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Article

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Global liquidity and commodity prices uncertainty using SFAVEC model

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A B S T R A C T

This paper examines the impact of global liquidity on global commodity prices and asset prices in some major developing and developed economies. Specifically, the global liquidity on global commodity prices and asset prices is investigated using data from six major developing and emerging economies; Brazil, Russia, India, China, South Africa and Mexico (BRICSM) and four major developed economies; Canada, the European Union (EU), Japan and the US (G4) over the period 1999:01 to 2019:12. Chakraborty and Bordoloi (2019) report that global liquidity positively impacts commodity prices over time. A structural factor-augmented vector error correction model which allows for a partition among short-run and long-run is estimated. Again a robust evidence of global liquidity leads to significant and persistent upsurges in global commodity prices and global asset prices. The key finding is the positive innovations in BRICSM M2 that are linked with a positive effect on the commodity prices that is more than the impact of unexpected increases in G4 M2 on commodity prices. The commodity price uncertainty is attributed to commodity price volatility in developed and developing countries, with the uncertainty effect being more significant and persistent in emerging economies.

1. Introduction

Over the year's financial researchers and policymakers have been fascinated by the impact of global liquidity on global commodity prices. Financial economists have made great advances in understanding the factors that create global liquidity on global commodity prices and the economic consequences in many countries. Many of the methods in this study is built on such economic models. The impacts of global liquidity on global commodity prices, goods prices inflation and the volatility of asset prices are persistent. The empirical evidence of persistence inspired by Ratti and Vespignani (2015) who used a structural factor-augmented vector error correction (SFAVEC) model to examine liquidity in some developed and emerging economies on commodity prices. The study found that emerging countries liquidity are essential and persistent in commodity prices relative to increases in developed countries liquidity, and the dissimilarity surges over time. Increases in liquidity in emerging economies have much more consequences for global commodity prices compared to developed economies. The 2008 commodity price increase, coupled with loose monetary policy and persistently low-interest rates, are significant matters that fueled the price hike (Hamilton, 2009). Belke et al. (2010) examine the impact of global liquidity shocks on goods prices and asset prices and report that global liquidity has a considerable effect on goods prices but not asset prices and argue that global liquidity needs similar attention as the current interest rate. The study reports that excess global liquidity is a significant determinant of asset and good prices and has three monetary policy implications. Hashmi and Bhatti (2019) investigate the dynamics of theoretical and atheoretical methods of global liquidity using monthly data. They demonstrate that theoretical approaches are better than atheoretical measures within the actual description of financial and liquidity settings.

Even if prior studies suggest a link between global liquidity and global commodity, the link between global liquidity, global commodity and volatility effects on global commodity prices remains unexplored. The study therefore, explores the relationship between the global liquidity, global commodity and volatility effects on global commodity prices using a structural factor-augmented vector error correction (SFAVEC) model and the extent to which they can be explained by short-run and long-run.

In this paper, the impact of global liquidity on global commodity prices and asset prices is examined using six major developing and emerging economies; Brazil, Russia, India, China, South Africa and Mexico (BRICSM) and four major developed economies; Canada, the European Union (EU), Japan and the US (G4). This seeks to establish an empirical link between global liquidity, commodity prices and asset prices. Ideally, global liquidity (M2) is a proxy for monetary aggregate in emerging and developed economies. M2 was used for global liquidity of the monetary aggregates in US dollars for both BRICSM and G4

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economies over the period 1999:01 to 2019:12. Beckmann et al. (2014) applied a Markov-switching vector error correction model (MS-VECM), which permits a division among long-run and time-varying short-run dynamics. They argue that the impact of global liquidity increases due to increases in commodity prices over time. Chakraborty and Bordoloi (2019) report that global excess liquidity positively impacts commodity prices over time. Excess liquidity represented by M1 has more influence on commodity prices than M3. Belke et al. (2012) argue that food and commodity price inflation are caused mainly by the expansion within the developed economies and their term financialization. Moussavi (2015) investigated the impact of global excess liquidity on asset prices in BRICS economies and reported that excess global liquidity instigates momentous surges in asset classes, a genuine appreciation of exchange rates and a fall in 10-year sovereign interest rates. Giese and Tuxen (2007) report that an increase in global liquidity at the beginning of 2001 raised inflation and interest rates and house prices; however, restricted impact on stock prices and central banks ought to be concerned with liquidity glut. Brana et al. (2012) find that excess global liquidity has spillover effects on output and price levels on emerging economies which has a considerable impact on emerging economies' financial stability.

The elasticity of supply and demand adjusts with the period under consideration in that supplier and buyers take time to adjust to a difference in price pattern. The maximum adjustment of price, demand and supply to a condition of disequilibrium will not be immediate. However, these disequilibria in these markets will correct themselves through price adjustment. Commodities said to have a low elasticity display instant price increases, but those commodities' response with high elasticity is unresponsive. From a theoretical point of view, global liquidity will increase coupled with a rise in aggregate demand that will boost commodity prices. Akram (2009) reports that many commodities are priced in US currency in international markets. A decrease in the value of the US currency increases the cost and, therefore, commodity demand of foreign consumers while reducing foreign commodity suppliers' returns and possibly their supply. Some economists argue that the long-run effects of money depend solely on prices. However, the impact of monetary impulses on actual variables in the short run remains receptive dialogue which is still open to debate in the literature (Walsh, 2010).

Emerging economies are very important and significant in population, size, and international trade, reflecting an increasing role in global economies and global liquidity. In terms of purchasing power parity (PPP), we have two emerging economies among the top five world economies, China and India. The five largest world economies are Eurozone, the US, China, Japan, and India account for 65 % of the world economy. The global liquidity and global commodity prices are investigated with six majors developing and emerging and four major developed economies. The structural factor-augmented vector error correction model to examine the effect of BRICSM M2 and G4 M2 innovations on global commodity prices. There is an extant body of empirical work on global liquidity, but only a few studies look at the potential nonlinear effects on global liquidity. The strand of literature that has used the nonlinear model, include, but not limited to, the following: Belke et al., 2010; Brana et al., 2012; Beckmann et al., 2014; and Ratti and Vespignani, 2015. Global liquidity is an elusive concept. Theoretically, global liquidity is a broad money concept that comprises the M2, among other things.

This article used a structural factor-augmented vector error correction (SFAVEC) model, which allows for a partition among short-run and long-run links to an underlying model. The model permits us to differentiate between short-run and long-run relations suggested by economic theory. Admittedly the ECM terms create some gradual adjustment process, yet it is still a constant adjustment to disequilibrium activity. An SFAVEC model captures better the effect of global liquidity on global commodity prices and global interest rates, global CPI and global trade of goods in developing and emerging and developed economies. These variables are parallel to those used somewhere else in the literature. We tend to use this methodology for six emerging economies (6 BRICSM) and four developed economies (G4) data, employing a different approach from the prevailing literature. Given the general nature of interdependencies within the world economy, it is appropriate that all the country-specific variables and global factors are regarded endogenously (Dees et al., 2007). The focus is on the dynamics of interdependence between global liquidity, commodity prices and interest rate, CPI and trade of goods in developing and emerging economies and developed economies. The generalized impulse response function (GIRFs) and structural impulse response function (IRFs) are also computered an endogenous determination of a global liquidity shock. The model's innovation is to explore linkages and the transmission of shocks from emerging economies to developed economies, long-run trend in an emerging market to long-run trends in the G4 market (Syriopoulos, 2011; Belke et al., 2012).

This paper is related to a large literature on principal components and factor analysis. The literature on principal components and classical factor models is enormous and well-articulated (Bernanke et al., 2005: Laganà, 2009; Ratti and Vespignani, 2015), and these dynamic factor models have been applied. Despite numerous empirical studies, there is no consensus on global liquidity on global commodity prices and the used of principal components and classical factor models. There are still unresolved vital problems, regrettably thus far none of the empirical studies have been proven to be conclusive. The study seeks to point out limitations and research gaps in the literature to date and indicate how they are addressed. We spell out why and how our study will add value to the existing literature. This paper seeks to address the following numerous questions in the literature and investigate thoroughly:

1. why global liquidity has changed over time?
2. will global liquidity affect the commodity prices?
3. what proportion are the dynamics effects on the economy over time and what are the volatility effects?.

The relevance of the proposed procedure is to analyze empirically the dynamic changing relationship between structural global liquidity shocks and commodity price using a structural factor-augmented vector error correction model that captures better global liquidity expansion condition. Moreover, we are not aware of any study which investigates commodity price dynamics pattern of price adjustment to a global liquidity shock in a logical approach. An SFAVEC model is the preferred model specification relative to the standard VAR model. Bernanke et al. (2005) principal component approach to non-stationary monthly of major developed economies and developing economies data was used as well as employing different method from the prevailing literature.

The main contribution that this article makes to the literature is to establish an empirical link between global liquidity and commodity prices. Hence, the originality in this study is acknowledgement of the impact of liquidity on commodity prices in liquidity in 6 BRICSM and G4 economies. Secondly the study aims at contributing to the literature on the volatility effects on global commodity prices. The third objective is to model some country-specific macroeconomic variables such as interest rates, CPI and trade of goods composed in the vector form. The real-world economy's overall interdependencies show that all the country-specific variables and international factors are endogenous. Finally, this study is among the few papers that investigate matters concerning the global liquidity and employs a structural factor-augmented vector error correction model that permits for a partition among short-run and long-run. Hence, it is predicted that a structural factor-augmented vector error correction model can show a lot of extreme reliance relative to the standard VAR. Under the vector error-correction model, the variables are not far from each other once long-run equilibrium circumstances are used (Engle and Granger, 1987). This methodology proved to be a sensible and pragmatic one. We employ different indicators to distinguish the importance of global liquidity has significance impact on commodity process and asset prices being studied within the major emerging and developed economies. The model's innovation or originality uses a structural factor-augmented vector correction model to establish an empirical link between global liquidity and commodity prices in BRICSM and the G4 economies. This model has many innovation implications that link global liquidity to commodity prices. Theoretically, surges in liquidity are associated with growth in aggregate demand that will surge in commodity prices, thus the emphases on the impact of global liquidity differentiate between short-run and long-run over time. Therefore, this paper extends this quantitative method to investigate the link between global liquidity on global commodity prices and asset prices in emerging and developed economies.

To summarize our results, the study finds that the BRICSM M2 has more significant impact on positive shocks than that of positive shocks in G4 M2. Specifically, BRICSM M2 increased significantly to about 13.2 billion in US dollars against 13.0 billion in G4 M2. We tend to attribute BRICSM M2 increase to economic reforms. One of the key findings is the positive innovations in BRICSM M2 that are linked with a positive effect on the commodity prices which is more than the impact of unexpected increases in G4 M2 on commodity prices. The commodity prices uncertainty is attributed to commodity price volatility in developed and developing countries, with the uncertainty effect being more significant and persistent in emerging economies. The study found that BRICSM M2 and G4 M2 and commodity prices are cointegrated. Again there are no portentous difference between GIRFs and IRFs, and the results of the finding were very similar. The forecast error variance decomposition's empirical analysis showed that commodity prices volatility is more pronounced in developing and emerging economies than in developed economies.

Two decades ago, the world witnessed excess global liquidity from the developed economies to the benefit of emerging economies, fueling undue volatility in capital inflows and commodity prices. In the face of the global covid 19 pandemics, global liquidity, in the form of capital inflows from developed economies to emerging economies, scaled back drastically and had stimulating effects on the emerging economies' monetary stability. Most of the developed economies have numerous economic responsibilities to stabilize their domestic economies. For instance, concerning emerging economies, the global financial crisis has long-established that progresses in emerging economies still rest well on developed economies. Furthermore, as pointed out by International Financial Services (IFS), the capital inflows to emerging economies have trended downward over time considerably from $1,200bn in 2008 to $622bn in 2009 due to the financial crisis that erupts the world stock markets.

This paper's remaining sections are as follows: Section two presents the literature review on international liquidity. Section three describes the methodology applied in the study, data set and how we measure global liquidity. Section four presents the key findings of this study. The final section concludes this paper.

2. Literature review

In this section, the conceptual background to the more advanced theoretical perspectives and state-of-the-art empirical work of research literature. The full adjustment of price, demand and supply to a condition of disequilibrium will not be instant. It is essential, consequently, to analyze the time path which demand takes in responding to changes in supply, and which supply takes in responding to changes in demand. Elasticity changes with the time dimension under consideration. Both the producers and consumers take time to act in response to a change in price. The longer the time dimension, the larger the response, and the greater the elasticity of supply and demand. If prices are expected to change in the near future, this will affect the behaviour of buyers and sellers. Many commodity prices are decided in global markets affected by global supply and demand impacts. Global liquidity can influence commodity prices and asset prices has been examined in the literature. Using a structural vector autoregression (SVAR) on global liquidity to deal with the short-run relationship between global liquidity and commodity prices, Kang et al. (2016) found that global liquidity has had a significant effect on commodity prices since the financial crisis in 2009. The authors claimed that a price-based liquidity indicator has a superior explanatory power for the commodity price dynamics than monetary aggregates.

Commodity prices are understood to be a chief indicator of inflation through two basic networks. Chief indicators frequently display measurable economic transformations before the economy as a whole does. There is one theory that indicates that commodity prices react speedily to overall economic shocks such as upsurges in demand. The next indicates that changes in prices echo total shocks, which can reduce the supply of goods and services and consequently increase the costs of supply. The compelling circumstance for commodity prices as a chief indicator of expected inflation is that commodities react speedily to general economic shocks. These kinds of incidences imply that commodity-inflation movements hang on what is propelling the commodity change. Darius and Radde (2010) showed that global liquidity substantially impacted house prices, however, it had insignificant effect on equity prices and oil prices. They further argued that domestic factors contribute to a rise in house price compared to international factors. Miguel and Andrea (2006) used a structural vector autoregressive (SVAR) and found that global monetary aggregate declines significantly while significantly global liquidity aggregate surges.[1] The crucial point is that monetary policy and its impact on prices can lower interest rate, consequently increase demand in commodity prices. In their empirical work, Baffes and Savescu (2014) reported that the long-term interest rates on commodity prices increase considerably. Baks and Kramer (1999) found a negative correlation between real short-term interest rates and stock return volatility. Notice that a negative correlation between two assets describes two series that move in opposite directions.

Dees et al. (2007) use a global VAR (GVAR) model to explore the Euro area. Their results showed that economic shocks transmission from the US to the Euro area is of interest to researchers in finance and policymakers since the US and the Euro areas are the two largest economies. Ideally, one may expect that the impacts of financial shocks can be enlarged from the US to the Euro area through recessions of various channels. Using both structural factor model and structural VAR approaches, Fonri and Gambetti (2010) pointed out that the factor model is in sharp contrast with those obtained with the VAR model. Their results showed that bilateral real exchange rates react contemporaneously with sizable increases in monetary policy shock. Notice that the monetary policy shocks have significant effects on the dynamic side of changing aspect of both real and nominal variables.

The literature has found that oil price-driven by positive shocks precautionary demand. Considering the relation between oil price-driven and demand shock, Anzuini et al. (2015) reported that shocks to precautionary oil demand justified the US recession of the early 1990 s and 2000 s. They further argued that "positive precautionary demand shocks increase oil inventories, differently from generic oil spot price increases that cause inventories to be drawn down'' (p. 969). According to the authors, swollen economic uncertainty raises both volatility and the term premium on 10-year Treasuries thanks to positive shocks to the oil's precautionary demand. Using a structural vector autoregressive (SVAR), Anzuini et al. (2013) tested the impact of monetary policy shocks on commodity prices and found that monetary policy shocks

[1] Sims (1992) uses structural vector autoregressive (SVAR) to explore the effects of monetary policy to show that monetary policy shock impacts the increase in commodity prices. Similarly, Kim (1999) uses structural vector autoregressive (SVAR) to identify monetary policy assumptions across countries and find that financial shocks impact increasing commodity prices. Both studies are consistent with numerous previous studies.

surge commodity price in all its components significant but not tremendously huge. Belviso and Milani (2006) reported that monetary policy shock has positive surprises to the federal funds rate decreases industrial production and inventories, whereas the unemployment rate increases.

Another strand of literature has centered on exploring different variables. Using a macroeconomic dataset of the US, Chudy and Reschenhofer (2019) found that the forecasting performance strongly depends on the number of contained factors. Munir and Qayyum (2012) examine the effects of Pakistan's monetary policy using both the Factor Augmented VAR (FAVAR) model and standard VAR model. They found the FAVAR model performed well than the standard VAR model. The FAVAR model describes the effects of monetary policy consistent with the theory compared to the standard VAR model. Kronick (2014) examined monetary policy shocks from the EU and the US to sub-Saharan Africa countries with a floating or fixed exchange rate regime using a structural VAR (SVAR) model. He finds that, following shock, floating exchange rate countries have a generally negative GDP response, whereas fixed exchange rate countries have mixed GDP responses. Spiegel and Tai (2017) investigated the international transmission of Japanese monetary shocks with its major trading partners, Korea, China and the U.S., using a global FAVAR model. The authors proved that shocks to 2-year Japanese rates do have considerable influences on Japanese economic activity. They found that only small global spillovers from Japanese monetary policy shock to its major trading partners.

In the literature quite a lot of theoretically and empirical arguments have been advocated to justify the strength and weakness of several model specifications in the realm of global liquidity on commodity prices and asset prices. Stock and Watson (2002) reviewed a list of the other possible reasons for the number of methodological issues.

There are several methods of measuring global liquidity. Some researchers used the floating exchange rate regimes while others employed fixed exchange rate regimes of individual countries. Using two different regimes of measurement will automatically cause significant differences in individualized country analysis. Given the circumstances surrounding the measurement, the literature has not been able to categorically state which of the two regimes, floating or fixed exchange rate regime best suit the measurement. However, comparative analysis revealed that their findings are not qualitatively or quantitatively different.

specification. The SFAVEC model is parsimonious that can model a large quantity of information set. The SFAVEC model's sensitivity is an extensive information set, essentially incorporating all variables macroeconomic data; thus, more significant information sets of economic instruments are maintained. Conversely, a VEC model may be a problem because of a small number of variables that may apply in both estimation and identification. Therefore, it may be inappropriate for this paper. According to Lagana (2006, p. 1751), the VEC model is misspecified due to policymakers' small information set. Moreover, a VEC model might cause a Type-I error since its power is feeble.

To estimate the model, Bernanke et al. (2005) and Ratti and Vespignani (2015) principal component vectors is followed in a simultaneous equation method to build a structural factor-augmented error correction model. The principal components can be controlled according to the variation from the original set of predictors explained by each component (Chudý and Reschenhofer, 2019). The present study uses international and global interchangeable variables. The global variables are structural factors estimated by principal components. M2 is used for liquidity for the BRICSM economies and M2 for G4 economies; global commodity prices, global variables, global interest rates, global trade of goods, and global consumer price index (CPI). As already stated, there is a tendency to use one factor for global interest rate, global trade of goods and global CPI to maintain parsimony within the model. A structural factor-augmented error correction model is stated as follows:

$$B_o X_t = \beta + \sum_{i=1}^{j} B_I X_{t-1} + \delta ECT1_{t-1} + \theta ECT2_{t-1} + \varepsilon_t \tag{1}$$

where B_O is an $n \times n$ matrix of identifying restrictions, Bi, $i = 1,\ldots, j$, are $n \times n$ matrices of autoregressive coefficients, the optimal lag length j is determined using Schwarz information criteria, X_r is a vector of endogenous variables, ε_{1t} and ε_{2t} as the error correction term, i.e. $ECT1_t = \varepsilon_{1t}$and $ECT2_t = \varepsilon_{2t}$ are the error correction terms for liquidity and commodity prices and liquidity, global trade of goods and global prices, in that order, and ε_t is the vector of structural changes, which is serially and mutually independent. The objective is to model some country-specific macroeconomic variables such as interest rates, CPI and trade of goods composed in the vector form. In a real-world economy, overall interdependencies show that all the country-specific variables and international factors are endogenous.

The vector X_t expressed as:

$$X_t = \left[GIR_{t,}\, \Delta\log(G4\,M2_t),\ \Delta\log(BRICSM\,M2_t),\ \Delta\log(GCPI_t),\ \Delta\log(GTOG_t),\ \Delta\log(COM_t)\right] \tag{2}$$

3. Methodology

3.1. The model

The changing relationship between global liquidity and commodity price is empirically examined using a structural factor-augmented vector error correction model. A structural factor-augmented error correction (SFAVEC) model is estimated using endogenous variables, the three factors, the two indicators of the M2 monetary aggregate for developed and emerging countries, and the commodity price index, using the principal component approach. As evidenced from the literature review to date, only a few researchers have used this model to estimate liquidity and commodity prices. A structural factor-augmented vector error correction (SFAVEC) model is the preferred method relative to the standard VEC model. The standard VEC model presupposes a small number of user variables. The model may be an essential factor in model selection on the assumption that an SFAVECM is the preferred model

An identification assumption in the SFAVCE model, the monetary transmission instrument, is that monetary policy shock is orthogonal to the variables. Economic variables in the central bank's information set do not react contemporaneously to the understandings of the monetary policy shock, and as such, the variables are exogenous to policy shock (Munir and Qayyum, 2012). Note that the central bank's information, coupled with contemporary nature, is significant in identifying exogenous monetary policy shock. Khan (2008) examined the monetary policy change on output and inflation and concluded that the transmission mechanism is much quicker in the consumer price index than in the industrial production index. Our choice of structural identification scheme based on generalized impulse response function (GIRF), proposed by Koop et al. (1996) and modified by Pesaran and Shin (1998) is chosen rather than the orthogonalized impulse responses (OIR) since one of the main aims of this paper is to use the GIRF approach.

3.2. Identification

The theoretical motivation for choosing identification restrictions is based on the earlier works of Koop et al. (1996), Pesaran and Shin (1998) and (Dees et al., (2007). This study follows the approaches by Koop et al. (1996), Pesaran and Shin (1998) and (Dees et al., (2007) to evaluate the generalized impulse response function (GIRF) and structural impulse response function (IRFs) to attain a sensible structural identification scheme specified in the literature in the area. This study evaluates distinct alternative contemporaneous restrictions grounded on typical assumptions in the literature. A sequence of diagnostics is assessed, equally through graphical techniques, to explore the dynamics of the transmissions of shocks in the model's structural system. Identifying factors is habitually challenging, particularly when is hoped to give them economic clarification (Dees et al., 2007). The GIRF is invariant to ordering the variables and the countries in the SFAVEC model, which is undoubtedly a significant reflection (Dees et al., 2007). The authors highlight that GIRFs can offer valuable information on the dynamics of the transmission of shocks. The interest rate reacts contemporaneously to money (G4 M2 and to BRICSM M2), and the BRICSM M2 depend on the price level and real activity. The generalized impulse response function can provide helpful information on a structural shock's dynamic effect on macroeconomic variables.

The model's identification is completed by asking the following two questions:

1. what is the extent to which commodity prices procured to be contemporaneously exogenous to all variables in the SFAVEC model?
2. what is the time to which commodity prices impact consumer prices and trade of goods contemporaneously, the underlying structural shocks, particularly those to monetary policy?

Using identifying restrictions on structural shocks associated with the data; innovations will be precise once the structural shocks are identified. A log-likelihood ratio (LR) test statistic due to Sims (1980) for over-identification restrictions to evaluate the most appropriate condition for the data is used. The following structural model is obtained based on the likelihood test results.

$$B_0X_t = \begin{bmatrix} 1 & -b_{12} & -b_{13} & 0 & 0 & -b_{16} \\ -b_{21} & 1 & 0 & -b_{24} & -b_{25} & 0 \\ -b_{31} & 1 & 0 & -b_{34} & -b_{35} & 0 \\ 0 & 0 & 0 & 1 & -b_{45} & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ -b_{61} & -b_{62} & -b_{63} & -b_{64} & -b_{65} & 1 \end{bmatrix} \begin{bmatrix} GIT_t \\ \log(G4M2_t), \\ \log(BRICSMM2_t), \\ \log(GCPI_t) \\ \log(GTOG_t) \\ \log(COM_t) \end{bmatrix} \tag{3}$$

The identification scheme follows Kim (1999) and Anzuini et al. (2013). In Eqn. (3), commodity prices are contemporaneously endogenous, and Anzuini et al. (2013) indicate that the primary line is the interest rate. It is a money-supply equation modelled as a response function of the monetary authority. They assumed that due to information adjournments or postponements, the current price and goods' trade is not obtainable to the monetary authority. The second line is a money-demand equation in which demand for real money balances hinge on actual activity and the opportunity cost of holding money. The third and fourth lines summarize the hypothesis of price stickiness and adjustment costs: the real movement reacts to price and financial signals only with a lag to innovations on the variables. Lastly, equilibrium within the artefact market, within which arbitrage in a very financial market presupposes all variables, have contemporaneous impacts on commodity prices. Belviso and Milani (2006) showed that "the main identifying assumption requires that the errors are uncorrelated both within factor subgroups and across different subgroups". This assumption can be a possible drawback of the model since this assumption cannot be achieved empirically. Eqns. (1) – (3) use the generalized cumulative impulse response to impose restrictions on the contemporaneous structural global factors so wise economic variables obtained.

Fig. 1 shows the M2 in US dollars (the global liquidity of the monetary aggregates) for both BRICSM and G4 economies over the period 1999:01 – 2019:12. As can be seen, the BRICSM M2 started from 10.4 billion in US dollars in 1999 increased significantly to about 13.2 billion in US dollars in 2015 before it started trending downward to about 12.9 billion in US dollars in 2019. Between 2010 and –2015, it demonstrated that the BRICSM M2 is over and higher than the G4 M2. There is a tendency to attribute BRICSM M2 increased to economic reforms. G4 M2 started from 12.5 billion in US dollars before and ended 13.0 billion in US dollars in 2019. Fan and Xu (2011) showed that index investors contribute global liquidity to commodity artefact markets.

Fig. 2 shows the M2 in US dollars (the global liquidity of the monetary aggregates) for both BRICSM and G4 economies over the period 1999:01 – 2019:12. The two liquidities, that is, for BRICSM and G4 economies were separated. The BRICSM M2 had experienced a continuous upward trend until 2009, then began to dwindle and then increase to 13.2 billion in US dollars in 2015 before it started trending downward to about 12.9 billion in US dollars in 2019. However, G4 M2 has a downward and upward trend before ending a little over 13.0 billion in US dollars in 2019.

Fig. 3 shows the logs form of the US dollar commodity price index and commodity price component indices for energy commodities, aluminium commodities, gold commodities, precious metal commodities, and raw materials commodities. The based year indices is set to a hundred for 2010. Since 1999, the commodity prices experienced a continual upward trend until 2009, the global financial crisis (GFC), when the commodity price trended downward and thenceforth increased many times. During the same period, energy commodities, aluminium commodities, gold commodities, precious metal commodities, and raw materials commodities behave in similar situations associate degree an upward and downward trend. While aluminium commodities and raw material commodities started from a scale of about 4.25 in 1999, energy commodities, precious commodities and gold commodities started from a leaf of about 3.00 in the same period. Another general conceptual concern from the classes of commodities was explored. Specifically, the energy commodities, which are a major asset class, trended upward until 2009 and 2016, when they trended downward and increased many times. The commodity prices uncertainty is attributed to commodity prices volatility in both developed and developing countries, with the uncertainty effect being more significant and persistent in emerging economies. Latent uncertainty has a more substantial impact on BRICSM economies relative to G4 economies, which has a long-run positive effect on commodity prices' volatility.

3.3. Data

To conduct the analysis, monthly time series data from 1st January 1999 to 31st December 2019 is used for the four majors developed economies: Canada, the European area (EU), Japan and the US (G4) and the six developing and emerging economies: Brazil, Russia, India, China, South Africa and Mexico (BRICSM). The monthly frequency data was used. Rather than overcoming limited observations, monthly data is preferred to quarterly data, which offers adequate information to estimate the model. The starting point is to coincide with the establishment of the European Central Bank for the interest rate. M2 is used as a measure of liquidity, global liquidity that depends on national aggregates parameters. Monetary aggregate for M2 for the G4 economies (G4, M2) Canada, the EU, Japan and the US and M2 for the developing economies (BRICSM, M2) Brazil, Russia, India, China, South Africa and Mexico is computed. The M2, global commodity price and commodity price components data for Canada, the EU, Japan and the US, Brazil, Russia, India, China, South Africa and Mexico and the data for indicators are from World Bank and International Monetary Fund. The present study uses international and global interchangeable variables. Also, the

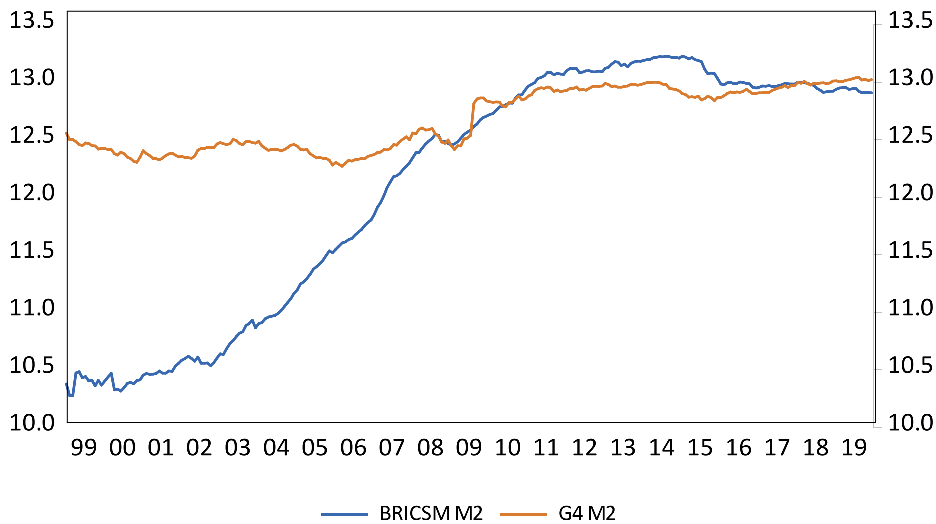

Fig. 1. BRICSM M2 and G4 M2 in billions of US dollars: 1999:01–2019:12. Notes: The BRICSM economies are Brazil, Russia, India, China, South Africa and Mexico. G4 economies are Canada, EU, Japan and the US. The data are monthly over the period 1999:01–2019:12 in billions of US dollars. The scale of the left-hand side of Fig. 1 is M2 for the G4 economies, and the scale of the right-hand side of Fig. 1 is M2 for BRICSM economics.

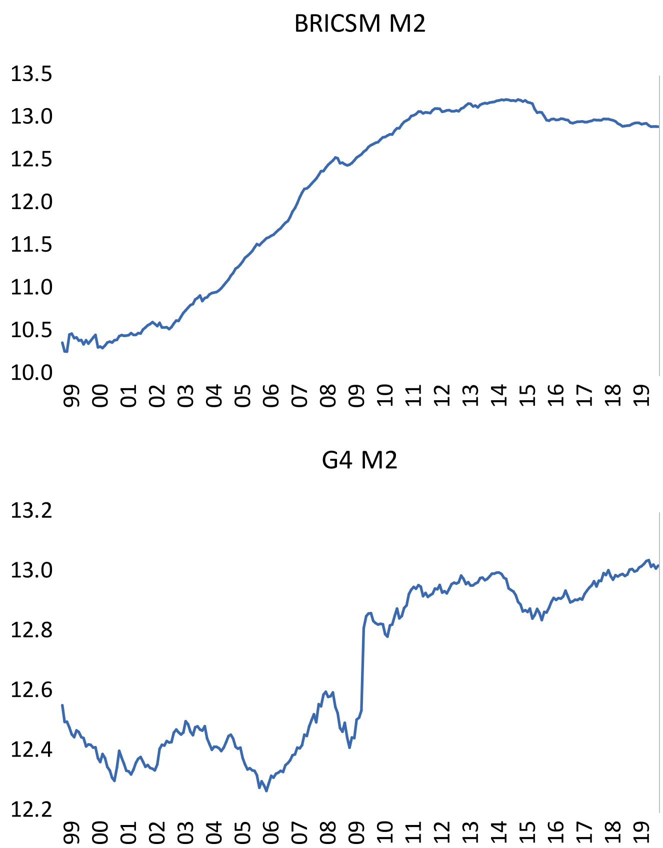

Fig. 2. BRICSM M2 and G4 M2 in billions of US dollars: 1999:01–2019:12. Notes: The BRICSM economies are Brazil, Russia, India, China, South Africa and Mexico. G4 economies are Canada, EU, Japan and the US. The data are monthly over the period 1999:01–2019:12 in billions of US dollars. The scale of the top of Fig. 2 is for M2 for the BRICSM economies, and the scale of the downside of Fig. 2 is for M2 for the G4 economics.

data for global consumer price (GCPI) variables, global interest rate (GIR) variables, global trade of goods (GTOG) variables for G4 economies and BRICSM economies are from International Financial Statistics. It is predicted that all the variables will have contemporaneous or synchronous impacts on commodity prices. All the variables transformed into natural logarithms except interest rates before the econometric analysis.

3.4. Measuring global liquidity

There are several methods of measuring global liquidity. The monetary aggregate is calculated in US dollars. The quantity-based measure is used to measure monetary aggregates relative to other standards which are uncontroversial. To compute a global indicator of global liquidity, one needs to rely on a well-liked method that reflects most researchers' choices. In this study, the global liquidity is monetary aggregate indicators: are M2 for the G4 economies (G4, M2) Canada, the EU, Japan and the US and M2 for the emerging economies (BRICSM, M2) Brazil, Russia, India, China, South Africa and Mexico using an exchange rate.[2] The monetary aggregates is computed by converting them into a common currency in the US dollar in each country's local currency terms. We employed monetary aggregates M2 widely used in the empirical literature because of its attractiveness and straightforward. This methodology is well known and analogous by converting diverse currency units to a single currency. The advantage of this approach is that it is simple and the preferred choice of most researchers. Again, a benefit of the measure is that global and developed, and emerging economies use it to measure international liquidity. Prior studies have used the quantity indicator of global liquidity as a sum of monetary aggregates, converted into a common currency (Beckmann et al., 2014; Sousa and Zaghini, 2007; Baks and Kramer, 1999). Sousa and Zaghini (2007) construct global liquidity as the sum of the monetary aggregates for G5 economies (the Euro area, the US, Japan, the UK and Canada) exchange rate based on euro-based purchasing power parity.

The simple sum method was used. The monetary aggregates were

[2] Belke et al. (2010) construct a quarterly global liquidity indicator built on monetary aggregates for 11 OCED countries based on narrower monetary aggregates. International Monetary Fund (2010) used two different global liquidity methods based on monetary aggregates M2 and reserve money for G4 countries (the Euro area, the US, the UK and Japan). Agostino and Surico (2009) measured global liquidity as the simple average of broad money growth rates in the G7 economies. Baks and Kramer (1999) used the weighted sum of monetary aggregates' growth rates for G7 economies. Darius and Radde (2010) construct global liquidity as the total international reserves based on the US base money.

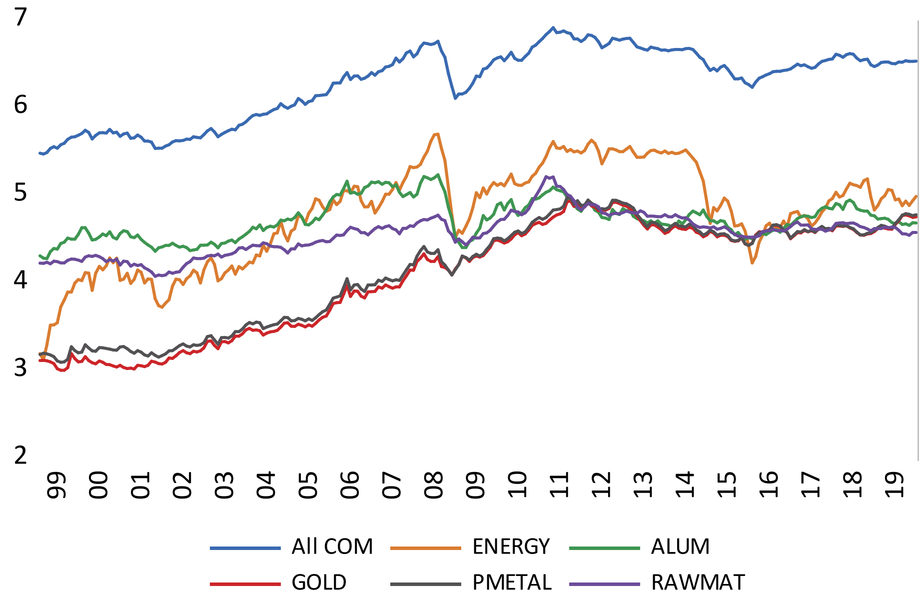

Fig. 3. Log of US dollar commodity price indices: 1999:01–2019:12. Notes: The US dollar commodity price component indices are for energy commodities, aluminum commodities, gold commodities, precious metal commodities, and raw materials commodities.

computed by converting them into a common currency in the US dollar in each country's local currency terms and summing them up.

$$SUM_t = \sum_{t=1}^{N} m_{i,t}/e_{i,t} \tag{4}$$

where SUM_t the monetary aggregate at a time t,$m_{i,t}$ is the money of country i in time t $e_{i,t}$ and denotes the exchange rate of country i in time t, exchange rate denotes one local currency unit per US dollar.

4. The empirical results

4.1. Global interest rate, consumer price index and trade of goods

Structural variations in the economy could, in supplement, lead to variations in the co-movements of variables, these need adjustments in the underlying factor model. These variables could respond to individual structural shocks in a time-varying manner. In this section, each structural factor is a link to each economic variable. The interest rate, consumer price index, and trade of goods of each of the G4 and BRICSM economies play a significant position between the global liquidity and commodity prices. Global indicators of the interest rate, consumer price index, and trade of goods constructed on the principal component approach to G4 and BRICSM economies' data are used.

The indicators of global interest rate, global CPI, and global trade of goods are the prominent principal components of the G4 and BRICSM economies' interest rates, CPI, and goods trade. All variables are in the log form except interest rate. The factors and the idiosyncratic components have stochastic volatility, which permits a change in global shocks' prominence and country-specific shocks.

$$GIR_t\left[IR_t^{CA},\ IR_t^{EU},\ IR_t^{JA},\ IR_t^{US},\ IR_t^{BR},\ IR_t^{RU},\ IR_t^{IN},\ IR_t^{CH},\ IR_t^{SA},\ IR_t^{ME}\right] \tag{5}$$

Eqns. (5) – (7) are a vector comprising the interest rate, consumer price index and trade of goods for Canada, Euro area, Japan, the US, Brazil, Russia, India, China, South Africa and Mexico. The first principal components obtained from Eqns. (5) – (7) are displayed in Fig. 4. The first principal component for the global interest rate, GIR, is shown in graph one of Fig. 4. It portrays the collapse in interest rates at the end of 2007 of the global financial crisis of 2007 – 2009, couple with a reasonably low-interest rate between 2002 and 2005 and 2009 – 2019. By September 2016 – 2019, interest rates were negative in Japan. Spiegel and Tai (2017) found that Japan's negative short-term interest rate is usually modest in size. Notice that in theory, the existence of negative or low-interest rates would boost the economy by inspiring consumers and banks to borrow and loaning more cash.

The first principal component for the global consumer price indices, GCPI, is shown in graph two of Fig. 4. From 1999: 01 – 2019: 12, the GCPI slopes linearly or slowly upward, demonstrating that the global flat rate of inflation is weak. Fragile CPI implies that both the economies of BRICSM and G4 are feeble. At a given time, the cost expressed relative to a base year is that the consumer price index (CPI), and therefore the percentage change in the CPI over a certified time is consumer price inflation, the most commonly used measure of inflation. For instance, if the base year CPI is a hundred and therefore the current CPI is a hundred and twenty, inflation is twenty per cent over the period. The CPI is usually kept constant over time for consistency. However, it is adjusted occasionally to reflect changing consumption patterns. The flat rate of inflation in CPI leads to an increase in the commodity price change. Under these circumstances, the magnitude of the impact under both BRICSM and G4 economies is somewhat identical under common economic condition; however, there are significant variations between emerging and developed economies.

The first principal component for the global trade of goods, GTOG, is indicated in graph three of Fig. 4. The trade of goods has downward and upward slopes until the global financial crisis in 2009, once it had been

$$GCPI_t\left[CPI_t^{CA},\ CPI_t^{EU},\ CPI_t^{JA},\ CPI_t^{US},\ CPI_t^{BR},\ CPI_t^{RU},\ CPI_t^{IN},\ CPI_t^{CH},\ CPI_t^{SA},\ CPI_t^{ME}\right] \tag{6}$$

$$GTOG_t\left[TOG_t^{CA},\ TOG_t^{EU},\ TOG_t^{JA},\ TOG_t^{US},\ TOG_t^{BR},\ TOG_t^{RU},\ TOG_t^{IN},\ TOG_t^{CH},\ TOG_t^{SA},\ TOG_t^{ME}\right] \tag{7}$$

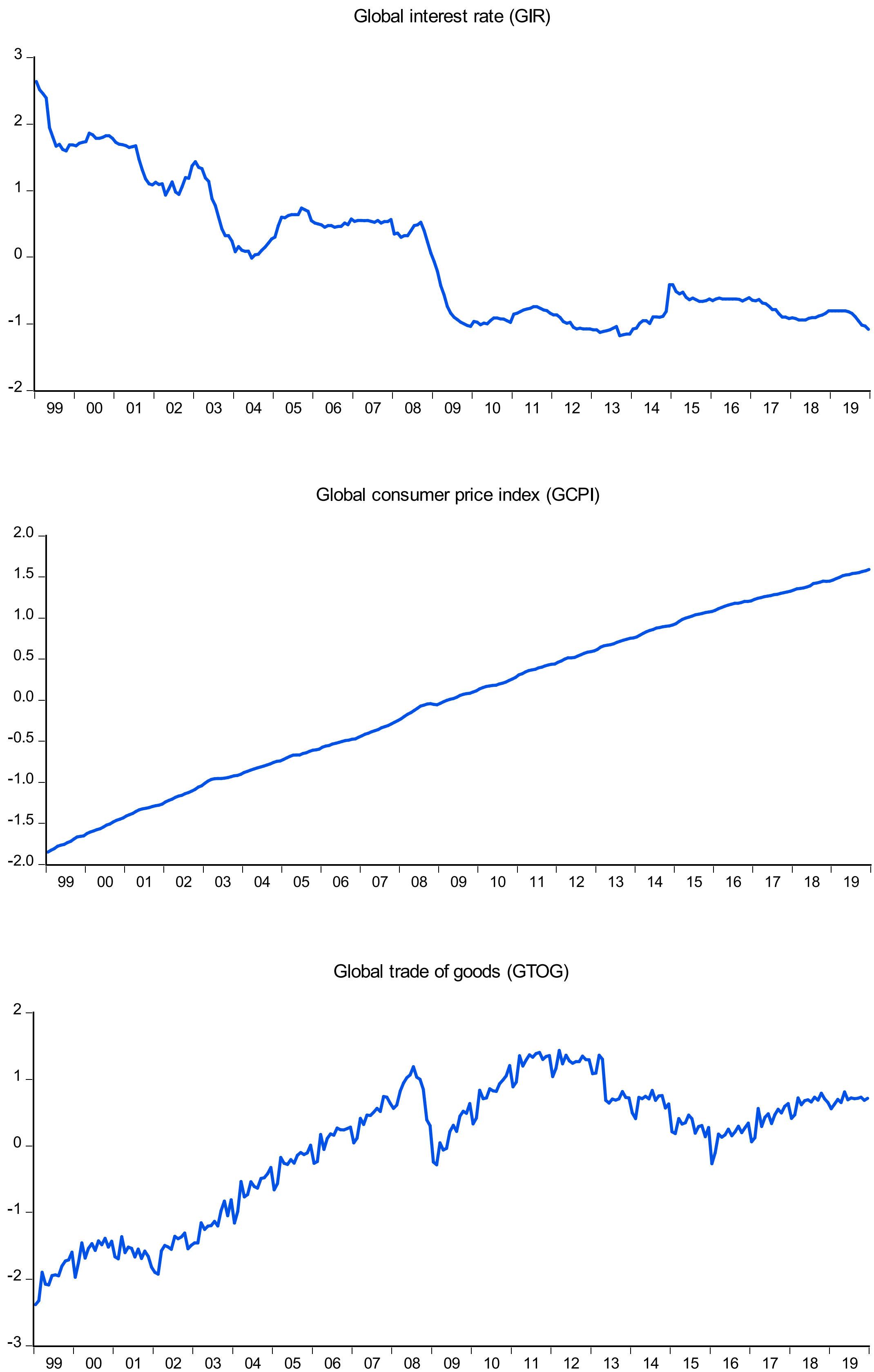

Fig. 4. Principal components estimation of global variables: 1999:01–2019:12. Notes: The principal components of the BRICSM and G4 economies' interest rate, CPI, and trade of goods taken to represent global interest rate, global CPI, and global trade of goods, respectively.

Table 1
Descriptive statistics of 250 observations.

Panel A: Global factor – Country IR										
Country-specific										
	CAN	EU	JAP	US	BRA	RUS	IND	CHI	SOA	MEX
Mean	2.188[a]	1.819[a]	0.145[a]	1.941[a]	13.652[a]	12.931[a]	6.746[a]	4.532[a]	8.272[a]	6.273[a]
Median	1.750	1.500	0.100	1.250	12.875	11.000	6.250	3.250	7.000	7.020
Maximum	5.750	4.750	0.500	6.500	33.000	25.000	8.500	10.000	18.830	9.760
Minimum	0.250	0.300	−0.100	0.125	4.500	5.500	4.750	2.000	5.000	3.000
Std. Dev.	1.585	1.399	0.164	2.001	5.321	6.171	0.857	2.678	2.838	1.920
Skewness	0.672[a]	0.527[a]	0.326[b]	0.873[a]	0.886[a]	1.055[a]	0.185	0.804[a]	0.972[a]	−0.262
Kurtosis	2.231[a]	1.973[a]	2.676[a]	2.397[a]	4.163[a]	2.695[a]	2.675[a]	2.196[a]	3.208[a]	1.682[a]
Jarque-B.	25.191[a]	22.755[a]	5.575[a]	38.846[a]	47.169[a]	47.709[a]	2.554[a]	33.793[a]	40.107[a]	21.122[a]
Panel B: Global factor – Country CPI										
Mean	4.584[a]	4.589[a]	4.623[a]	4.574[a]	4.556[a]	4.420[a]	4.537[a]	4.585[a]	4.555[a]	4.543[a]
Median	4.592	4.595	4.616	4.598	4.558	4.548	4.459	4.592	4.569	4.562
Maximum	4.768	4.735	4.663	4.771	5.140	5.205	5.234	4.850	5.087	4.972
Minimum	4.364	4.430	4.597	4.322	3.853	3.097	3.932	4.368	4.035	4.010
Std. Dev.	0.112	0.089	0.017	0.129	0.370	0.583	0.417	0.152	0.316	0.257
Skewness	−0.228	−0.156	0.509[a]	−0.317[b]	−0.151	−0.434[b]	0.132	0.051	0.060	−0.164
Kurtosis	1.942[a]	1.737[a]	2.078[a]	1.841[a]	1.966[a]	2.103[a]	1.505[a]	1.513[a]	1.745[a]	1.963[a]
Jarque-B.	13.650[a]	17.757[a]	19.827[a]	18.331[a]	12.199[a]	16.363[a]	24.188[a]	23.313[a]	16.682[a]	12.437[a]
Panel C: Global factor – Country TOG										
Mean	10.339[a]	11.388[a]	10.846[a]	11.461[a]	9.361[a]	10.124[a]	9.413[a]	11.917[a]	8.556[a]	9.124[a]
Median	10.423	12.062	10.912	11.556	9.555	10.203	9.665	11.648	8.713	9.539
Maximum	10.691	12.690	11.261	11.913	10.173	10.825	10.396	12.354	9.224	10.432
Minimum	9.769	11.028	10.197	10.867	7.900	8.413	7.893	9.306	7.534	7.153
Std. Dev.	0.235	0.398	0.236	0.326	0.582	0.629	0.783	0.861	0.477	1.076
Skewness	−0.681[a]	−0.650[a]	−0.645[a]	−0.361[b]	−0.746[a]	−0.735[a]	−0.559[a]	−0.721[a]	−0.633[a]	−0.606[a]
Kurtosis	2.145[a]	2.131[a]	2.462[a]	1.606[a]	2.204[a]	2.282[a]	1.783[a]	2.151[a]	2.016[a]	1.659[a]
Jarque-B.	27.170[a]	25.698[a]	20.503[a]	25.866[a]	30.058[a]	28.109[a]	28.656[a]	29.385[a]	27.023[a]	34.304[a]

Notes: [a] and [b] denote statistical significance at the 1% and 5% level, respectively. Jarque-B. means Jarque-Bera. Summary statistics for country-specific and global factor for interest rate (IR), for consumer price index (CPI) and trade of goods (TOG) are reported in Table 1. Note that Std Dev. and Jarque-B stand for Standard Deviation and Jarque-Bera respectively. The global factors are given by the first principal components for the global interest rate (GIR), for global CPI (GCPI), global trade of goods (GTOG). Panel A contains the global factor and country IR, Panel B contains the global factor and country CPI, and Panel C has the global factor and country TOG.

downward. The in-depth sort of estimates could be a sign of the still astronomical uncertainty regarding the chance of any economic recovery in 2019. From 2010 to 2012, the global trade of goods was upwards sloping before trending downwards in 2013 – 2016 and will probably stay at the levels observed in 2019. The magnitude of this will be dependent upon the extent of policies that BRICSM and G4 countries will implement to revive their economies. The global financial crisis of 2007 – 2009 and the Eurozone crisis of 2010 – 2018 indicate the economic uncertainty combined with financial linkages. The variables are usually measured over the period 1999:01 – 2019:12, and the obtained time series are plotted one versus another. Considering how relationships among the variables in this paper are evolving, per the explanation so far, these variables, in the long run, vary considerably over time. It is indicated that the variables are time-varying. However, the interdependence of the variables is mainly caused by an increase in volatility in the long run.

Table 1 reports the descriptive statistics for country-specific and global factor for the short-term interest rate (IR), for consumer price index (CPI) and trade of goods (TOG). The global factors are given by the first principal components for the global interest rate (GIR), for global consumer price index (GCPI) and global trade of goods (GTOG).

Panel A of Table 1 depicts the global factor and country interest rate. The mean log returns which are flattering for all countries are statistically significant. The log return of Brazil has the highest mean. Skewness is primarily positive and significant for all countries. Only India and Mexico have positive and negative insignificant skewness, respectively. Russia has the highest standard deviation. Table 1 also indicates convincing variation in the level of kurtosis across panels. The kurtosis is mostly less than ($k < 3$) and positive and significant. The exceptions are Brazil and South Africa, where the coefficients are more than ($k > 3$) and statistically significant. Indeed, kurtosis's presence indicates volatility clustering and fat-tailedness (Joseph et al., 2020). The jarque–bera statistics reject the normality test of all countries at the 1 % significance level.

Panel B of Table 1 shows the global factor and country consumer price index. The mean log returns are positive and significant for all countries. Skewness is mostly negative and insignificant. Only Japan, India, China and South Africa are positive. The kurtosis returns are always positive and significant. The jarque–bera statistics reject the normality test at the 1 % level of significance.

Panel C of Table 1 reports the global factor and country trade of goods. The mean log returns are highly positive and significant for all series. All countries return contain considerable skewness and kurtosis, which infer that the observations are non-normally distributed. Skewness is always negative and significant, whilst kurtosis is still positive and significant. The Jarque-Bera test statistic results are non-normal.

Table 2 shows the Pearson correlations coefficients between country-specific and global factor for interest rate (IR), consumer price index (CPI) and trade of goods (TOG). The first principal components give the global factors for the global interest rate (GIR), global CPI (GCPI) and global trade of goods (GTOG).

Panel A of Table 2 shows the global interest rate correlation among country interest rate. India's interest rate is negatively correlated with all countries interest rates except with Japan which is positive. The country's interest rate between Canada and China is highly correlated, with India and Russia being the lowest. The correlation coefficients for most countries interest rates are at 1 % significant level, except India and Euro areas and India and Japan which is 5 % significant level. There is a positive and highly significant correlation coefficient between China and Canada.

Panel B of Table 2 is the global consumer price index correlation with country consumer price index. The country's consumer price index correlation between Brazil and all countries is very high, except Japan which is 0.388. The country's consumer price index correlation for each

Table 2
Pearson correlation coefficients between country-specific and global factors.

Country/global										
Panel A: global/country IR										
	BRA	CAN	CHI	EU	IND	JAP	MEX	RUS	SOA	US
BRA	1									
CAN	0.554[a]	1								
CHI	0.523[a]	0.938[a]	1							
EU	0.537[a]	0.862[a]	0.869[a]	1						
IND	−0.163[a]	−0.116[a]	−0.112[a]	−0.074[b]	1					
JAP	0.537[a]	0.710[a]	0.763[a]	0.868[a]	0.071[b]	1				
MEX	0.338[a]	0.644[a]	0.588[a]	0.570[a]	−0.300[a]	0.386[a]	1			
RUS	0.759[a]	0.678[a]	0.640[a]	0.680[a]	−0.336[a]	0.470[a]	0.440[a]	1		
SOA	0.726[a]	0.729[a]	0.659[a]	0.762[a]	−0.335[a]	0.625[a]	0.567[a]	0.793[a]	1	
US	0.401[a]	0.933[a]	0.919[a]	0.732[a]	−0.193[a]	0.559[a]	0.693[a]	0.576[a]	0.583[a]	1
Panel B: global /country CPI										
	BRA	CAN	CHI	EU	IND	JAP	MEX	RUS	SOA	US
BRA	1									
CAN	0.995[a]	1								
CHI	0.973[a]	0.976[a]	1							
EU	0.990[a]	0.996[a]	0.986[a]	1						
IND	0.978[a]	0.977[a]	0.992[a]	0.985[a]	1					
JAP	0.388[a]	0.361[a]	0.441[a]	0.370[a]	0.444[a]	1				
MEX	0.995[a]	0.997[a]	0.978[a]	0.995[a]	0.981[a]	0.372[a]	1			
RUS	0.992[a]	0.994[a]	0.962[a]	0.989[a]	0.965[a]	0.303[a]	0.993[a]	1		
SOA	0.990[a]	0.988[a]	0.985[a]	0.990[a]	0.993[a]	0.436[a]	0.992[a]	0.980[a]	1	
US	0.988[a]	0.997[a]	0.976[a]	0.996[a]	0.971[a]	0.332[a]	0.992[a]	0.992[a]	0.980[a]	1
Panel C: global /country TOG										
	BRA	CAN	CHI	EU	IND	JAP	MEX	RUS	SOA	US
BRA	1									
CAN	0.930[a]	1								
CHI	0.964[a]	0.908[a]	1							
EU	0.960[a]	0.933[a]	0.972[a]	1						
IND	0.961[a]	0.914[a]	0.979[a]	0.969[a]	1					
JAP	0.900[a]	0.909[a]	0.852[a]	0.891[a]	0.859[a]	1				
MEX	−0.284[a]	−0.240[a]	−0.424[a]	−0.379[a]	−0.410[a]	−0.070[b]	1			
RUS	0.964[a]	0.954[a]	0.943[a]	0.956[a]	0.943[a]	0.926[a]	−0.190[a]	1		
SOA	0.974[a]	0.934[a]	0.956[a]	0.969[a]	0.965[a]	0.919[a]	−0.273[a]	0.966[a]	1	
US	0.941[a]	0.918[a]	0.955[a]	0.954[a]	0.974[a]	0.853[a]	−0.453[a]	0.919[a]	0.950[a]	1

Notes: Pearson correlations coefficients between country-specific and global factor for the interest rate (IR), for consumer price index (CPI) and trade of goods (TOG) indicated in Table 2. The first principal components give the global factors for the global interest rate (GIR), global CPI (GCPI) and global trade of goods (GTOG). Panel A is global/country IR, Panel B is global /country CPI, and Panel C is global/ country TOG. The table presents Pearson correlation coefficients between country-specific and global factor for the interest rate (IR), for consumer price index (CPI) and trade of goods (TOG) a, b and c are significant at 1%, 5% and 10% respectively.

of the countries is positive and significant at 1 % level. The correlation shown in Panel B indicates positives and a highly significant correlation among all countries' consumer price indexes.

Panel C of Table 2 is the global trade of goods correlation with country trade of goods which is very high and positive for both emerging and developed economies, except Mexico which has a negative correlation with all the countries. The trade of goods correlation coefficients is 1 % significant for all countries except Mexico and Japan which is 5 % significant.

4.2. Collinearity statistics

The tolerance and variance inflation factor (VIF) is indicated in Table 3. Table 3 presents collinearity statistics allowing assessment of multicollinearity for country-specific and global factors for the interest rate (GIR), consumer price index (GCPI) and trade of goods (GTOG). The global factors are given by the first principal components for the global interest rate (GIR), for consumer price index (GCPI) and the trade of goods (GTOG). We used tolerance and variance inflation factor to assess the severity of the multicollinearity. Tolerance denotes the percentage of variance in undeniable predictors that cannot be explained by the additional independent variables. If the estimated tolerance is close to 1 there is minute multicollinearity. If the projected tolerance is close to 0, this suggests that multicollinearity may exist. The reciprocal of the tolerance is documented as the VIF (Oke et al., 2019; Senaviratna and Cooray, 2019). The VIF shows how considerable the variance of the estimated is being magnified by multicollinearity. Jamal (2017) suggests that if the estimated VIF values are greater than 5 or 10 then multicollinearity exits.

Panel A shows the global interest rate with a country interest rate, none of the tolerance is either close to 1 or 0, and none of the VIF is near 3, hence there is no multicollinearity.

Panel B presents the global consumer price index with the country consumer price index, none of the tolerance is either close to 1 or 0, and none of the VIF is greater than 3, hence there is no multicollinearity.

Panel C indicates the global trade of goods with country trade of goods none of the tolerance is either close to 1 or 0, and none of the VIF is greater than 3, hence there is no multicollinearity.

4.3. Stationarity test

In this section, testing is done to ascertain whether the variables are stationary or non-stationary. A non-stationary time series in a multivariate technique determine by a decreased number of common stochastic trends. A common stochastic trend will mean that the stochastic trend in emerging and developing economies is related to the stochastic trend in developed economies (Syriopoulos, 2011). The stationary properties of the data is presented in Table 4. The Augmented Dickey-Fuller (ADF), Phillips–Perron (PP) and Kwiatkowski–-Phillips–Schmidt–Shin (KPSS) tests are used for each set of the data. The null hypothesis for each of the ADF and PP test is that the variable has a unit root, and the null hypothesis for the KPSS test is that the variable is

Table 3
Collinearity statistics.

Collinearity statistics		
Variable	Tolerance	Variance inflation factor (VIF)
Panel A: global / country interest rate (IR)		
BRA	0.672	1.354
CAN	0.543	1.482
CHI	0.719	1.542
EU‘	0.592	1.493
IND	0.602	1.381
JAP	0.810	1.124
MEX	0.469	2.006
RUS	0.522	1.502
SOA	0.654	1.378
US	0.710	1.255
Panel B: global / country consumer price index (CPI)		
BRA	0.592	1.520
CAN	0.624	1.434
CHI	0.610	1.453
EU	0.645	1.421
IND	0.515	1.614
JAP	0.502	1.394
MEX	0.598	1.512
RUS	0.585	1.543
SOA	0.519	1.594
US	0.510	1.398
Panel B: global / country trade of goods (TOG)		
BRA	0.778	1.565
CAN	0.732	1.579
CHI	0.824	1.446
EU	0.891	1.435
IND	0.678	1.671
JAP	0.740	1.582
MEX	0.594	1.728
RUS	0.589	1.738
SOA	0.597	1.788
US	0.868	1.458

)Notes: Country-specific and global factors for the interest rate (IR), consumer price index (CPI) and trade of goods (TOG) are indicated in Table 3. The first principal components give the global factors for the global interest rate (GIR), global consumer price index (GCPI) and global trade of goods (GTOG). Panel A is global/country IR, Panel B is global /country CPI, and Panel C is global/ country TOG. The table presents collinearity statistics allowing us to assess multi-collinearity for country-specific and global factors for the interest rate (IR), consumer price index (CPI) and trade of goods (TOG).

stationary. The ADF and PP statistics tests cannot reject a unit root's null hypothesis for nine variables for level data; hence, nine variables are non-stationary. The ADF and PP unit root test results demonstrate that one variable each is stationary for level data. The results are not shocking because, according to the literature, traditional ADF and PP, both tests lack power in detecting the null hypothesis. But for both ADF and PP tests, the first differenced series are stationary significant at the 1 %. The KPSS test rejects the null hypothesis that all the variables are stationary at the 1 % statistically significant level, except one variable, which is a 5 % significant level, signifying stationarity. In general, a unit root's testimony means that the economic shock has a permanent effect on the series. However, the KPSS test for each variable in the first difference fails to reject the null hypothesis has a unit root in 7 out of 10 variables.

4.4. Cointegration test

Cointegration tests were used to examine whether the global liquidity and commodity prices for developed and emerging economies are cointegrated. Engle and Granger (1987) found that a linear combination of two or more I(1) series could be stationary, or I(0), then series are cointegrated. A cointegrating test between variables was carried out to determine the validity of a VAR approach to investigate global liquidity. The trace test statistic tests the null hypothesis of r cointegration vector against r co-integrating vectors' alternative hypothesis. The maximum eigenvalue test statistic tests the null hypothesis of exactly r co-integrating vectors against the alternative of $r + 1$ co-integrating vectors. The asymptotic critical values for Johansen's cointegration test for trace and maximum eigenvalue tests (MacKinnon et al., 1999).

We test logs of commodity prices and money (G4 M2) and (BRICSM M2) are cointegrated vector amid these three variables with intercept. The results reported in Table 5.1.1 and 5.1.2. Johansen's cointegration test reveals that the null hypothesis of cointegration vectors is less or equal than r is rejected when $r = 0$ based on trace test. Johansen's test suggests that either the null hypotheses of $r \leq 1$ and $r \leq 2$ cannot be rejected for the trace statistic test. The null hypothesis of the cointegrating vector is r rejected when $r = 0$. Likewise, the cointegrating vector cannot reject the null hypotheses of $r = 1$ and $r = 2$ for the maximum eigenvalue test.

We also test for cointegration between global consumer price index, money (G4 M2) and (BRICSM M2), and global trade of goods demonstrates one cointegration vector among the variables with intercept and linear trend introduced to the model. The results presented in Table 5.2.1 and 5.2.2 are based on trace test and eigenvalue test, respectively. Johansen's cointegration test reveals that cointegration vectors' null hypothesis is less or equal than r rejected when $r = 0$ based on trace test. Johansen's test indicates that either the null hypotheses of $r \leq 1$ and $r \leq 2$ cannot be rejected for the trace statistic test. The

Table 4
Test for unit roots.

Null hypothesis for ADF test: the variable has a unit root
Alternative hypothesis for ADF test: the variable does not have a unit root
Null hypothesis for P.P. test: the variable has a unit root
Alternative hypothesis for P.P. test: the variable does not have a unit root
Null hypothesis for KPSS test: variable is stationary
Alternative hypothesis for KPSS test: variable is not stationary

Level	ADF	PP	KPSS	First difference	ADF	PP	KPSS
log(COM)	−1.620	−1.598	1.568[a]	Δlog(COM)	−11.966[a]	−12.230[a]	0.056
log(ALUM)	−2.755[c]	−2.704[c]	0.525[b]	Δlog(ALUM)	−12.191[a]	−12.424[a]	0.032
log(BRICSM M2)	−1.582	−1.939	1.835[a]	Δlog(BRICSM M2)	−10.226[a]	−14.610[a]	0.353[a]
log(G4 M2)	−0.277	−0.514	1.761[a]	Δlog(G4 M2)	−13.717[a]	−13.776[a]	0.111
log(GOLD)	−1.103	−1.095	1.802[a]	Δlog(GOLD)	−13.995[a]	−13.956[a]	0.153[b]
log(GCPI)	−0.054	−0.010	2.046[a]	Δlog(GCPI)	−10.724[a]	−10.327[a]	0.114
log(GIP)	−1.529	−1.921	1.828[a]	Δlog(GIP)	−4.484[a]	−22.764[a]	0.047
log(LEAD)	−1.541	−1.557	1.540[a]	Δlog(LEAD)	−12.235[a]	−12.235[a]	0.054
log(PMETAL)	−1.135	−1.154	1.783[a]	Δlog(PMETAL)	−13.451[a]	−13.372[a]	0.126[c]
log(RAWMAT)	−1.915	−1.798	1.176[a]	Δlog(RAWMAT)	−7.863[a]	−12.635[a]	0.049

Notes: a, b and c indicate statistical significance at the 1%, 5% and 10%, respectively. The lag selection criteria for the ADF is based on Schwarz information Criteria (SIC), and the PP and KPSS are based on the Newey–West Bandwidth.

Table 5
VAR Johansen cointegration test summation.

5.1 Cointegration test: logs of commodity prices and money (G4 and BRICSM)
Endogenous variables: log(commodity prices$_t$); log(G4 M2$_t$); log(BRICSM M2$_t$)
Exogenous variables: log(global trade of goods$_t$); global interest rate
5.1.1 Unrestricted cointegration rank test (trace)
Null hypothesis: the number of cointegrating vectors is less than or equal to *r*
Alternative hypothesis: there are more than *r* cointegrating vectors

Hypothesized Null	Alternative	Eigenvalue	Trace Statistic	0.05 Critical value	Prob. *
r = 0	r ≥ 1	0.098	35.349	29.797	0.010
r ≤ 1	r ≥ 2	0.031	9.966	15.495	0.283
r ≤ 2	r ≥ 3	0.009	2.123	3.841	0.145

5.1.2 Unrestricted cointegration rank test (maximum eigenvalue)
Null hypothesis: the number of cointegrating vectors is *r*
Alternative hypothesis: there are (r + 1) cointegration vectors

Hypothesized Null	Alternative	Eigenvalue	Max-eigenvalue statistics	0.05 Critical value	Prob. *
r = 0	r = 1	0.098	25.384	21.132	0.012
r = 1	r = 2	0.031	7.843	14.265	0.395
r = 2	r = 3	0.009	2.123	3.841	0.145

5.2 Cointegration test: logs of Global CPI (GCPI), money (G4 and BRICSM) and Global trade of goods (GTOG)
Endogenous variables: log(Commodity prices,); log(G4 M2$_t$); log(BRICSM M2$_t$)
Exogenous variables: log(global trade of goods); global interest rate

5.2.1 Unrestricted cointegration rank test (trace)
Null hypothesis: the number of cointegrating vectors is less than or equal to *r*
Alternative hypothesis: there are more than *r* cointegrating vectors

Hypothesized Null	Alternative	Eigenvalue	Trace Statistics	0.05 Critical value	Prob.**
r = 0	r ≥ 1	0.112	44.332	42.915	0.036
r ≤ 1	r ≥ 2	0.035	15.120	25.872	0.565
r ≤ 2	r ≥ 3	0.025	6.362	12.518	0.416

5.2.2 Unrestricted cointegration rank test (maximum eigenvalue)
Null hypothesis: the number of cointegrating vectors is *r*
Alternative hypothesis: there are (r + 1) cointegrating vectors

Hypothesized Null	Alternative	Eigenvalue	Max-eigenvalue Statistic	0.05 Critical value	Prob.**
r = 0	r = 1	0.112	29.212	25.823	0.017
r = 1	r = 2	0.035	8.758	19.387	0.749
r = 2	r = 3	0.025	6.362	12.518	0.416

**MacKinnon-Haug-Michelis (1999) p-values.

cointegrating vector's null hypothesis is r can only reject when r = 0 based on the maximum eigenvalue. The null hypotheses of the number of the cointegrating vector are r can only be rejected when r = 0, whilst the hypothesis of either r = 1 and r = 2 cannot reject for the maximum eigenvalue test.

The empirical findings indicate one cointegration vectors, co-movements and linkages expected for the G4 economies and BRICSM emerging economies. The above results suppose that the null hypothesis of 1 cointegration vector was found among global CPI, global trade of goods and G4 M2 and BRICSM M2. Eqns. (1) and (2) present the following two cointegration vectors into the SFAVEC model:

$$ECT1_t = \log(COM_t) - \beta - \delta\log(BRICSM\,M2_t) - \alpha\log(G4\,M2_t) \sim I(0) \quad (8)$$

$$ECT2_t = \log(GCPI_t) - \beta - \lambda\log(GTOG_t) - \mu\log(BRICSM\,M2_t) - \psi\log(G4\,M2_t) - \omega t \sim I(0) \quad (9)$$

4.5. Short-run and long-run over time

This section determines short-term, and long-run behaviour and linkages of BRICSM emerging economies and G4 developed economies.

Table 6
Panel A: Normalised cointegrating vector.

BRICSM M2	G4 M2	COM	ICPI	ITOG
1.000000	0.000000	1.970	9.056	−8.310
		(1.786)	(1.882)	(2.227)
		[1.103]	[4.812]	[-3.731]
0.000000	1.000000	−4.209	−5.608	6.000
		(0.827)	(0.871)	(1.031)
		[-5.089]	[−6.438]	[5.819]

Panel B: Adjustment coefficients vector

BRICSM M2	−0.016
	(0.003)
	[−5.333]
G4 M2	−0.002
	(0.003)
	[−0.667]
COM	0.001
	(0.003)
	[0.333]
GCPI	−0.000
	(0.000)
	[-0.000]
GTOG	−0.009
	(0.006)
	[-1.500]

Notes: Figures in () and [] are standard errors and t-statistic, respectively.

The results from Johansen's cointegration test show that there is one cointegration vector in the sample variables. The normalized cointegration vectors of BRICSM M2 and G4 M2 countries.

Panel A of Table 6 summarises normalized cointegration vectors obtained from BRICSM M2 and G4 M2. The cointegration vectors indicate that the BRICSM M2 has a long-run effect on the global consumer price index and global trade of goods but no impact on global commodity prices. G4 M2 wields a long-run effect on global commodity, global consumer price index and global trade of goods. Developing and emerging economies are very open to international trade that increases their share in world trade. The importance of quick-growing emerging economies and, consequently, the demand for commodities accounted for, together with exports of emerging countries that enter the long-run association. These findings indicate that BRICSM and G4 economies play a significant role in global liquidity. Therefore, we find strong support for long-run equilibrium conditions for both BRICSM M2 and G4 M2, but short-run adjustment for global commodity prices for BRICSM M2. This indicates that the BRICSM M2 is time-varying.

Panel B of Table 6 shows the speed of adjustment. The result of BRICSM M2 indicates the speed of adjustment towards the long-run equilibrium path. The BRICSM M2 is statistically significant; this implies that BRICSM M2 has a long-run effect on global commodity, global consumer price index and global trade of goods. The larger adjustment coefficient for the BRICSM M2 signifies a more rapid adjustment relative to the G4 M2; this suggests that the increase in liquidity is more likely to raise aggregate demand for goods and services in theory. "The long-run path of the system characterized by the adjustment coefficients is influenced by the international money variable, while at the same time it exhibits "no levels feedback". That is, it is not influenced by the other variables of the system and is weakly exogenous for the long-run structure" (Belke et al., 2012, p. 21).

The G4 M2 is statistically insignificant and has a short-run effect on the global commodity, global consumer price index and global trade of goods. The results show that G4 M2 is time-invariant. The coefficients indicate that adjustment to shocks to liquidity take a couple of years to many years before returning to equilibrium levels in these emerging and developed economies. In different words, the speed of adjustment

Table 7
Granger causality tests.

Null hypothesis: variable a does not Granger cause variable b Alternative hypothesis: variable a Granger cause variable b			
Granger test/lags 2 4			
BRICSM M2 does not Granger Cause COM	F-Stat. Prob.	1.594 0.205	1.015 0.401
COM does not Granger Cause BRICSM M2	F-Stat Prob.	4.630[a] 0.011	3.261[b] 0.013
G4 M2 does not Granger Cause COM.	F-Stat. Prob.	2.753[b] 0.066	2.374[c] 0.053
COM does not Granger Cause G4 M2	F-Stat. Prob.	0.851 0.428	1.096 0.359
G4 M2 does not Granger Cause BRICSM M2.	F-Stat. Prob.	5.967[a] 0.003	4.778[a] 0.001
BRICSM M2 does not Granger Cause G4 M2	F-Stat. Prob.	4.252[a] 0.015	2.444[c] 0.047

Notes: a, b and c indicate statistical significance at the 1%, 5% and 10%, respectively. Variables are in logs.

reverts to its parity at a slow paste.

4.6. Tests for Granger causality

Granger causality is a method for deciding whether a one-time series is helpful in forecasting another. Granger (1986) argued that there is a clarification or analysis of a set of tests as divulging something about causality. BRICSM M2 or G4 M2, or both Granger cause commodity prices are assessed.

Table 7 indicates the results of the Granger causality test. The null hypothesis that BRICSM M2 does not Granger cause commodity prices cannot be rejected at conventional levels using two sets of lags. The null hypothesis that commodity prices do not Granger cause BRICSM M2 are rejected at 5 % statistical significance levels using both sets of lags, ratifying that causal direction is from commodity prices to BRICSM M2. The null hypothesis that G4M2 does not Granger causes commodity prices rejected using both sets of lags, sanctioning that causal direction is from G4 M2 to commodity prices. While the null hypothesis that commodity prices do not Granger causes, G4 M2 cannot be rejected at conventional levels using both sets of lags.

We can see from Table 7 that G4 M2 Granger cause BRICSM M2 using both sets of lags of BRICSM M2 are statistically significant at 1 % level in the equation of G4 M2. Likewise, BRICSM M2 Granger causes G4 M2 is significant in the equation of BRICSM M2. That is to say, both lags are significant, and therefore there was bi-directional causality. One cannot reject the null hypothesis that G4 M2 does not Granger cause BRICSM M2. Similarly, we cannot reject the null hypothesis that BRICSM M2 does not Granger causes G4 M2 using both lags. On the whole, we infer that Granger casualty goes from commodity prices to BRICSM M2, and Granger casualty goes from G4 M2 to commodity prices.

4.7. Variance decomposition

The dynamic interdependencies among the variables are further examined using forecast error variance decompositions. Panel A and Panel B of Table 8 shows the forecast error variance decomposition computed by BRICSM M2 and G4 M2 to innovation shocks on the other variables. The variance decomposition splits the variation in an endogenous variable due to one standard deviation shock of its own and other variables in the model. The variance decomposition results show evidence about each random innovation's relative significance in influencing the variables in the model.

Panel A of Table 8 shows that the global consumer price index and commodity price shocks formed the more significant proportion of the total variation in BRICSM M2.

Table 8
Variance decomposition.

Panel A: Variance decomposition OF BRICSM M2

Period	Standard Error	GCPI	GIR	COM	GTOG	BRICSM M2
1	0.026	1.372	5.77E-05	5.015	0.005	93.607
2	0.038	2.109	0.023	9.008	0.465	88.395
3	0.049	2.580	0.082	12.290	0.638	84.410
4	0.058	2.859	0.160	15.142	0.725	81.114
5	0.066	3.040	0.257	17.743	0.752	78.208
6	0.074	3.163	0.371	20.172	0.748	75.546
7	0.081	3.247	0.503	22.461	0.725	73.064
8	0.088	3.303	0.652	24.621	0.691	70.732
9	0.095	3.337	0.820	26.653	0.652	68.538
10	0.101	3.354	1.004	28.559	0.610	66.473

Panel B: VARIANCE DECOMPOSITION G4 M2

Period	Standard Error	GCPI	GIR	COM	GTOG	G4 M2
1	0.024	0.381	0.285	7.823	6.12E-07	91.510
2	0.035	0.904	0.604	6.247	0.177	92.068
3	0.043	1.511	1.218	6.054	1.147	90.069
4	0.050	1.918	2.136	6.206	2.347	87.392
5	0.055	2.141	3.347	6.356	3.503	84.653
6	0.059	2.239	4.812	6.419	4.533	81.996
7	0.063	2.258	6.484	6.392	5.422	79.442
8	0.067	2.229	8.315	6.295	6.175	76.986
9	0.070	2.170	10.262	6.147	6.803	74.617
10	0.073	2.095	12.286	5.964	7.323	72.330

Also, Panel B of Table 8 depicts the global interest rate, and commodity price shocks formed the more significant proportion of the total variation in G4 M2. It is obvious from the variance decomposition that; global liquidity can justify the movement of commodity price. An increase in the global liquidity, based on both the BRICSM M2 and G4 M2, caused a rise in commodity prices. BRICSM M2 has superior explaining power to forecast error variance of the commodity prices than G4 M2. Thus, the empirical analysis shows that during the sample period under consideration, BRICSM M2 significantly impacts more than G4 M2 on commodity prices. This suggests that commodity prices volatility is more pronounced in developing and emerging economies than in developed economies. It has been argued that this decomposition offers information about business cycle causes, but its connection with business cycles is incredibly pathetic (Pagan and Robinson, 2014). The results indicate the variance decomposition estimated and their standard errors for different periods following the innovation shocks. The standard error computed becomes more significant as we move from one period to another period. Even though substantial residual errors denote the extreme level of uncertainty in calculating the short-run adjustment dynamics, the standard error computed indicates that both the BRICSM and G4 economies were estimated with reasonable complication.

4.7. Impulse response function

This section, illustrates the generalized cumulative impulse response function (GIRFs) in BRICSM M2 and G4 M2 of the estimated SFAVEC model in equations (1) and (2) from the shocks of the global variables. The dynamic response following a shock was computed using Monte Carlo simulations for 1000 repetitions showing the impulse response over a 60-month horizon. The study used the most parsimonious model, which was the SFAVEC model. The responses to a one standard deviation shock, whilst the dashed lines denote plus or minus two standard error bands around the estimates of the generalized cumulative impulse response function's coefficients and impulse response function. The liquidity shock is one standard deviation of the monetary aggregates (BRICSM M2 and G4 M2) of developing and developed countries.

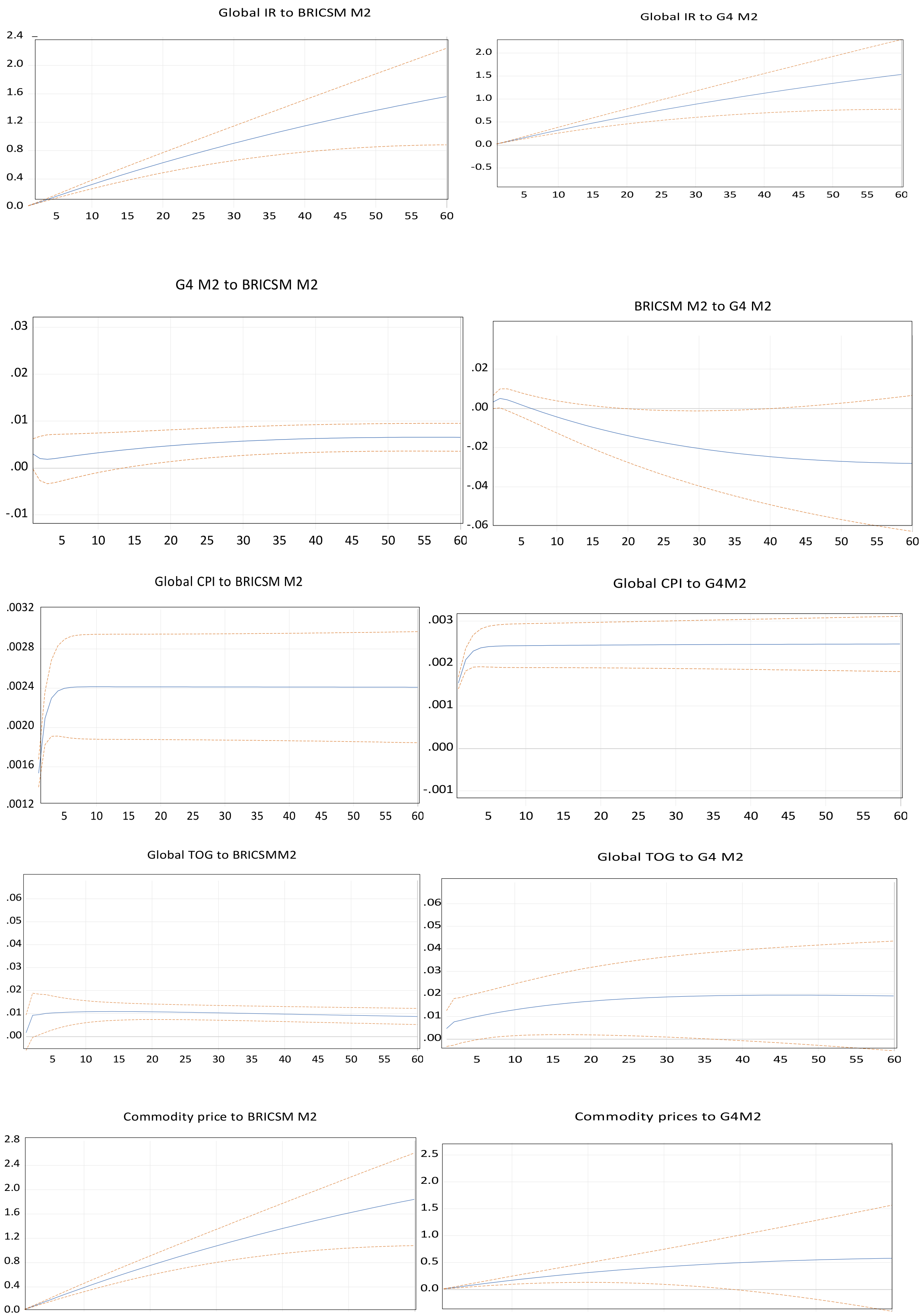

Fig. 5. One standard deviation generalized the cumulative response of global variables to shocks in BRICSM M2 and G4 M2 Notes based on the SFAVEC model in equations (1) and (2).

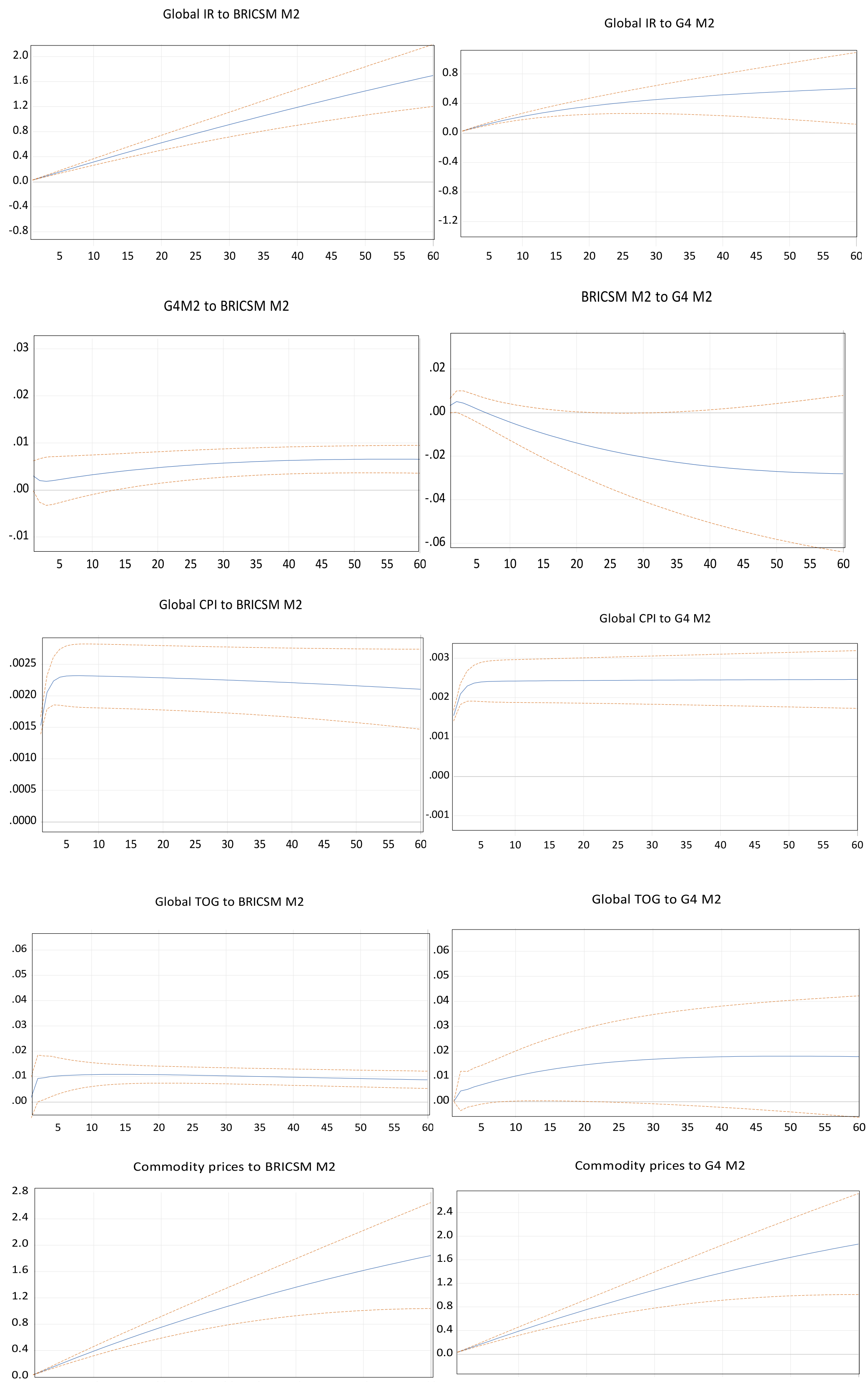

Fig. 6. One standard deviation cumulative impulse response of global variables to shocks in BRICSM M2 and G4 M2: Commodity price contemporaneously endogenous Notes that these results based on the SFAVEC model in equations (1) – (3).

The first column of each panel of Fig. 5 shows the positive innovations shock in BRICSM M2 lead to significant and persistent surges in the global interest rate and commodity prices. The shocks have larger and more persistent effects on commodity prices, followed by global trade of goods and global interest rates. With an increase in central bank discount rates, the money supply decreased. This is consistent with the conventional transmission of money that an upsurge in interest rate triggers the money supply to fall. It is well known that the generalized impulse response functions help study the persistence of shocks. Innovation in the BRICSM M2 does not substantially impact on global consumer price index and global trade of goods. A positive shock to BRICSM M2 leads to a positive increase in G4 M2 (Fig. 6).

The second column of each panel of Fig. 5 shows that G4 M2′s shock does not produce significant changes in the global interest rate, global trade of goods, and the consumer price index shock has a considerable price decline statistically. As expected, a shock to BRICSM M2 generates the most significant impact than G4 M2 effects once shocked. Shock in the G4 M2 has only limited effect in BRICSM M2. A positive innovation in G4 M2 produces a significant positive response that leads to a surge in commodity prices. Still, the response in the commodity price of the magnitude is relatively small compared to BRICSM M2.

Table 6 illustrate the cumulative impulse response function (IRFs) in BRICSM M2 and G4 M2 of the estimated SFAVEC model in equations (1) – (3) from the shocks of the global variables. Amusing the SFAVEC model in equations (1) – (3) to one standard deviation to perform the shocks' structural impulse response functions from identifying restrictions imposed in equation 3. Similar results were obtained from generalized impulse response functions from the SFAVEC model in equations (1) and (2) and the cumulative impulse response function from the SFAVEC model in equations (1) – (3). It has been argued that the monetary policy has a contemporaneous effect on M2. The difference between cumulative impulse response function from the SFAVEC model in equations (1) – (3) is that G4 M2 and BRICSM M2 are restricted not to impact each other contemporaneously. Finally, the standard errors of the plots seem well worked, signifying that the estimates are sensible. No portentous difference was found between GIRFs and IRFs, and the results of the finding are very similar.

5. Conclusion

This empirical study employed the SFAVEC model to establish the linkage between global liquidity on global commodity prices. The study's motivation was to investigate the interdependence between global liquidity, commodity prices and global interest rate, global CPI, and global trade of goods in emerging economies and developed economies. Numerous questions that seem to bother investors on a global scale, were thoroughly investigated. This revealed that specific value for the commodity prices requires a degree of uncertainty, looking at the significant differences between the BRICSM M2 and G4 M2 on the commodity prices. The commodity price volatility will prevail for some time to come as the demand for these commodities exceeds the supply. Latent uncertainty has a more significant impact on BRICSM economies relative to G4 economies, which has a long-run positive effect on commodity prices' volatility. The positive innovations shock in BRICSM M2 leads to significant and persistent surges in the global interest rate, global trade of goods and commodity prices. With an increase in central bank discount rates, the money supply decreases. This is consistent with the conventional transmission of money that an upsurge in interest rate triggers the money supply to fall. A positive innovation in G4 M2 produces a significant positive response that leads to a surge in commodity prices, but the response in the commodity price of the magnitude is relatively small compared to positive innovations in BRICSM M2 linked with a positive effect on the commodity prices.

Enhanced understanding of BRICSM liquidity and G4 liquidity relationships has potentially significant implications for the healthier version of the major developing and developed economies. The results also have important implications for BRICSM M2, to the extent that BRICSM M2 liquidity has significant effects on commodity prices that could help stabilize the developing and emerging economies during the global financial crisis. Granger casualty goes from commodity prices to BRICSM M2, and Granger casualty goes from G4 M2 to commodity prices. The BRICSM M2 is statistically significant. This implies that BRICSM M2 has a long-run effect on global commodity, global consumer price index and global trade of goods, but G4 M2 has a short-run impact on the global commodity, global consumer price index and global trade of goods. The study also found that BRICSM M2 and G4 M2 and commodity prices are cointegrated. The underpinning financial regulation in commodity markets expected to influence commodity prices through liquidity shrinks significantly. The findings have significant implications for policymakers, market participants, investors, and international finance in commodity futures markets to affect investment strategies. Future research may consider using an SVAR model to explore global liquidity, commodity prices and alternative identification schemes.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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