gibbs sampling in Markov Chain Monte Carlo (MCMC) algorithm.

4. Description of variables and data

Global commodity prices

In this paper, international commodity price movements have been measured using two alternative commodity price indices, viz., IMF Primary Commodity Price Index (representing spot prices) and Reuters-Jeffery CRB Commodity Price Index (representing future prices). The International Monetary Fund compiles indices of primary commodity prices on monthly basis. In the IMF index, individual commodity price indices are compiled in USD and SDR terms with base 2005. The group-indices are computed as weighted averages of individual commodity price indices, with the weights derived from their relative trade values compared to the total world trade. The IMF primary commodity index is mainly dominated by the Energy Group with a weight of 63.1%, of which Petroleum and Natural Gas has weights of 53.6% and 6.9% respectively. In the Non-Energy Group, Food and Industrial Inputs have weights of 16.7% and 18.4% respectively. In the IMF index, Petroleum price index is derived from the spot prices of UK Brent, Dubai Fateh and WTI.

The Reuters-Jefferies Commodity Research Bureau (CRB) index covers commodities that have significant contracts. The index has been designed to provide more liquid and economically relevant benchmark that represents commodities as an asset class more accurately. The data are collected from 19 future markets, with quotations for 5 commodities are collected from NYBOT and 4 are collected from NYMEX. Energy has the maximum weight (39%), of which WTI crude oil has a weight of 23% in the overall index. Data on CRB Commodity Index has been collected from Jeffries-Reuters web site. The monthly index has been estimated as the daily average.

Global liquidity

For measuring the impact of global liquidity on the commodity prices, this paper uses the variable "excess liquidity". Excess Liquidity has been estimated as the deviation of the money supply from its trend estimate. The OECD defines the M1 (Narrow money) consisting

of currency i.e. banknotes and coins, plus overnight deposits. The OECD M3 consist of the total of M1, deposits with an agreed maturity of up to two years and deposits redeemable at notice of up to three months, repurchase agreements, money market fund shares/units and debt securities up to two years. The area totals for the monetary aggregate indices are based on annually chain-linked Laspeyres indices. The weights for each yearly link are derived as the previous year's gross domestic product adjusted for purchasing power parity. Based on these two alternative measures of money, two excess monetary liquidity measures viz. Excess_Liquidity1 (M1 based) and Excess_Liquidity3 (M3 based) have been estimated. HP filter has been used to estimate the Trend.⁵

Global output

Due to lack of monthly World GDP data, the monthly Index of Industrial Output of the OECD countries, compiled by the OECD has been used to represent World output. Data for OECD-IIP has been collected from the OECD database.

Global equity prices

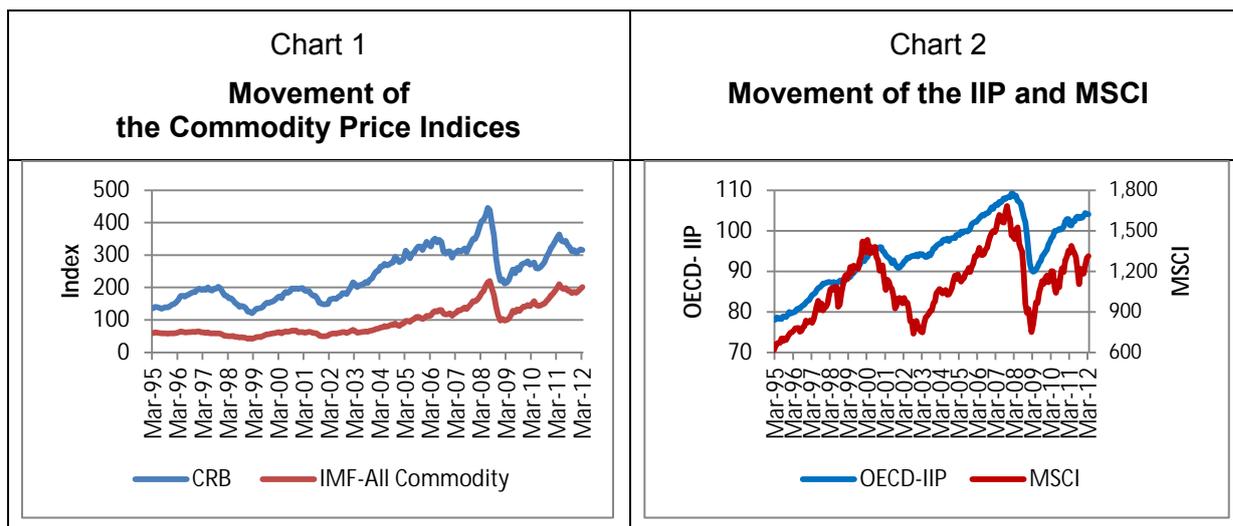
As liquidity flows to the equity markets also, the equity price is captured through the Morgan Stanley Capital Investment- World Equity Index (MSCI). The monthly data has been collected from the Morgan Stanley website. The MSCI World Equity Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets. It consists of 24 market country indices, viz. Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hongkong, Ireland, Israel, Italy, Japan, Netherlands, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the UK and the USA.

The paper uses monthly data over the period from April 1994 to March 2012. All the above data have been obtained from public sources, viz., the websites of OECD, IMF, Reuters / CRB and Morgan Stanley.

5. Basic statistical properties of the data

During the sample period, the IMF Commodity price index showed an increasing trend from middle of 2001 till middle of 2008 and then declined sharply during the crisis period. The CRB commodity price index also showed an increasing trend towards the end of 2001 till the middle of 2008. The CRB commodity index is observed to be more volatile than the IMF commodity index prior to the financial crisis of 2008 (Chart 1). The behavior of OECD IIP and MSCI indicate considerable co-movements and the sharp downturn at different points of time indicate existence of structural breaks (Chart 2).

⁵ The behavior of these excess liquidity estimates have been validated with respect to an excess liquidity measure used by the IMF, viz., residuals of a money demand function based on quarterly data.



5.1 Pre-processing of the data

For empirical analysis, all the variables were transformed in logarithm and data are seasonally adjusted using the U.S. Census Bureau's X-12-ARIMA procedure. Further empirical analysis is carried out using seasonally adjusted data. The OECD publishes seasonally adjusted data on Industrial Production, M1 and M3 and hence no seasonal adjustment has been made for these variables.

5.2 Unit root test

Initially test for the existence of unit roots was conducted using the widely applied ADF test and Phillips-Perron (PP) test, with the appropriate lag length is selected by the Schwarz Bayesian Criterion (SBC). Table-1 and Table-2 presents the results of the unit root test at level and first difference respectively. The ADF test indicates that the variables M1, M3, IIP, CRB and MSCI to be $I(1)$. The PP test also suggest that these variables to be $I(1)$, except for M3 under the specification "Constant".

Test for existence of unit root has also been conducted using the Zivot-Andrews (ZA) unit root test that considers existence of a single break in the series. All variables, except IIP are found to be $I(1)$ under ZA test. The peculiar behavior of IIP could be due to the crisis period fluctuations, which may not be amenable to the unit root test used. All the three tests suggest both the measures of Excess Liquidity to be $I(0)$.

Table-1
Results of the unit root test at level

Variables	Without break			With break (Zivot-Andrews test)		
	ADF	PP (Trend)	PP (Constant)	Intercept (Model A)	Trend (Model B)	Both (Model C)
Log(M1)	-1.36	-1.18	-0.37	-4.69 (Jun-06)	-3.38 (Jun-03)	-4.43 (Jun-06)
Log(M3)	-0.63	-0.19	-4.73***	-3.03 (Feb-09)	-2.33 (Mar-01)	-2.46 (Jan-01)
Log(IIP)	-2.63	-1.83	-2.13	-5.98*** (Aug-08)	-3.90 (May-06)	-6.10*** (Aug-08)
Log(CRB)	-2.70	-2.09	-1.63	-4.25 (Aug-08)	-3.41 (Mar-07)	-4.15 (Aug-08)
Log(IMF)	-2.16	-1.77	0.01	-4.12 (Dec-97)	-4.00 (Dec-98)	-4.30 (Oct-03)
Log(MSCI)	-2.56	-2.19	-2.15	-3.17 (Jun-08)	-2.87 (Jun-97)	-3.43 (Sept-00)
Excess_Liquidity1	-5.41***	-4.95***	-4.95***	-5.92*** (Nov-08)	-5.80*** (Jun-06)	-6.03*** (Nov-08)
Excess_Liquidity3	-6.06***	-4.83***	-4.83***	-6.85*** (Aug-09)	-6.68*** (Mar-09)	-7.17*** (Sept-08)

Note: (1) ***, ** and * indicates significance at 1%, 5% and 10% probability level respectively.

(2) The Critical values for ADF test with trend at 5% level is -3.43. The Critical values for Phillips-Perron test with Trend and Constant are at 5% level are -2.87 and -3.43 respectively, while the Critical values for the Zivot-Andrews test under Model A, Model B and Model C at 5% level are -4.80, -4.42 and -5.08 respectively.

Variables	Without break			With break (Zivot-Andrews test)		
	ADF	PP (Trend)	PP (Constant)	Intercept (Model A)	Trend (Model B)	Both (Model C)
dLog(M1)	-11.27***	-11.33***	-11.33***	-6.72*** (Sept-08)	-6.42*** (Apr-97)	-6.82*** (Sept-08)
dLog(M3)	-7.34***	-8.09***	-7.38***	-7.05*** (Feb-09)	-6.40*** (Feb-08)	-7.47*** (Mar-09)
dLog(IIP)	-5.26***	-7.78***	-7.67***	-5.18*** (Mar-09)	-4.75*** (Dec-08)	-5.36*** (Feb-08)
dLog(CRB)	-7.13***	-10.08***	-10.06***	-4.99** (Mar-99)	-4.80** (Dec-03)	-5.30** (Jul-08)
dLog(IMF)	-10.77***	-10.87***	-10.82***	-5.81*** (July-08)	-5.49*** (Nov-04)	-6.24*** (Aug-08)
dLog(MSCI)	-12.67***	-12.76***	-12.73***	-6.01*** (Mar-09)	-5.64*** (Nov-08)	-6.09*** (Mar-09)

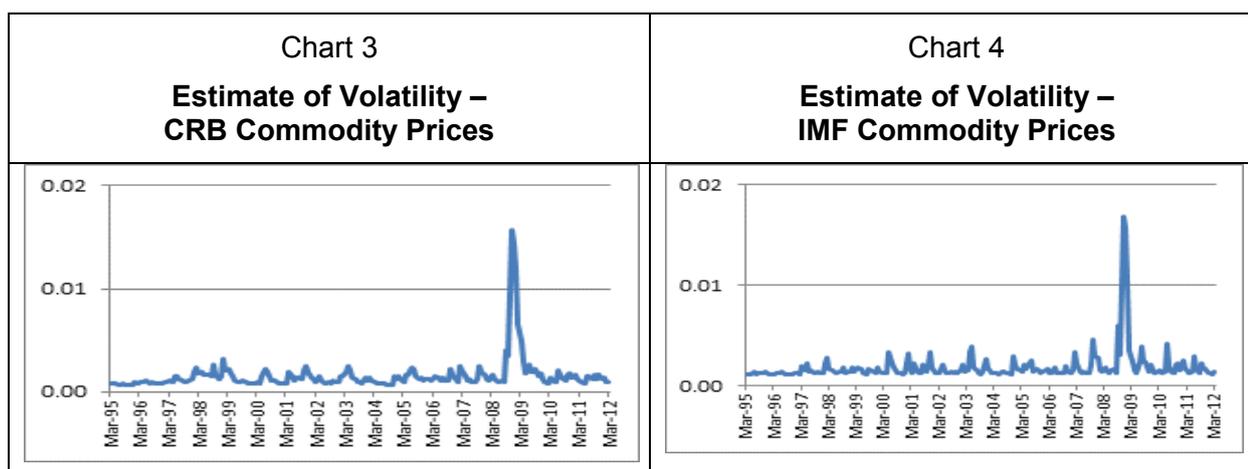
Note: (1) ***, ** and * indicates significance at 1%, 5% and 10% probability level respectively.

(2) The Critical values for ADF test with trend at 5% level is -2.88. The Critical values for Phillips-Perron test with Trend and Constant are at 5% level are -2.88 and -3.43 respectively, while the Critical values for the Zivot-Andrews test under Model A, Model B and Model C at 5% level are -4.80, -4.42 and -5.08 respectively.

6. Empirical estimates

6.1 Estimating volatility in commodity price

Initially, we tried to estimate the volatility of the two commodity price indices using a GARCH model. For this, the mean equation is estimated through an AR(1) process while the volatility is estimated through a GARCH(1,1) process. Chart-3 and Chart-4 presents the estimate of volatility in CRB and IMF commodity prices respectively. From the charts it can be observed that the volatility in both the commodity prices spiked during the crisis year of 2008. The commodity prices declined sharply during the period from August 2008 to December 2008. Further, the estimated volatility is found to be lower in CRB than IMF, on an average.



6.2 Estimating the impact of excess monetary liquidity on commodity price using Vector Autoregression Model

In this section attempt has been made to estimate the impact of excess liquidity on commodity prices through a Structural VAR (SVAR) model. The model includes the variables output and equity price. To capture the impact of the recent financial crisis in 2008, a dummy variable has been used. The dummy takes a value “1” from September 2008 onward, prior to which it take a value “0”. For empirical analysis, we have used the excess liquidity measure, both based on M1 and M3.

For the SVAR model, it is assumed that output will be impacted by all other variables with a lag. Commodity price is impacted by output contemporaneously. Equity price is assumed to be contemporaneously impacted by output and commodity price, while global excess liquidity is assumed to have been impacted by all other variables contemporaneously.

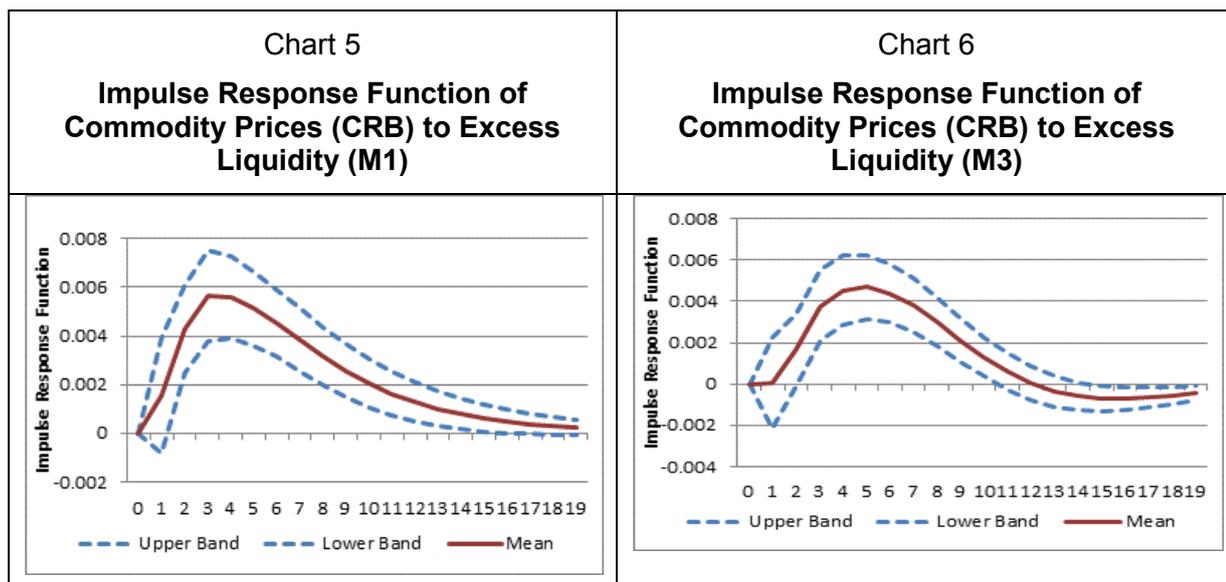
Using both the measures of excess liquidity, the AIC suggest the lag length at 2, while SCB suggest the lag length of the VAR model at 1 for excess liquidity measured using M1 and 2 for M3 respectively. The residuals are found to be white noise when the lag length has been taken as 2 and as such the lag length of the SVAR model has been considered as 2. Table 3 and Table 4 present the forecast error variance decomposition of the CRB commodity price, under the two SVAR model, based on the Excess_Liquidity1 and Excess_Liquidity3 respectively, up to 16 months.

From the variance decomposition it is observed that the excess liquidity condition has the ability to explain the movement of commodity price. Excess liquidity, estimated using M1 has better explaining power to forecast error variance of the commodity price than M3. After a period of 12 months, M1 based Excess Liquidity explains approximately 11% of variance decomposition compared to around 7% based on M3 measure. The empirical analysis thus indicates that during the sample period, commodity price is better explained by M1 than M3.

Steps	Standard Error	dLog(IIP)	dLog(CRB)	dLog(MSCI)	Excess_Liquidity1
1	0.033	0.800	99.200	0	0
2	0.036	1.812	90.941	7.095	0.151
3	0.037	3.130	88.638	6.828	1.404
4	0.037	3.882	85.841	6.732	3.545
5	0.038	4.281	83.329	6.782	5.608
6	0.038	4.527	81.398	6.787	7.288
9	0.039	4.768	78.551	6.701	9.979
12	0.039	4.794	77.864	6.670	10.672
16	0.039	4.794	77.734	6.662	10.811

Steps	Standard Error	dLog(IIP)	dLog(CRB)	dLog(MSCI)	Excess_Liquidity3
1	0.034	1.018	98.982	0	0
2	0.036	2.443	91.156	6.401	0.000
3	0.037	5.011	88.636	6.173	0.180
4	0.037	6.468	86.348	6.092	1.092
5	0.038	7.003	84.395	6.221	2.381
6	0.038	7.193	82.805	6.261	3.740
9	0.039	7.092	80.392	6.133	6.383
12	0.039	7.189	79.944	6.094	6.772
16	0.039	7.322	79.751	6.103	6.824

The impulse response functions of shocks given to the excess liquidity on the commodity prices indicate significant impact of excess liquidity on CRB commodity prices (Chart-5 and Chart-6). An increase in the excess liquidity, based on both the alternative measures, caused to an increase in the commodity price. The impact is found to be significant from 2 to 15 months in case of M1, while from 2 to 11 months in case of M3. The confidence bands are constructed using Markov Chain Monte Carlo (MCMC) method assuming the coefficients of the SVAR to follow beta distribution and the covariance matrix of the residuals to follow inverse Wishart distribution. Further, the impact on commodity price is found to be immediate in case of M1 based excess liquidity, while in case of M3 the impact starts after one month.

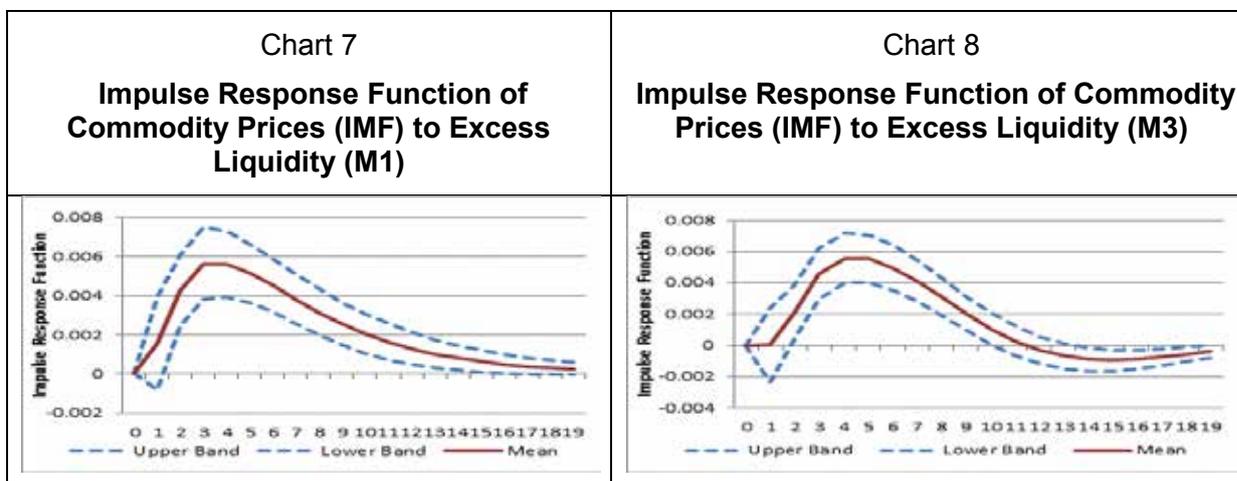


Next, an attempt has been made to estimate the impact of global liquidity on IMF commodity prices (IMF). Interestingly, it is found that the World Equity prices, that explain the CRB Commodity price by between 6.0 per cent to 7.0 per cent, can explain from around 11.0 per cent to 12.0 per cent of the forecast error variation of IMF commodity price. Among the two measures of liquidity, excess liquidity measured using M1 has better ability to explain the IMF commodity price than M3. Both the measures of global liquidity have almost similar ability to explain the commodity price variation, measured.

Steps	Standard Error	dLog(IIP)	dLog(IMF)	dLog(MSCI)	Excess_Liquidity1
1	0.036	1.228	98.772	0	0
2	0.039	1.838	85.556	12.285	0.321
3	0.040	2.690	82.905	12.706	1.699
4	0.041	3.346	80.360	12.464	3.830
5	0.041	3.671	78.249	12.300	5.781
6	0.042	3.861	76.698	12.194	7.247
9	0.042	4.072	74.592	11.956	9.379
12	0.043	4.109	74.096	11.888	9.907
16	0.043	4.116	73.987	11.872	10.025

Table 6					
Variance Decomposition of Commodity Prices (IMF)					
Steps	Standard Error	dLog(IIP)	dLog(IMF)	dLog(MSCI)	Excess_Liquidity3
1	0.037	1.458	98.542	0	0
2	0.039	2.445	86.396	11.159	0
3	0.040	4.459	83.886	11.393	0.262
4	0.041	5.880	81.522	11.163	1.435
5	0.041	6.383	79.409	11.089	3.119
6	0.042	6.485	77.775	11.034	4.705
9	0.042	6.356	75.719	10.736	7.189
12	0.042	6.512	75.392	10.706	7.391
16	0.043	6.636	75.145	10.719	7.500

The impulse response functions of shocks to the excess liquidity on the IMF commodity prices are found to be very similar to those of CRB commodity prices (Chart-7 and Chart-8). An increase in the excess liquidity, based on both the alternative measures, caused to an increase in the IMF commodity price. The impact is found to be significant from 2 to 15 months in case of M1 and from 2 to 11 months in case of M3. The impact on IMF commodity price is found to be immediate in case of M1 based excess liquidity, while in case of M3, the impact starts after one month.



6.3 Estimating the impact of excess monetary liquidity on commodity price using State Space Model

Further, exploration has been made to measure the impact of the excess liquidity on commodity prices (CRB) through the time varying parameter approach under a State Space Model, assuming constant volatility. Excess liquidity has been found to have significantly impact the CRB commodity price after 2 months. For this, the following specification has been made,

$$d\text{Log}(\text{CRB})_t = a_t + b_t(\text{Excess_Liquidity})_{t-2} + g_t d\text{Log}(\text{IIP})_t + d_t d\text{Log}(\text{MSCI})_t + u_t$$

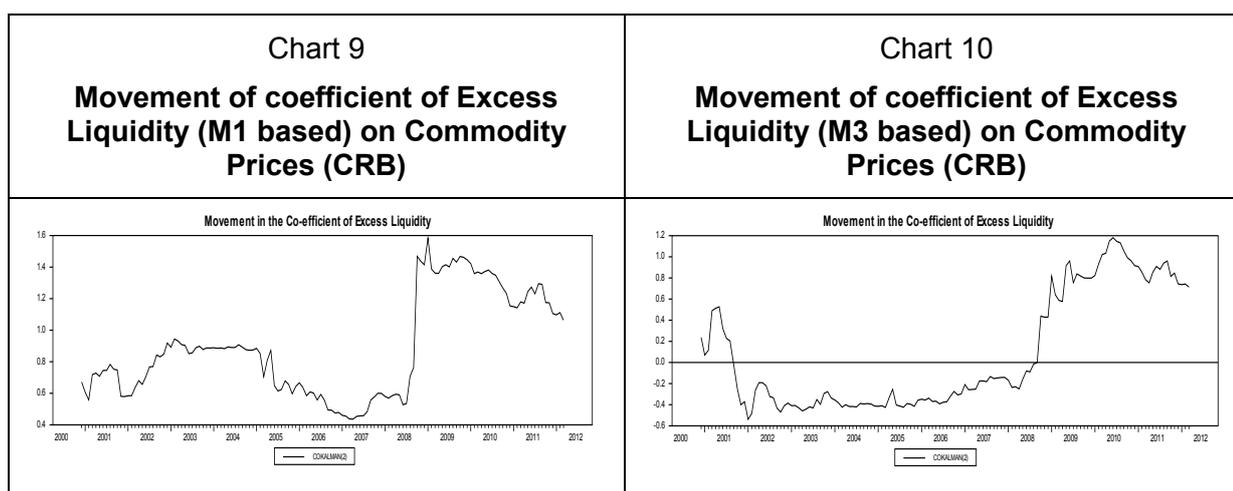
$$a_t = a_{t-1} + u_{1t}$$

$$b_t = b_{t-1} + b_{t-2} + u_{2t}$$

$$g_t = g_{t-1} + u_{3t}$$

$$d_t = d_{t-1} + u_{4t}$$

The estimates of the coefficient of excess liquidity on commodity prices (CRB) are presented in Chart-9 (M1 based) and Chart-10 (M3 based). The coefficient of M1 based excess liquidity has been found to be positive over the sample period and increased sharply during the crisis period and thereafter started to fall gradually. Thus an increase in the excess liquidity is expected to lead to significant increase in the commodity prices after 2 months and the impact has gone up sharply post financial crisis period compared to pre financial crisis period. The coefficient of excess liquidity, measured using M3, on commodity prices, was found to be negative in the pre-crisis period that became positive after the financial crisis. Post 2008, the coefficient of both the measures of excess liquidity on commodity prices has been found to be positive, indicating that an increase in the liquidity from its optimum path leads to an increase in the commodity prices. In the recent period from 2010 onwards, the coefficient of excess liquidity has shown a declining trend, suggesting lesser impact of liquidity on the commodity prices in the recent time period. The sharp increase in the estimate of the coefficient of excess liquidity on commodity price during the crisis period of 2008 lead to the suspicion of the constant volatility assumption.



Similarly, exploration has been made to measure the impact of the excess liquidity on IMF commodity price under the same State Space Model, with significant impact of excess liquidity on commodity price has been found to be contemporaneous. For this, the following specification has been made,

$$d\text{Log}(\text{IMF})_t = a_t + b_t(\text{Excess_Liquidity})_t + g_t d\text{Log}(\text{IIP})_t + d_t d\text{Log}(\text{MSCI})_t + u_t$$

$$a_t = a_{t-1} + u_{1t}$$

$$b_t = b_{t-1} + b_{t-2} + u_{2t}$$

$$g_t = g_{t-1} + u_{3t}$$

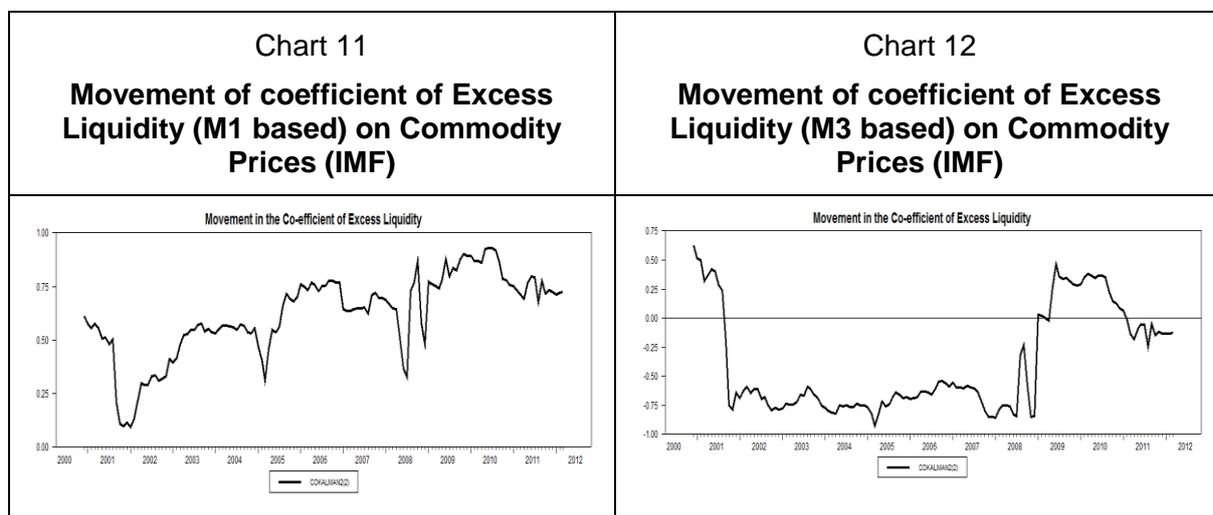
$$d_t = d_{t-1} + u_{4t}$$

The estimate of the coefficient of excess liquidity on IMF commodity price is presented in Chart-11 and Chart-12. The estimates of the impact of M3 based excess liquidity on both the measures of commodity prices are found to be very similar, while the impact of M1 based excess liquidity on IMF commodity prices is found to be volatile.

Chart-11 indicates that the impact of global excess liquidity, measured using M1, has shown an increasing trend since 2001, amid with a volatile movement. This suggests that an

increase in the M1 based excess liquidity is expected to lead to an increase in the IMF commodity price.

Chart-12 presents the coefficients of M3 based excess liquidity on commodity price. The coefficient of M3 based excess liquidity that has been estimated to be negative from 2001 to 2008, had sharply increased to positive after the crisis of 2008. The coefficient of the measure has shown a declining trend since 2010, suggesting lesser impact of liquidity on IMF commodity price in the recent period.



6.4 Estimating the impact of excess monetary liquidity on commodity price using Time Varying Vector Autoregression with Stochastic Volatility (TVP-VAR) Model:

Alternatively, attempt has also been made to estimate the impact of excess liquidity on commodity price using Structural VAR with stochastic volatility model proposed by Primiceri (2005). A brief write-up on the methodology of TVP-VAR is given in Annex-I. The model consist of the variables output, commodity price, equity price and global excess liquidity. The model has been formulated as – output will be impacted by all other variables with a lag only. Commodity price is impacted by output contemporaneously. Equity price is assumed to be contemporaneously impacted by output and commodity price, while global excess liquidity is assumed to have been impacted by all the other three variables contemporaneously. One major advantage of the TVP-VAR methodology is its ability to measure the impact of shocks given to a variable on other variables at different time points. Accordingly, the impact of excess liquidity on commodity price has been presented at three time point viz. February 2001, September 2005 and August 2009. The last time point presents the impact of excess liquidity on commodity price after the financial crisis of 2008.

Chart-13, Chart-14 and Chart-15 presents the impulse response function of M1 based global excess liquidity on CRB commodity price during February 2001, September 2005 and August 2009 respectively. The thick line indicates the posterior mean of responses to shocks given to excess liquidity. The two dotted lines present the response of the 85th and 15th percentile of shocks given to excess liquidity on commodity price.

It is observed that a shock given to excess liquidity during February 2001 leads to an increase in the commodity price and reach its peak after three months and then starts decline gradually. As against this, a shock given during September 2005, leads to an increase in the commodity price from the second month and sustain the peak between the third to the fifth month. However, a shock given in August 2009 is found to be sharper and reach the peak after three months.

Chart-16 presents the sum of the coefficients of the excess liquidity on commodity price. From the chart it can be observed that the impact of excess liquidity on the commodity price has gone up since the mid of 2005 and remained flat since 2010 onwards.

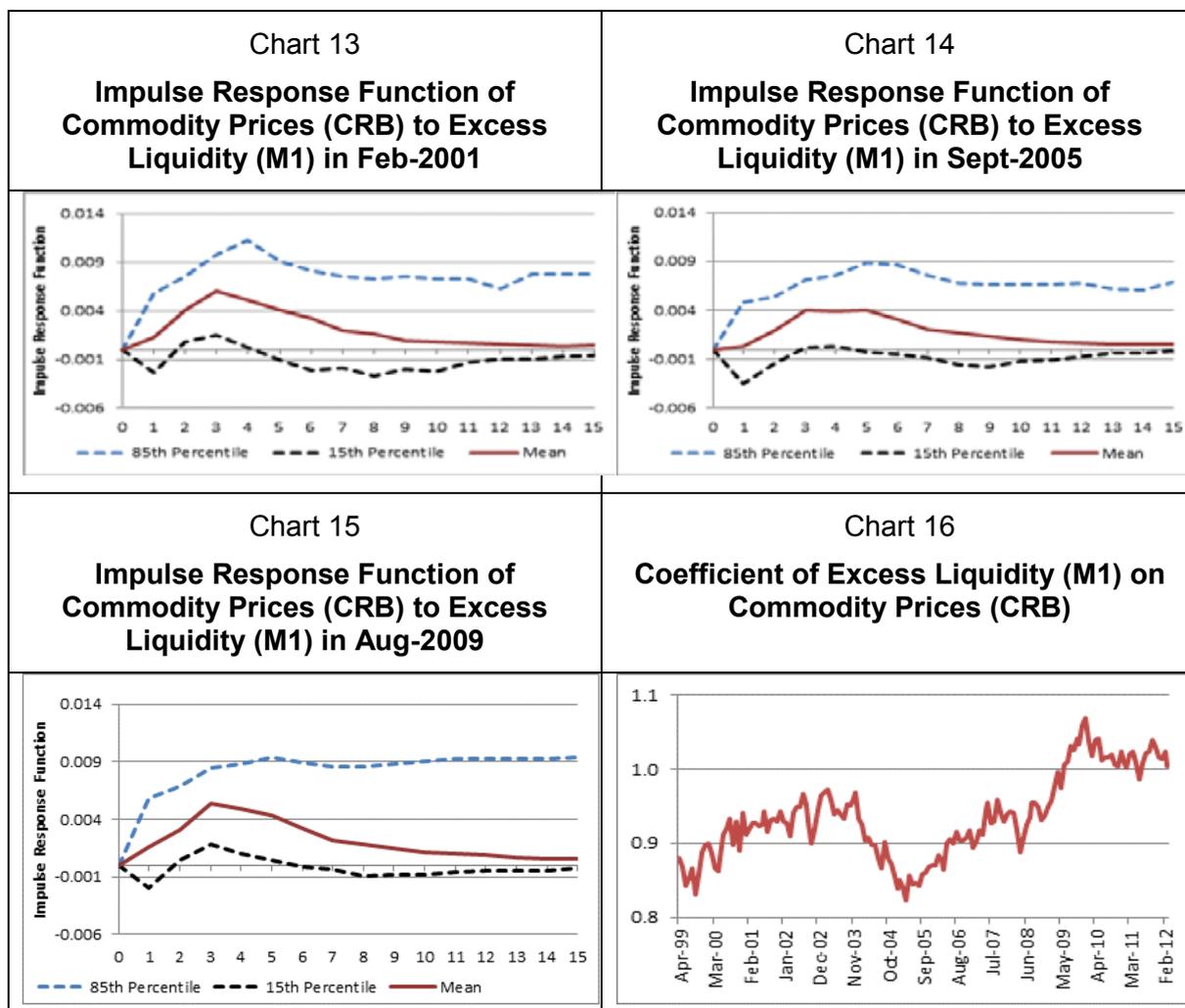


Chart-17, Chart-18 and Chart-19 presents the impulse response function of excess global liquidity, measured using M3, on CRB commodity price during February 2001, September 2005 and August 2009 respectively. Empirically, it has been found that M1 based excess liquidity on CRB commodity price is higher than the M3 based excess liquidity.

Empirically, it has been found that a shock to excess liquidity during February 2001 leads to a fall in the commodity price after one month, while a shock given during September 2005 is found to have no major impact on commodity price till one month and increases slowly thereafter. The impact is found to be more in September 2005 than February 2001. As against this, a shock given to excess liquidity in August 2009 is expected to lead to a sharp increase commodity price immediately. Further the impact during August 2009 is found to be higher than those prior to the financial crisis period of 2008. The maximum impact was observed after three months at all the three time points.

Chart-20 presents the sum of the coefficients of the M3 based excess liquidity on commodity prices. The impact of excess liquidity on the commodity prices has been found to have gone up since the mid of 2005 and thereafter started decline since 2010. The finding of moderation of impact of excess liquidity on commodity prices in the recent period is consistent with those

estimated using State Space Model with constant variance in the previous sub-section. Further the impact is found to have been more for M1 based excess liquidity than M3.

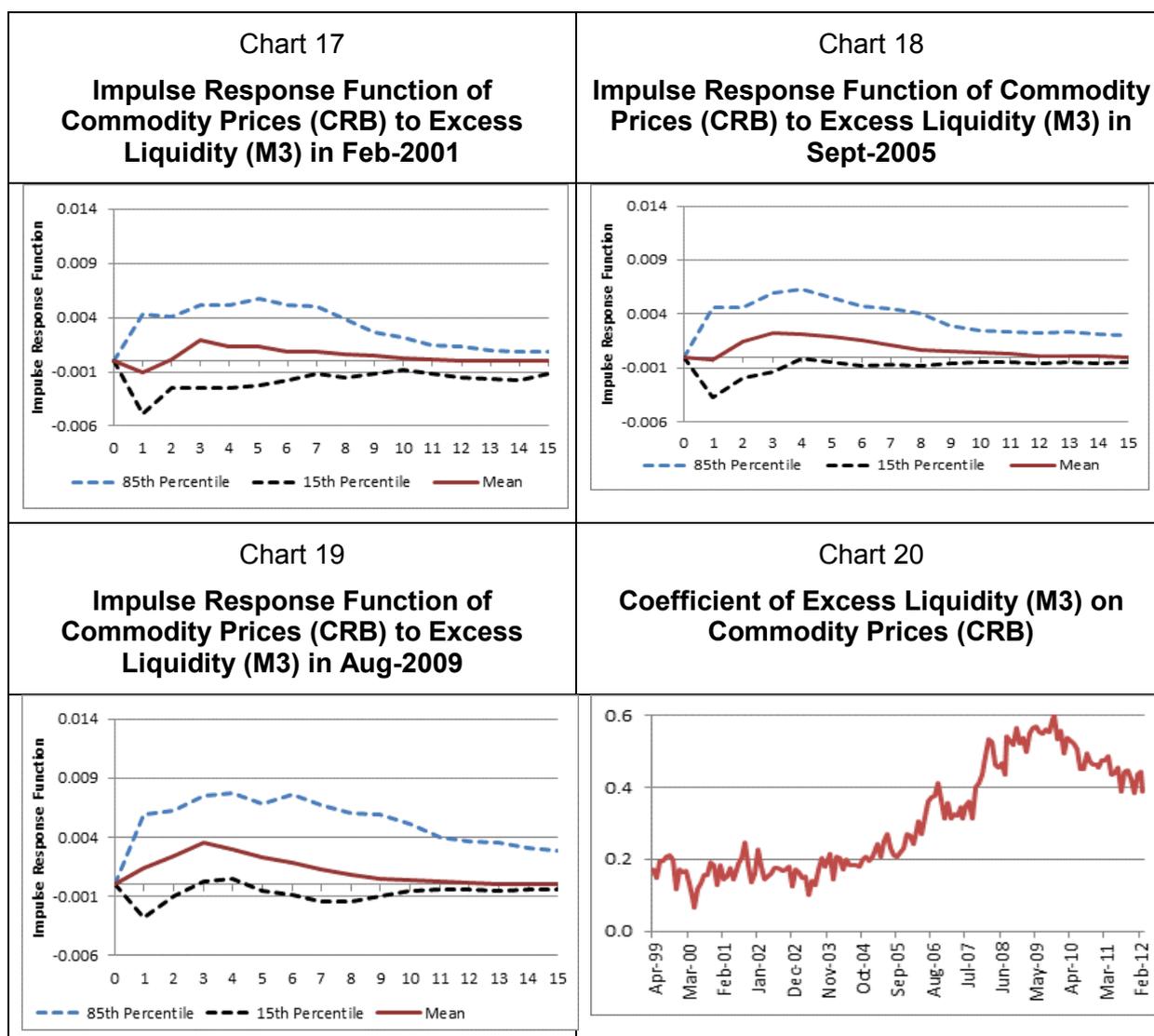


Chart-21, Chart-22 and Chart-23 presents the impulse response function of M1 based excess liquidity on IMF commodity price during February 2001, September 2005 and August 2009 respectively. The impulse response function indicates that a shock given in August 2009 to excess liquidity on commodity price is sharper and higher than the previous two time points.

Chart-24 presents the sum of the coefficients of the M1 based excess liquidity on IMF commodity price. The impact of excess liquidity on the commodity prices has been found to have gone up since the mid of 2005. The finding is found to have been in consistent with CRB commodity price.

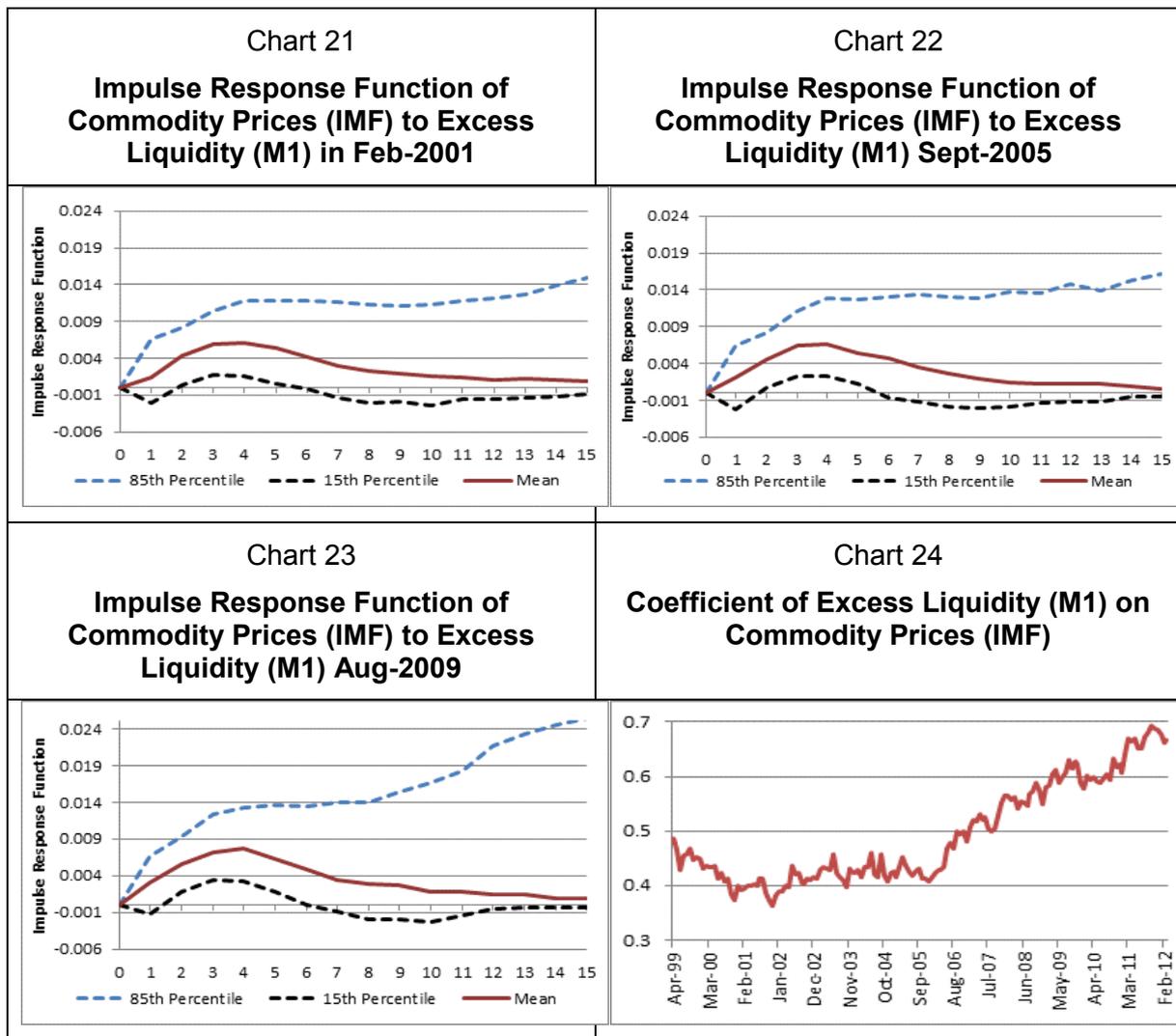
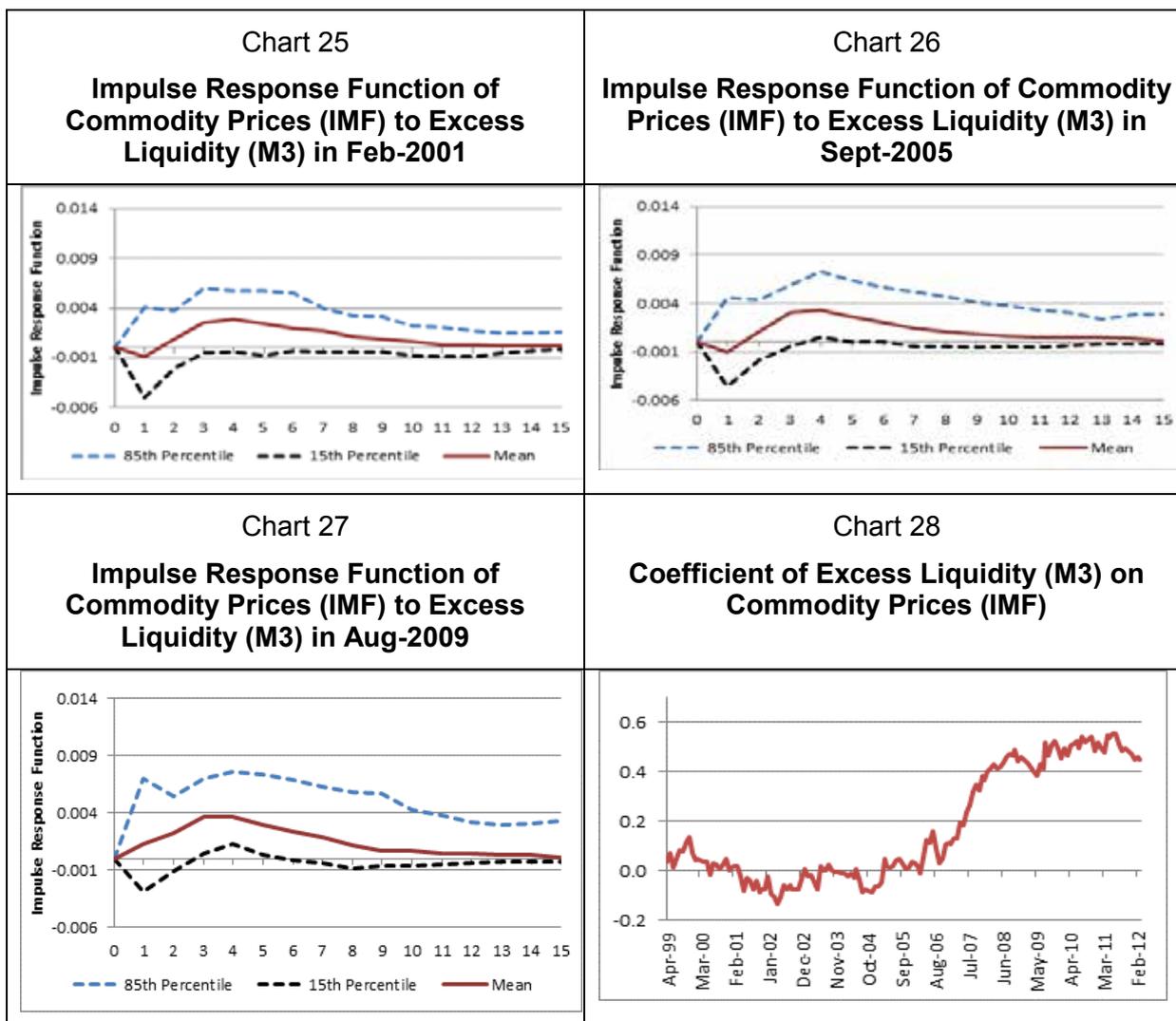


Chart-25 to Chart-27 presents the impulses response function of M3 based excess liquidity on IMF commodity prices for the same three time points. The impulse response function indicates that a shock given to M3 based excess liquidity on IMF commodity price is sharper and higher than the previous two time points. A shock given in February 2001 is expected to lead to an increase in commodity price at a slower rate than at the other two time points. Further, empirically it has been found that a shock to M1 based excess liquidity will have more impact on IMF commodity price than M3 based excess liquidity.

Chart-28 presents the impact of M3 based excess liquidity on IMF commodity price. It is observed that the impact of excess liquidity on commodity price has gone up since 2005 and remained firm since 2010.



7. Conclusions

In the recent time, the international commodity prices have experienced large fluctuations. Steep rise in commodity prices were observed till the financial crisis of 2008 and was followed by a sharp decline during the peak of the financial crisis. Since the early 2009, prices of major groups of commodities rose at a historically high level. Alternative views exist regarding the drivers of the commodity price developments. One view attributes the fundamental demand-supply factors while the other view attributes financialisation of commodities as the drivers of commodity price. In this background, this paper tries to explore whether global liquidity has a role in driving the commodity prices and also to test whether the speed of impact has changed post financial crisis of 2008. For empirical analysis, this paper uses the Time Varying Structural VAR- with Stochastic Volatility (TVP-VAR) to measure the impact of global excess liquidity on commodity prices. The estimates of TVP-VAR have been compared with the Simple Structural VAR and State Space Model assuming constant volatility. Empirical analysis suggests excess global monetary liquidity plays a significant role in explaining surge in both spot and future commodity prices. Excess liquidity, measured using M1 has been found to have more impact on commodity prices than M3. Further impact of shocks given to excess liquidity on commodity prices has also been found to have been sharper and higher post financial crisis of 2008 than the pre-crisis period. Also, empirically it has been found that, the impact of excess liquidity on commodity prices

has gone up since 2005. The impact of M1 based excess liquidity on IMF commodity prices have found be increasing throughout the sample period while those of M3 based excess liquidity have been remained firm at the same level since 2010. As against this, the impact of M1 based excess liquidity on Reuter-Jeffery CRB commodity price has remained at the same level since 2010, while M3 based excess liquidity has declined since 2010.

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