Volatility of International Commodity Prices in Times of Covid-19: Effects of Oil Supply and Global Demand Shocks

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Abstract

This study examines the effects of oil supply and global demand shocks on the volatility of commodity prices in the metal and agricultural commodity markets using the SVAR model. The empirical evidence is based on real time daily closing international commodity prices covering the period 2 December 2019 to 1 October 2020. The findings are presented in cumulative impulse responses and variance decompositions. The former is utilized to examine the accumulated influence of structural shocks on the volatility of agricultural and metal commodities whereas the latter reflect the share of variation in the volatility of each commodity arising from each structural shock. Various patterns are provided on how metal and agricultural commodity prices have been influenced by the COVID-19 pandemic. Policy implications are discussed.

Keywords: Covid-9; Commodity Prices

JEL Classification: H12; I12; O10

1. Introduction

The purpose of this study is to examine the impact of oil supply and global demand shocks on commodity prices in the metal and agricultural commodity markets in the context of the COVID-19 pandemic. While the impacts of the COVID-19 outbreak are still unfolding, the pandemic has already had significant effects on the economies of most countries (KPMG, 2020; Faria-e-Castro, 2020; Atkeson, 2020; Cullen, 2020; Price & van Holm, 2020) and international financial and commodity markets. After recording a 2.9 percent growth in 2019, the global economy was projected to grow by 3.3 percent in 2020 until the outbreak of COVID-19 in China, which has since caused shockwaves across the globe (Oskoui & Belaifa, 2020; Baldwin & di Mauro, 2020). The negative externalities of the pandemic which were first felt in China have now extended to the entire world. These include shocks to supplies of commodities (Asongu & Diop, 2020; Price & Adu, 2020; Amankwah-Amoah, 2020; Asongu, Diop, Nnanna, 2020).

According to the World Bank (2020), the underlying externalities on commodity prices are contingent on the type of commodity. According to the narrative, at the onset of the COVID-19 pandemic: (i) the monthly price of crude oil substantially dropped by almost 50% to a historic low as some benchmarks were trading at negative levels. (ii) Metal prices also fell, with the most significant drop in zinc and copper which were directly linked to the slowdown in global economic activity. (iii) Prices of agricultural commodities which are less linked to economic growth did not drop significantly, with the exception of rubber which is directly linked to transportation activities.

Commodity prices globally are down significantly since the coronavirus outbreak. The proximate cause can be linked to falling Chinese demand, with manufacturing, air travel and transport fuel severely hit by the outbreak (Ake International, 2020). Given that China has a significant share of global commodity imports, a substantial domestic economic decline is expected to engender contagion effects across the international commodity market (AKE International, 2020).

As COVID-19 continues to alter the trajectory of the global economy, commodity investments are likely to be less liquid and more volatile compared to other investments (Goldman Saches, 2020). The risk of loss associated with trading in commodities can be substantially significant as a result of volatile economic, political and market conditions.

Commodity prices are inherently volatile since they respond rapidly to several unpredictable factors including labour strikes, weather conditions, foreign exchange rates, speculations, inflation, *inter alia*. (Goldman Sachs, 2020). According to the Economic Community of West African States (ECOWAS) Commission (2020), the spread of the virus has had negative economic impacts on commodity prices which are influenced exogenously.

Poor countries and most emerging economies often heavily depend on primary commodity exports. Such dependence exposes their economies to wild price variations as apparent during the COVID-19 pandemic (United Nations Coordinated Appeal, 2020). The Central Bank of Nigeria (CBN) (2020) has a similar perspective and highlights that the dwindling global output performance and growth since January 2020 has culminated in losses in global stock values, declining primary commodity prices and disruptions to the global supply chain owing to global lockdown in major economies in the world. Plummeting international commodity prices largely translate into huge losses in export earnings (Vam food security Analysis, 2020).

There seem to be a consensus that commodity prices have precipitously reduced significantly since the outbreak began (Erken et al., 2020; UNCTAD, 2020; Ozili & Arun, 2020; PWC, 2020a; United Nations Economic Commission for Africa [UNECA], 2020; Thilmany et al., 2020; Bank of International Settlement [BIS], 2020; Jackson et al., 2020; Ribakova, Ulku & Hilgenstock, 2020). Thus, from a theoretical perspective, commodity prices are very sensitive and are expected to decrease as COVID-19 unfavorably affects global aggregate demand and supply. In effect, COVID-19 reflects a combination of supply, demand, and uncertainty shocks (Vijlder, 2020; Hunter, Kim & Rubin, 2020). The underlying pandemic therefore has knock-on effects on commodity prices as well as financial conditions which in turn could have ramifications on economic growth (Vijlder, 2020; Crisil, 2020).

The energy sector has already felt the impacts of COVID-19 arising mostly from demand shocks (Kingsly & Henri, 2020). The pandemic has contributed to a decline in demand for oil, resulting in falling oil prices and decrease in production, especially in the wake of the price war between the Organisation of Petroleum Exporting Countries (OPEC) and Russia. In the same vein, the outbreak of the pandemic has negatively affected the non-energy commodity sector. For instance, demand for copper has decreased, as major auto and home appliance manufacturing hubs have been hit by the outbreak and visible stocks are expected to continue building over the coming weeks as demands keep dropping. Similarly, aluminium end-use demand as well as semi fabricators' operation has been affected by the outbreak, resulting in a large inventory build (Citigold, 2020). Prices of other raw commodities like cotton plunged even lower than experts projected, due to the worsening pandemic. As prices plummeted, producers were faced with the options of either making margin calls or liquidating their positions by way of price fixation. Producers largely preferred the latter option, which prompted the market to slide even further (United States Department of Agriculture [USDA], 2020).

Although when and how the COVID-19 outbreak would be contained is still an ongoing assessment, one of the important questions is to what extent the commodity prices have so far been affected by the epidemic. With data and literature on impacts of the COVID-19 pandemic still evolving, the present study builds on the movements and trends of commodity prices using a recent monthly dataset to analyse the Global Price Index, Producer Price Index, Export Price Index and Imports Price Index, for all commodities.

The focus of this study departs from the extant contemporary studies on the COVID-19 pandemic which have focused on, *inter alia*: the nexus between COVID-19 and oil price crash (Albulescu, 2020), analyzing the information-rich wheat markets at the early phase of COVID-19 (Vercammen, 2020); anticipating the impact of COVID-19 on country-specific trade in commodities (Barichello, 2020) and farmland markets (Lawley, 2020), the impact of COVID-19 on nexuses between crude oil and agricultural futures (Wang et al., 2020) and a review of the socio-economic impact of the COVID-19 pandemic which touches on some commodities (Nicola et al., 2020).

Four main studies are closest to the present study in the contemporary COVID-19 literature focusing on extractive industries, namely: Laing (2020), Bernauer and Slowey (2020), Francis and Pegg (2020) and Calvimontes et al. (2020). First, while Laing (2020) has assessed the economic effect of the COVID-19 pandemic and provided implications for the mining industry, the analysis is exploratory and based on March and April 2020 observations. The present study used data from the 2nd of December, 2019 to the 1st of October, 2020 on the one hand and on the other, it is not exploratory because the empirical analysis is based on a structural vector autoregressive (SVAR) analytical technique. Second, Francis and Pegg (2020) have highlighted challenges faced by a micro-scale development project amid the closure of schools owing to the COVID-19 outbreak in March 2020 in the Rural Nigeria Delta region of Nigeria. The attendant study is also exploratory, based on evidence from a single month (i.e. March 2020) and does not directly focus on products of extractive industries because the corresponding development project is understood within the framework of corporate social responsibility (CSR). Third, Bernauer and Slowey (2020) have focused on the impact of the COVID-19 crisis on the extractive industry and indigenous communities in Canada while Calvimontes et al. (2020) have been concerned with how the COVID-19 pandemic has affected cooperation and conflict in small-scale and artisanal mining of gold in the Brazilian Amazon. Both studies which exclusively focus on one country and respectively also have the shortcoming of being exploratory because of the absence of empirical analyses that inform corresponding conclusions.

In the light of the identified shortcoming above, this study departs from the discussed strand of exploratory and country-specific literature using an updated dataset (i.e. from the 2nd of December, 2019 to the 1st of October, 2020) to provide empirical evidence pertaining to oil supply and global demand shocks on the volatility of commodity prices in the metal and agricultural commodity markets using the SVAR model. The results are presented in the forms of cumulative impulse responses and variance decompositions. The impulse response is utilized to explore the accumulated influence of structural shocks on the volatility of agricultural and metal commodities whereas variance decompositions reflect the share of variation in the volatility of each commodity arising from each structural shock.

The rest of the study is structured as follows. Section 2 provides an overview of the impact of COVID-19 on commodity markets while Section 3 discusses the data and the methodology. Section 4 presents the empirical results and corresponding discussion while policy responses are provided in Section 5. Section 6 concludes with implications and future research directions.

2. Literature Review

2.1 Overview of impact of COVID-19 on Commodity Markets

Weaker Demand and Supply Chain Disruption: the Corona virus outbreak has triggered an unprecedented combination of shocks to global commodity markets, affecting both demand and supply chains. While measures taken to contain the pandemic are essential, they however have had adverse impacts on the supply of and demand for commodities. The unique combination of these shocks has had varying impacts on different commodities (World Bank, 2020). The pandemic has led to weaker global commodity demand. The demand for energy and metals is most affected. Baffes, Kabundi and Nagle (2020) argue that unlike demand for agricultural commodities, slowdown in economic activity strongly affects demand for energy and metals due to its higher income elasticity. Whereas energy price indices declined by -61.82 between December 2019 and April 2020, agricultural goods indices seem to be more resilient with the indices falling by -6.68% during the same period.

Global, Producer, Export and Import Price Indices of all commodities on the decline: These indices were obtained from the Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org/) for the period December, 2019-September, 2020. Global price index for all commodities denotes the benchmark of prices which are representative of the global market, and are determined by the largest exporter of a given commodity. Prices are basically periodic averages in nominal U.S. dollars.

The Export Price Index is a measure of change in price of domestically produced goods and services shipped or transferred to the residents of the other economic territories. This does not include re-exports. The Import Price Index on the other hand, measures price changes of imported goods and services (United Nations, 2007).

Producer price indices in manufacturing provide measures of average price movements received by the producers of different commodities. They are often viewed as advanced indicators of price variations throughout the economy, and may include changes in the prices of consumer goods and services (OECD, 2020).

Generally, commodity price indices have significantly declined as the pandemic continues to disrupt the global supply and demand chains. The global price index of all commodities (GPIAC) plummeted steadily from December 2019 through March 2020 with the margin of negative difference widening every month (See Figure 1(a)). For the purpose of comparison, we took the monthly average of price indices in 2008 to represent the similar global shock caused by the Global Financial Crisis (GFC). The trend shows that GPIAC declined from 119.91 in December 2019 to 119.55 in January 2020. Moreover, GPIAC in February 2020 was 111.09, representing about 7.6% decline from the previous month, while GPIAC dipped by 18.3% in February to settle at 93.88 in March. When compared to the GFC when the GPIAC averaged 163.13, it can be said that the shocks associated with COVID-19 outcomes had more negative impacts on the global commodity prices compared to corresponding impacts during the 2008 global financial crisis.

Similarly, Producer price Index, and Export and Import indices for all commodities have displayed modest declines between December 2019 and March 2020. While the Producer Price index ((See Figure 1(b)) and Import price index (See Figure 1(c)) appeared to have been hit more severely during the GFC, Import indices recorded are shown to have a more downward tick as a result of the COVID-19 pandemic compared to the GFC (See Figure 1(d)). Generally, the rallying point and early signs of recovery from declines of all the indexes started in May, 2020. The trends have largely maintained slow but steady upward movements through September, 2020.

Figure1. Trends of commodity price Indices

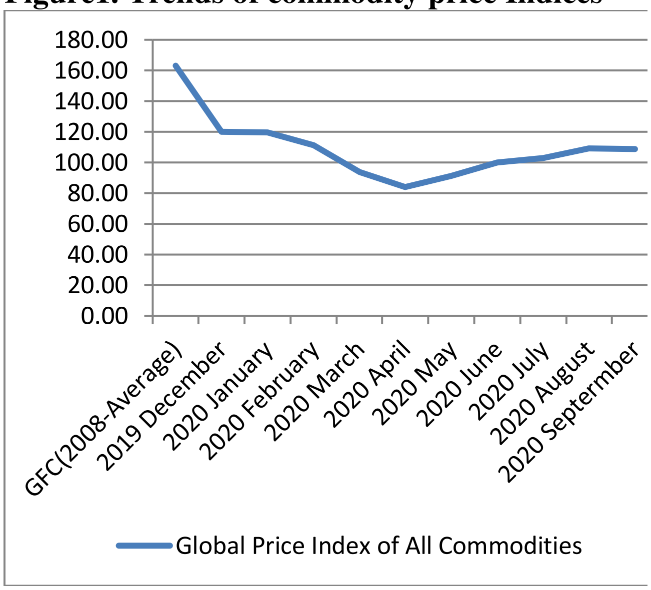


Figure 1(a)

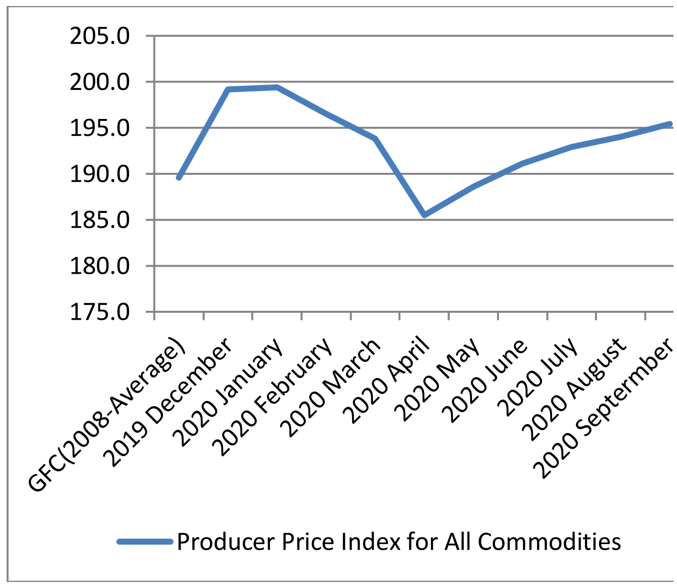
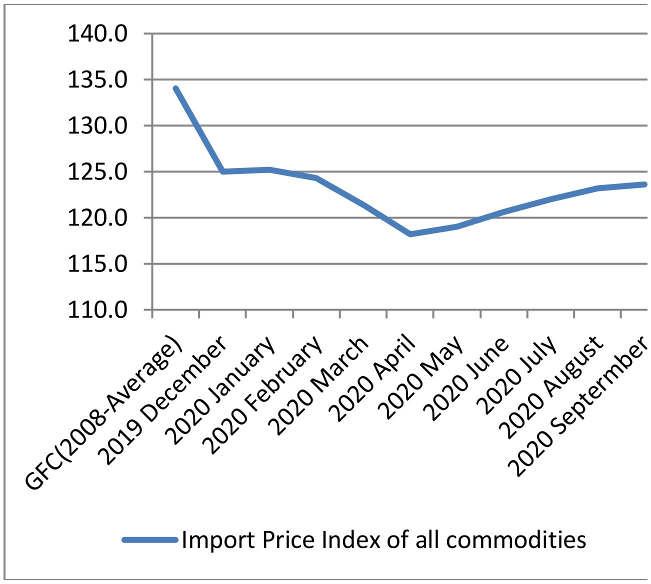


Figure 1(b)



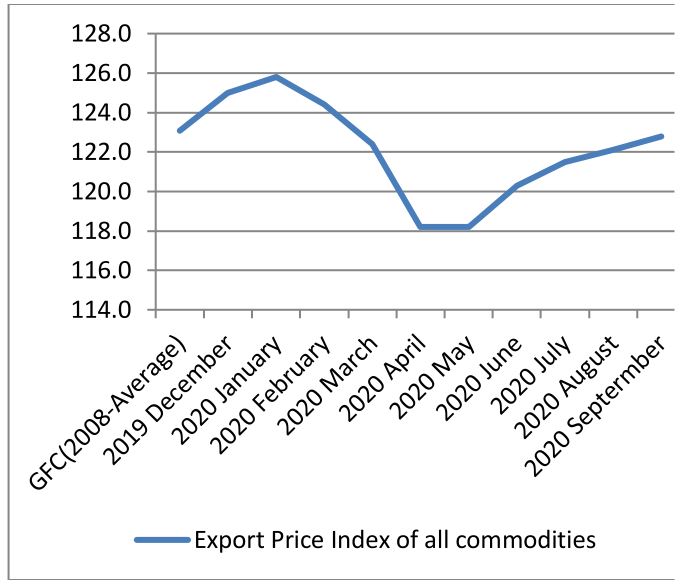


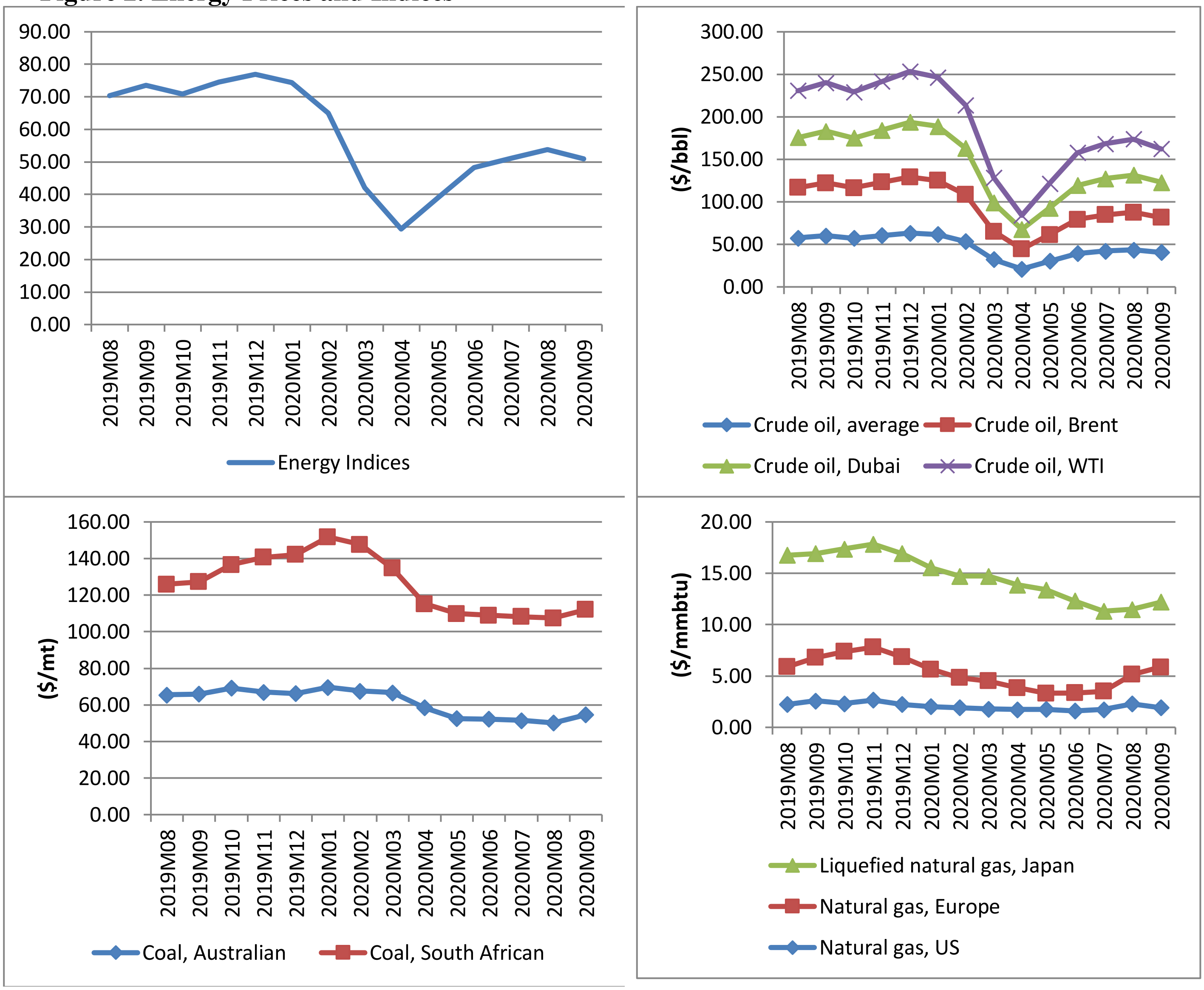
Figure 1(c)

Figure 1(d)

Energy Prices plummets: The impact of the pandemic has continued to hit the energy sector. The energy market is facing new signs of weakness as COVID-19 negatively affects refinery demand for crude oil (Citigold, 2020). The outbreak has led to dampened oil demands, resulting in plunging oil prices as well as declines in global oil production, especially in the wake of the OPEC-Russia price war (PWC, 2020). Energy indices and crude oil prices saw steady declines from December 2019. Changes in both parameters were in the negative trajectory through April 2020 as shown in Figure 2. Within the period, energy indices and average crude oil price declined by 61.82% and 66.78%, respectively. On a monthly basis, energy indices declined by 12.73% between January and February, 35.24% between February and March, and 30.19% between March and April 2020. As signs of rebound are weakened by prolonged global lockdown which has continued to affect the swiftness of global economic recovery, crude oil prices generally decreased.

The trend of falling industrial production is further reflected across diverse components of the energy sector, spanning from coal to natural gas which, as shown in Figure 2, plummeted during the period. Coal decreased more compared to natural gas that also declined but at a less decreasing rate. However, the depression experienced in the coal sector may reverse as domestic coal mines have been urged by the National Energy Agency to resume coal production.

Figure 2. Energy Prices and Indices



Agricultural prices showing signs of resilience with moderate declines in indices: On the supply side, the agricultural sector could be impacted through shortages of labour which limit food production and processing, especially of labour-intensive products. The transportation world has been significantly disrupted, as quarantine measures have restricted access of farmers to input and output markets; restrictions which have led to an increase in global food loss and waste owing to food supply chain disruptions (World Food Program [WFP], 2020). As shown in Figure 3, the agricultural commodity indices largely maintained a strong upward movement from

November 2019 to January 2020. Average monthly decline in agricultural indices between December 2019 and April 2020 was -0.89%.

Meanwhile, amid the pandemic, global cereal and grains markets appear well supplied with currently no significant impact on crop production (WFP, 2020). As shown in Figure 4, grains and cereals proved more resilient to the COVID-19 pandemic compared to other agricultural produce. This may be an indication of low price volatility in the international grains market. In Figure 5, the percentage change in grain indices between December 2019 and April 2020 remained positive at 5% while timber (-3.64%), raw materials (-5.06%), beverages (-7,16%), and oils and meals (-9.09%) were the most affected by the outbreak.

Figure 3. Agricultural Sector Indices

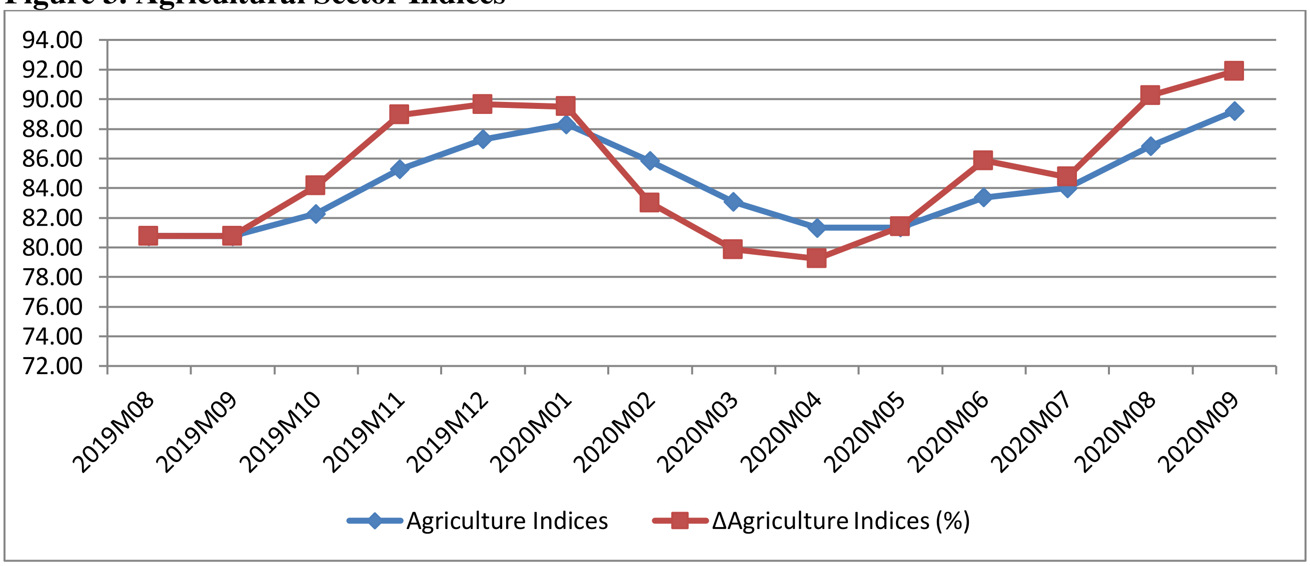


Figure 4. Crops and Raw material Indices

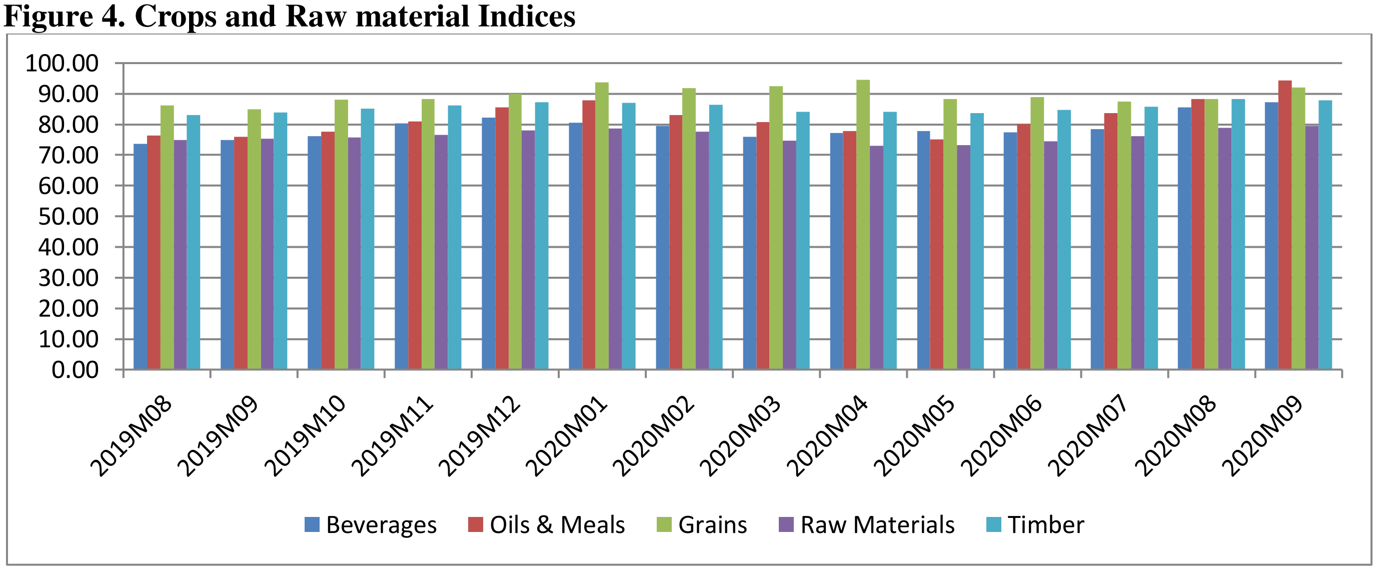
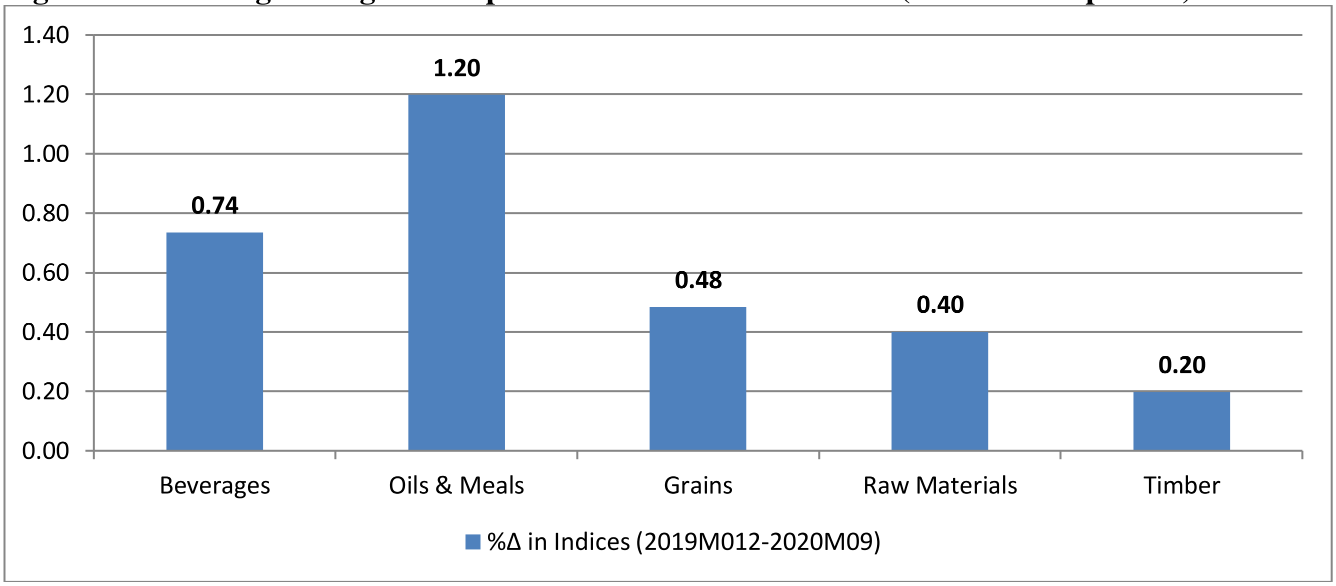
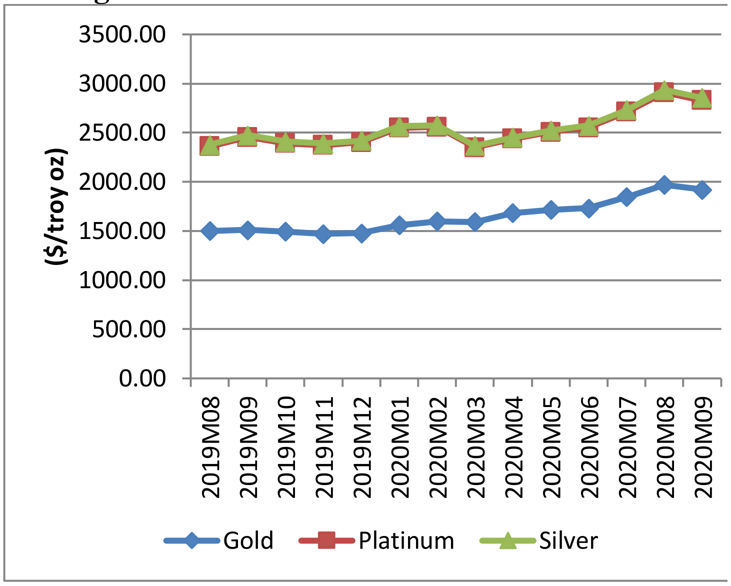


Figure 5. Percentage change in Crops and Raw Materials Indices (Dec. 2019-Sep. 2020)

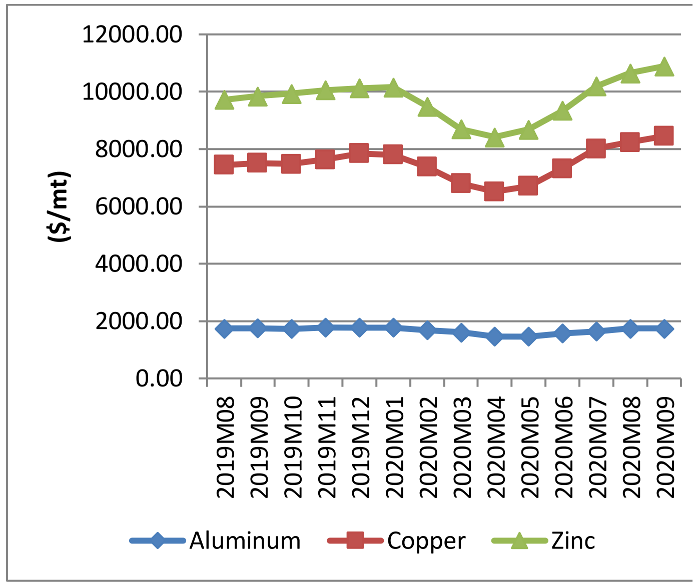


Base and Precious metals showing some resistance: Demand for copper and base metals have weakened, largely from COVID-19. This has lingered on as major auto and home appliance manufacturers around the world were hit by the virus outbreak. Similarly, the pandemic has weighed down on zinc and aluminum end-use demand. The outbreak has led to the shutting down of mines and decline in global base metals end-use demand. Of the major metals and minerals, aluminum appears to be less affected by the outbreak compared to copper and zinc (See Figure 6). Moreover, prices of precious metals have been fairly stable throughout the period of the outbreak. Gold prices maintained a steady increase while silver and platinum prices followed a similar tendency but at a weaker trend. Prices for all the precious metals fell only in March with some signs of a bounce back as reflected in their April price indices.

Figure 6. Base and Precious Metals Prices



Precious Metals Prices



Metals and Minerals Prices

It is important to note that weather factors (such as the dry and hot summer in Europe) have also had an impact on agricultural commodities such as wheat (Beillouin et al., 2020). Moreover, a key concern as to why precious metals and gold have remained buoyant could be traceable to safe haven investors and speculative demand instead of industrial demand (Copper-Ind, 2020).

2.2 Empirical Literature

The nexus between food commodity, metals and energy continues to interest researchers with a number of studies examining the linkages between agricultural commodity, metals and crude oil prices. In the existing empirical literature, vector autoregressive model (VAR) models have been widely employed to capture the effect of crude oil price fluctuations on agricultural and metal commodity prices (Vu, 2019; Lucotte, 2016; Ahmadi et al., 2016; Cha & Bae, 2011; Ma et al., 2016). Adam et al. (2018) utilized the VAR model to analyze nexuses between oil price, rice price and exchange rate. Their findings reveal that crude oil price has a unidirectional relationship with rice price, which only exists in the short-run. Wang et al. (2014) employed the SVAR model to explore the effect of different oil-related shocks on different agricultural commodity prices. The results show that the impact of oil-specific demand shocks on the various agricultural commodity prices was significant after the food price crisis.

Ahmadi et al. (2016) employed the SVAR model to analyse the effects of oil price shocks on volatility of metal and agricultural commodities. Their findings based on impulse response functions show that the response of volatility of each commodity to crude oil price shock varies significantly and is dependent on the underlying source of the shock for the periods captured in the study.

Han et al. (2015) used the multivariate normal mixture approach to examine the interactions between oil price and agricultural commodity prices. Their findings reveal that industrial commodity prices tend to affect one another more especially when the price and volatility transmission are triggered by financial crisis. Chen and Saghaian (2015) based their analysis on the VECM framework on Brazil, and showed that the association between oil, sugar and ethanol appeared stronger after the 2008 financial crisis. Accordingly, oil price appears to be weakly exogenous to other commodities, sugar price influences the ethanol price in the first sub-period whereas the influence between ethanol and sugar prices are reciprocal in the second sub-period.

Vu et al. (2020) used the SVAR to investigate the impact of different agricultural shocks on the agricultural and oil markets in the US between 1986 and 2018. Findings from this paper suggest that different agricultural shocks can affect oil price differently, and that corn use in ethanol tends to play an important role in the influence of corn demand shocks on oil price. The authors also find evidence that the agricultural market can influence oil prices through two main mechanisms, notably: direct biofuel effect and indirect cost push effect.

Based on the Johansen cointegration test, Ciaian and Kancs (2011) argue that, during the period 1994-2008, crude oil prices affected agriculture prices and that the inter-dependency between agricultural commodity and energy price tends to increase over time. Saghaian (2010) employed the VECM model during the period 1996-2008 to reveal that agriculture and oil prices are cointegrated while causality was found to run from oil to agricultural prices.

Suetal (2019) found that bidirectional relationships exist between crude oil price and agricultural commodity prices, and are more likely to be found when the sub-sample rolling estimation is used. Moreover, the study also suggests that agricultural commodities other than feed stocks of biofuel production tend to have bidirectional relationships with oil price.

3. Data and Methodology

The main purpose of this paper is to examine the impact of the COVID-19 pandemic on international commodity prices with empirical focus on the responsiveness of agricultural and metal commodity prices to oil price shock during the period of the outbreak. In this paper, we obtained real time daily closing prices of the variables of interest between the 2nd of December, 2019 and the 1st of October, 2020 from a mainstream investing source[1]. The time series include crude oil (WTI) prices, agricultural commodities (soybeans, corn, wheat and rough rice), and metals (gold, silver, copper and aluminium). By using the real prices of the commodities, the simultaneous inflationary influence of monetary policies on the commodity prices are controlled for (Ahmadi et al., 2016).

We analyse the responsiveness of the volatility of commodity returns to oil shocks within a Structural Vector Autoregressive (SVAR) framework. It has been suggested that metals and agricultural commodity prices are largely endogenous to oil price, and vice versa (Natanelov et al., 2011; Su et al., 2019; Avalos, 2014). Therefore, traditional regression models may not capture the bidirectional association among the commodities (Vu et al. 2019). Baumeister and Kilian(2014) argue that although the endogeneity problem can be treated using the VAR models, such models are considered inefficient in establishing a causal relationship between oil, metal and agricultural commodity prices. Thus, we adopted the SVAR model, with exclusion restrictions anchored on the economic theories as well as empirical evidence.

We first employed the GARCH (p,q) model proposed by Bollerslev (1986) in estimating the conditional volatility of each commodity return. The appropriate models were chosen based on the ARCH test, serial correlation and the Akaike Information Criterion (AIC). Thus, the selected model for soybeans, rough rice, wheat and corn is the AR(1)-GARCH(1,1), while for gold, copper, silver and aluminium, the AR(1)-GARCH(2,1) model proves to be more accurate. The parameters estimated fulfill the conditions of a non-negative conditional variance and the necessary stationarity conditions.

Table 1 presents the estimation outcomes of the variance equation in each GARCH model, the second moment condition as well as the relevant diagnostic tests.

[1] The interested reader can find more information about the investing source using the following website: https://www.investing.com/commodities/.

Table 1 Here

We employed the SVAR model to examine the time-varying responses of volatility of different commodities to different oil market shocks, namely oil supply, global demand, volatility and residual shocks. The SVAR specification is:

$$AX_t = \alpha \sum_{i}^{p} \varphi_i x_{t-1} + \varepsilon_t \qquad 1$$

In Equation (1), we have X_t= ($\Delta oilpr_t$, $\Delta aggrr_t$, $\Delta oilpr_t$, $\Delta aggripr_t$, $\Delta aggrmtpr_t$), where $oilpro_t$ is the natural logarithm of global crude oil production, $aggrr_t$ is the aggregate commodity price return, $oilpr_t$ denotes the real time crude oil price, $aggripr_t$ is the real time agricultural commodity price, $\Delta aggrmtpr_t$ is the real time metal commodity price and ε_t is the error term. Δ represents the first order differencing operator.

In line with the VAR structure proposed in Vu (2019), we imposed Matrix A where its inverse is represented in the following recursive structure:

$$A^{-1} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} \end{bmatrix} \qquad 2$$

The reduced form of Equation (2) is represented thus:

$$X_t = \beta + \sum_{i}^{p} \omega_i X_{t-1} + \epsilon_t, \qquad 3$$

Where,

$$\epsilon_t = \begin{bmatrix} \epsilon_t^{\Delta oilpro} \\ \epsilon_t^{\Delta aggrr} \\ \epsilon_t^{\Delta oilpr} \\ \epsilon_t^{\Delta aggripr} \\ \epsilon_t^{\Delta aggrmtpr} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} \end{bmatrix} \begin{bmatrix} \epsilon_t^{\Delta oilpro} \\ \epsilon_t^{\Delta aggrd} \\ \epsilon_t^{\Delta oilpr} \\ \epsilon_t^{\Delta aggripr} \\ \epsilon_t^{\Delta aggrmtpr} \end{bmatrix} \qquad 4$$

We estimated the SVAR model for the vector $X = \Delta oilpro_t$, $\Delta aggrr_t$, $\Delta oilpr_t$, $\Delta aggripr_t$ *and* $\Delta aggrmtpr_t$, The orders of the series in the vectors reflect the exclusion restrictions as widely established in the economic theories as well as empirical literature (Toetal, 2019; Wangetal, 2014). Existing empirical literature on the association between the oil market and the metal and agricultural markets often come to a consensus on the exogeneity of the oil price to both agricultural and metal markets (Kilian, 2009; McPhailetal, 2012; Qiuetal, 2012). As a result, oil market-related variables are widely considered to have higher orders in the vector of relevant endogenous series.

The perceived fluctuations in global aggregate demand, supply shocks and crude oil demand, which are mainly associated with improvements in trade openness, monetary and trade policies changes, contribute significantly to the fluctuation in demand for commodities and crude oil price (Vu et al. 2019). The SVAR enables us to untangle the influence of the commodities' demand and supply shocks from the common factors; the error terms are decomposed into mutually uncorrelated shocks (Vu et al. 2019).

Table 2 Here

Table 2 presents the descriptive statistics of returns on the time series. Oil price and aluminium prices have negative returns while the rest of commodities have positive but low returns. Among the agricultural commodities, corn prices reflect the lowest return while the precious metals (gold and silver) exhibit higher returns compared to the base metals (copper and aluminium).

Table 3 Here

As shown in Table 3, we ran the unit root tests based on the augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979), and Phillips-Perron (PP) (Phillips & Perron, 1988). The null hypothesis of the ADF and PP unit root tests is that the time series is non-stationary (or has a unit root). From the results, we cannot reject the null hypothesis that 8 out of 9 series were non-stationary at the 5% level of significance for both the ADF and PP tests. However, all the series of interest attained stationarity at the 1% significant level for the ADF and the PP tests.

4. Empirical Results and Discussion

We are examining the effects of oil supply and global demand shocks on the volatility of commodity prices in the metal and agricultural commodity markets using the SVAR model. The results are presented in the forms of cumulative impulse responses and variance decompositions. The impulse response is utilized to explore the accumulated influence of structural shocks on the volatility of agricultural and metal commodities whereas variance decompositions reflect the share of variation in the volatility of each commodity arising from each structural shock.

4.1 Agricultural Commodities

The estimated effect of oil shocks on the real time prices of selected agricultural commodities differs with each commodity as shown in the accumulated impulse response estimates in Figure 7. The result revealed that corn and wheat prices responded positively and significantly to oil market shocks whereas the responsiveness of soybeans and rough rice prices to oil shock were found to be negative. Figure 8 provides additional information on the historical decomposition of agricultural price returns from oil price volatility. The degree and magnitude of the observed responses are mixed. For instance, oil price volatility explained more of the variation in corn price returns, followed by rough rice, soybeans and wheat.

Figure 7 Here

Figure 8 Here

Figure 9 shows the cumulative responsiveness for agricultural price returns to oil price volatility which indicates that even though real time corn price responded positively to oil price, its returns responded negatively to oil price volatility. Price returns of soybeans and rough rice tend to respond positively to oil price fluctuations whereas wheat price returns remained more stable in terms of responsiveness. On the average, agricultural commodity prices appear to be weakened by shocks associated with volatility in the international oil market and these showed signs of recovery largely from days 150 to 175 (between June and July, 2020). This, in part, can be attributed to the economic impact of COVID-19 during the period which was characterized by global lockdown, while the period of recovery highlights the time when gradual ease of lockdowns seem to result in the reopening of most economies.

Figure 9 Here

With regards to the explanatory powers of oil market shock, results of variance decomposition estimates in Table 4 confirm the pattern of the historical composition and reveal that the responses of agricultural commodity price volatility to the oil shocks vary and the impact of oil price volatility on corn price return appears to be larger compared to other commodities.

Table 4 Here

4.2 Metal Commodities

The reactions of real time metal prices to oil shock differed between precious metals (gold and silver) and other base metals (copper and aluminium). This variation in response pattern is shown in Figure 10. The results indicate that gold and silver prices responded negatively to oil shock throughout the sampled pandemic period. On the other hand, copper prices responded positively to oil shock from days 0 to 130 (end of May, 2020) when its responsiveness to oil shock became negative for the rest of the period. Aluminium price, however, responded positively to oil shock over the period.

Figure 10

Figure 11

Figure 11 presents the historical decomposition of metal prices returns from oil price variations. The peculiarity of each metal did not follow a similar pattern with real time metal price where precious metals reacted in similar pattern and differed from other base metals. Gold price returns showed stronger signs of resistance to oil shock through the major phases of the pandemic. Returns of copper prices seem to experience more disruptions at the early phases of the pandemic than at the later stages. Silver and aluminium price returns exhibited more signs of fluctuations due to oil price volatility during the period.

Figure 12 shows the accumulated impulse response of metal price returns to oil price shocks. The results reveal that while gold and copper price returns responded positively to oil price volatility, silver and aluminium price returns responded negatively to oil price volatility for most of the periods. Cumulative impulse associated with gold returns appear to reflect the monthly price analysis which showed gold to be more stable compared to other metals during the height of the COVID-19 pandemic.

Table 5 presents the variance decomposition of metal prices due to oil price fluctuation. The result shows that larger percentages of changes in copper prices were explained by oil price fluctuations compared to other commodities. Gold, silver and aluminium returns accounted for smaller share of the explanatory power of oil price in that order.

Figure 12

Table 5

5. Policy Response

In the prolonged scenario where COVID-19 continues to threaten the global economy, its economic impact could be strong due to weak demand and extended disruption in the supply chains. In this case, contraction in global trade will be even more consequential in affecting the international commodity market in terms of driving down prices (Oskoui & Belaifa, 2020). It is therefore important to highlight that with such protracted disruption, aftershocks responses have to be considered. At first glance, monetary policy as a response may appear ineffective in addressing the economic impact of COVID-19 especially when measures taken to contain the outbreak also depress economic activities globally. For instance, a decrease in interest rate may not have the desired impact when there are disruptions in value chains of business entities and organisations around the world while, at the same time, some workers in households cannot go to work due to lockdown and travel restrictions. However, given the functioning of the financial market, timely actions from central banks can bring back confidence and help address the growing liquidity constraints and squeeze, confronting companies as well as primary producers (De Vijlder, 2020). Moreover, even though fiscal policy cannot address the persistent drop in economic activity largely due to COVID-19, it can directly support the shortfalls in demand. This could be done by implementing targeted fiscal measures towards small and medium-sized enterprises and other sectors of the economy severely affected by demand and supply shocks. Specifically, governments can address the underlying concern by stepping-up social security payments, making provision of loan guarantees, deferring value added tax, accelerating loan waivers – especially for farmers and critically affected extractive sub-sectors, and providing multi-phased stimulus for critical sectors of the economy. Hence, there is need for governments to identify strategic sectors with most production needs. In addition, as weak links in supply chains and dampened demand are expected, firms and manufacturing hubs can enhance their survival and benefits by reviewing their value chains structure, and making efforts to be less geographically confined.

6. Concluding implications and future research directions

The COVID-19 pandemic represents a mix of supply, demand and uncertainty shocks. These shocks have had substantial effects on the international commodity market and have also worsened financial conditions which are unfavorably affecting economic growth and by extension, economic recovery. Although the economic impact of the outbreak is multifaceted, this paper has assessed its impact on the commodity market with particular emphasis on the energy, agricultural and metals and materials sectors, using international prices and indices to trend the movements. Commodity price indices have significantly declined as the pandemic continues to disrupt global supply and demand chains.

The study first provides exploratory insights into trends of commodity indices before examining the effects of oil supply and global demand shocks on the volatility of commodity prices in the metal and agricultural commodity markets using the SVAR model. The empirical evidence is based on real time daily closing international commodity prices covering the period 2 December 2019 to 1 October 2020. The findings are presented in cumulative impulse responses and variance decompositions. The impulse response is utilized to explore the accumulated influence of structural shocks on the volatility of agricultural and metal commodities whereas variance decompositions reflect the share of variation in the volatility of each commodity arising from each structural shock. Various patterns are provided on how metal and agricultural commodity prices have been influenced by the COVID-19 pandemic.

The patterns of responses obviously have scholarly, practical and policy implications. On the scholarly front, the study has complemented the extant exploratory literature by providing empirical evidence on the volatility of international commodity prices in times of the COVID-19 pandemic with particular emphasis on the effects of oil supply and global demand shocks. Policy implications within the remit of global economic integration and corresponding managerial implications in terms of portfolio diversification are discussed in what follows.

First, on the front of global integration, in accordance with extant literature (Asongu, 2013), there are obvious implications for global economic integration in the perspective that the COVID-19 crisis has shown how economies in the world have become increasingly integrated, especially as it pertains to supply chains and cross-country dependence in the supply of factors of production. Such a tendency is apparent in the volatility of international commodity prices. It therefore confirms the perspective that policies designed by multilateral development institutions such as the World Trade Organization (WTO) to promote international trade are apparent in the light of the context of this study. It is worthwhile to articulate that despite the unfavorable effect of the COVID-19 pandemic in terms of uncertainty, the fact that global markets are integrated also enables investors to allocate their capital more efficiently in efforts to mitigate asymmetric shocks related to the underlying coronavirus crisis.

Second, from the stance of portfolio diversification, insights into the findings we have provided, is evidence to the fact that holding portfolios in different assets to hedge against the unfavorable effects of the COVID-19 pandemic can also be profitable to investors contingent on, *inter alia*, how the portfolios are diversified in countries and currencies. Hence, while no blanket strategies can be provided, investors or portfolio managers can leverage on the volatility tendencies documented in this study for arbitrage activity because of the absence of similar yields and liquidity for international commodity prices.

Given that the COVID-19 pandemic is still ongoing, there is obviously room for further research using more updated data as time unfolds. At the time of writing this paper in October 2020, many countries in Europe are taking measures to mitigate a second wave of the COVID-19 crisis. The framework of this study has covered the first wave. Hence, it would be worthwhile to assess if these findings withstand empirical scrutiny after the second wave in the months ahead.

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Table 1 GARCH Estimation

AR(1)-GARCH(p,q)	Variance equation			Information criteria	Diagnostic tests	
Commodities	$\alpha 1 + \alpha 2$	$\beta 1 + \beta 2$	Second moment condition	AIC	ARCH Serial correlation	
					F-stat	Q-stat
Soybeans	0.0470	0.9529	0.9907	-46.2016	4.8517***	14.3700
Rough Rice	0.0890	0.9057	0.9849	-51.0986	0.4376	11.2400
Wheat	0.0760	0.9164	0.9823	-48.5496	4.0125	22.0200
Corn	0.0410	0.9586	0.9904	-53.0946	2.0930	25.3000
	0.0480	0.9460	0.9839	-40.8592	4.81356**	-0.7910
Gold	0.0440	0.9563	0.9907	-52.0116	1.2952	14.1920
Copper	0.0380	0.9625	0.9908	-63.1826	4.25136**	12.0200
Silver	0.0400	0.9575	0.9875	-52.2056	0.0326	18.1890
Aluminium	0.0470	0.9529	0.9907	-46.2016	4.8517***	14.3700

Notes: ***, **denotes statistically significant at the 1% and 5%, respectively; AIC denotestheAkaikeInformationCriterion.

Table 2. Descriptive Statistics

Commodity	Mean	SD	Max	Min	Skewness	Kurtosis	Obs.
Oil	-0.016568	0.230303	0.3766	-3.0597	-11.09159	141.946	223
Soybeans	0.000435	0.008378	0.0323	-0.0239	0.40421	4.375852	223
Rough Rice	0.000564	0.030144	0.103	-0.259	-2.877075	28.54142	223
Wheat	0.000261	0.015048	0.0488	-0.0363	0.694772	4.034743	223
Corn	4.48E-06	0.013314	0.0391	-0.0524	-0.001664	4.245134	223
Gold	0.001201	0.013699	0.0577	-0.0468	0.005274	6.013578	223
Copper	0.000403	0.014336	0.0388	-0.0699	-0.842853	6.019793	223
Silver	0.001671	0.02797	0.0736	-0.1309	-0.789509	6.957285	223
Aluminium	-9.60E-05	0.013924	0.0394	-0.0352	0.042456	2.781074	223

Table 3. Unit root tests

	ADF		PP	
Commodity	**Levels**	**First Differencing**	**Levels**	**First Differencing**
Returns	**t-stat**		**t-stat**	
Oil	-3.50**	-14.24***	-3.49**	-14.30***
Soybeans	-0.91	-12.58***	-0.90	-12.55***
Corn	-0.58	-14.40***	-0.45	-14.41***
Wheat	-1.97	-15.65***	-1.98	-15.64***
Rough Rice	-2.63	-11.08***	-2.19	-10.80***
Gold	-3.29	-15.08***	-3.33	-15.13***
Copper	-1.26	-14.74***	-1.28	-14.80***
Silver	-1.89	-15.30***	-1.95	-15.30***
Aluminium	-1.09	-5.61***	-1.41	-22.45***

Figure 7. Cumulative responses of agriculture price volatilities to oil shocks

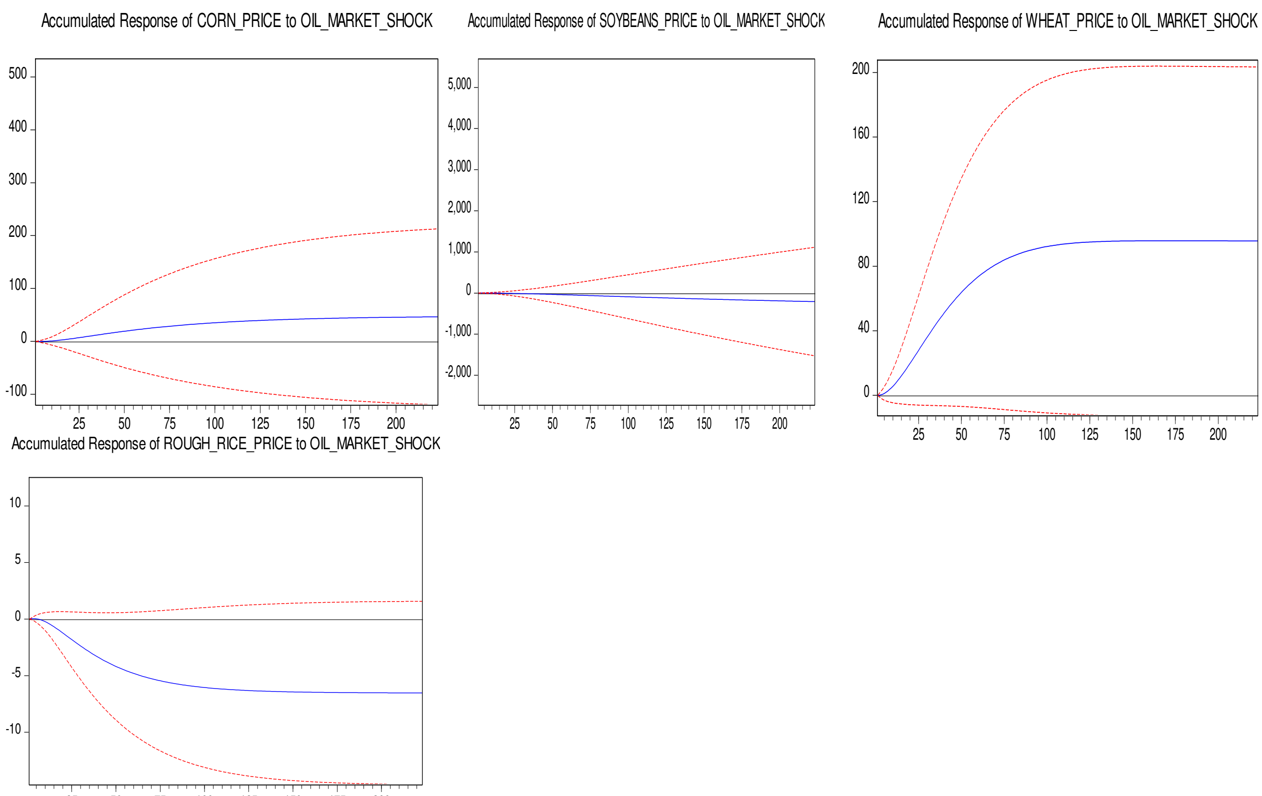
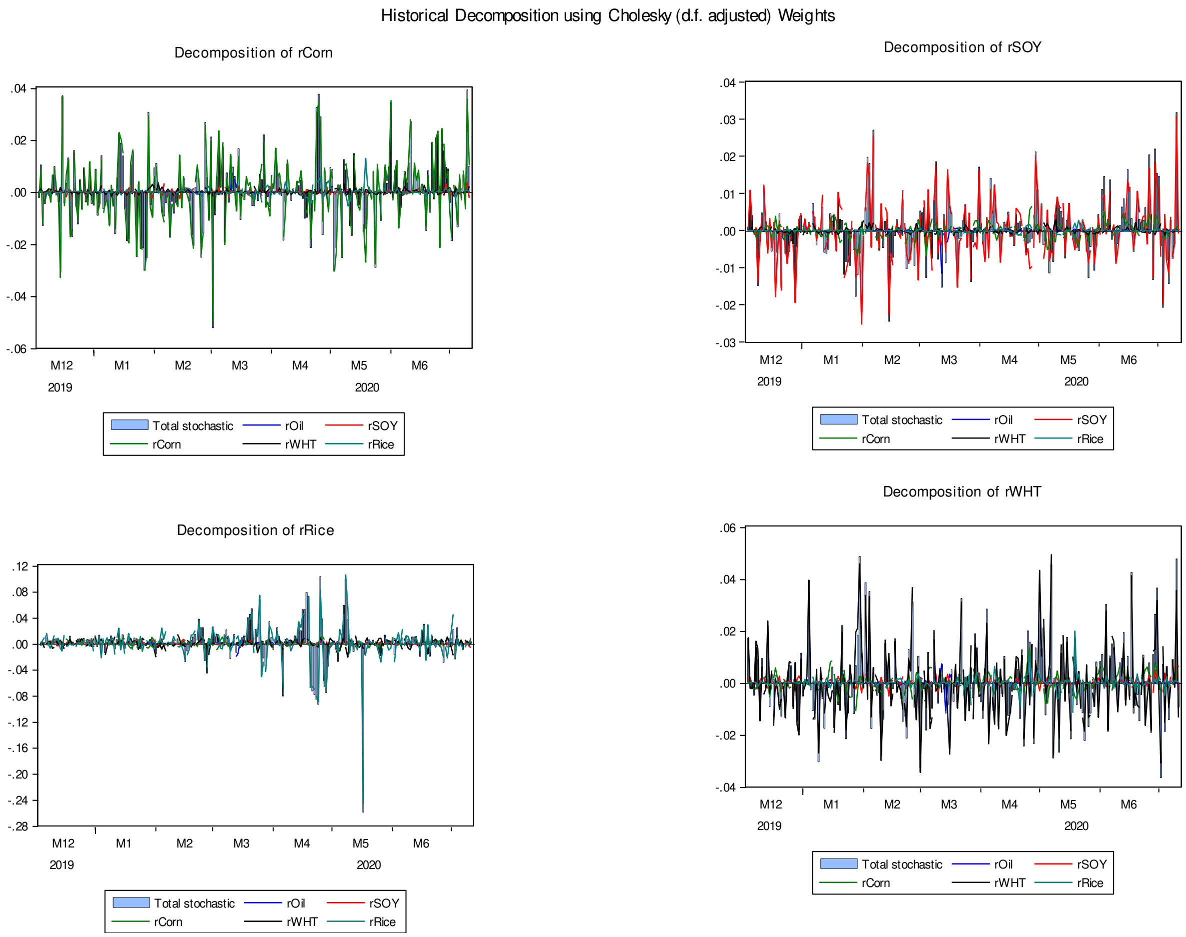
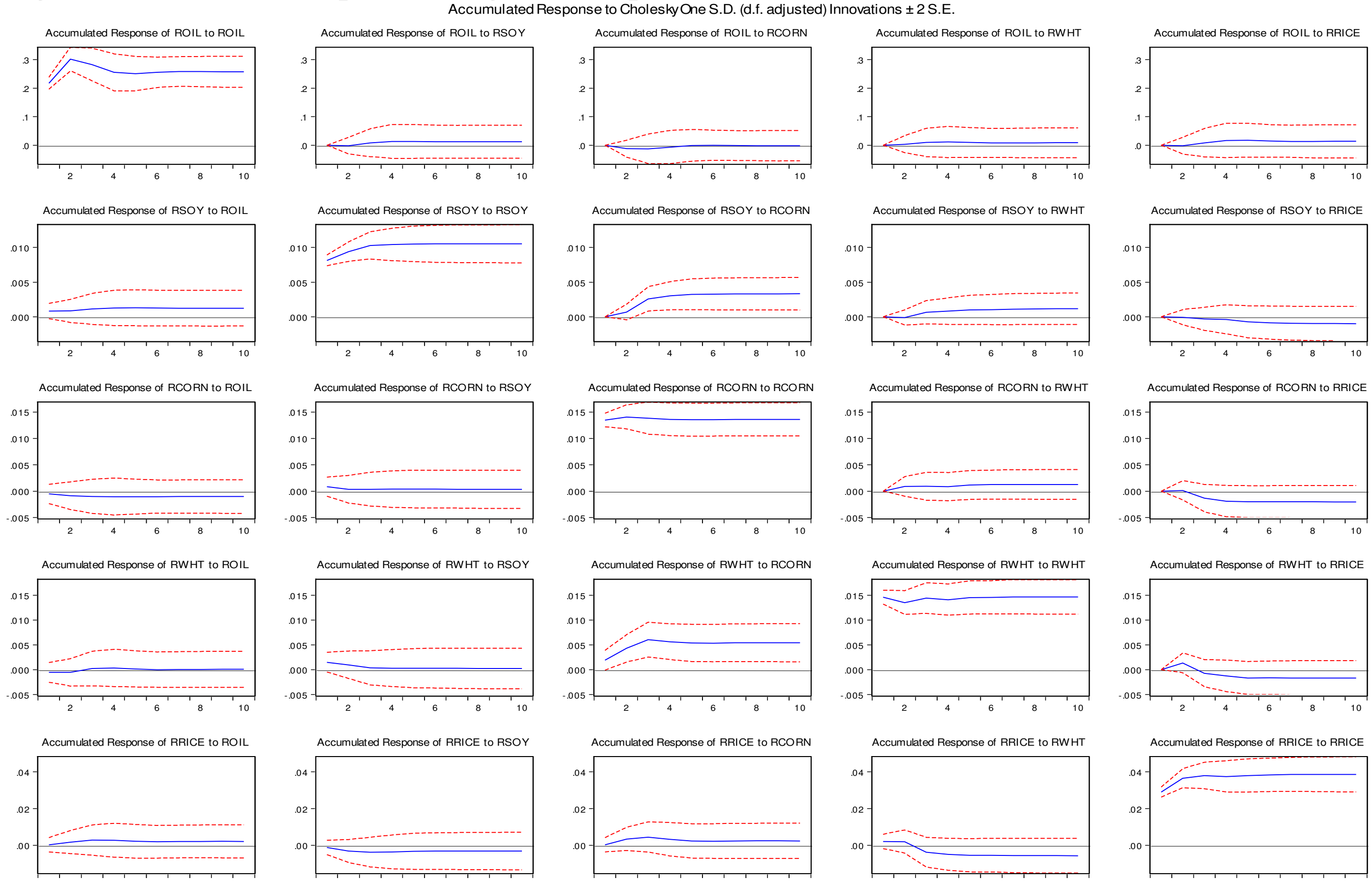


Figure 8. Historical Decomposition of Agricultural price returns from Oil price Volatility



Note: rOIL: return on crude oil price; rCORN: return on corn price; rSOY: return on soybeans price; rWHT: return on wheat price; rRICE; return on rough rice price

Figure 9. Cumulative responses of agriculture price volatilities to oil shocks



Note: rOIL: return on crude oil price; rCORN: return on corn price; rSOY: return on soybeans price; rWHT: return on wheat price; rRICE; return on rough rice price

Table 4. Variance decomposition of agricultural price returns

Period	S.E.	rOIL	rSOY	rCORN	rWHT	rRICE
1	0.217290	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.233466	99.69220	0.006377	0.275727	0.020790	0.004903
3	0.234740	99.26015	0.195912	0.273488	0.086732	0.183719
4	0.236580	99.03574	0.232333	0.335077	0.090115	0.306736
5	0.236710	98.96904	0.232078	0.397058	0.095140	0.306686
6	0.236781	98.95158	0.233723	0.397898	0.099436	0.317363
7	0.236806	98.94459	0.233712	0.401046	0.099416	0.321235
8	0.236808	98.94316	0.233847	0.401974	0.099787	0.321231
9	0.236809	98.94274	0.233882	0.402004	0.099923	0.321449
10	0.236810	98.94259	0.233883	0.402135	0.099923	0.321474

Note: rOIL: return on crude oil price; rCORN: return on corn price; rSOY: return on soybeans price; rWHT: return on wheat price; rRICE; return on rough rice price.

Figure 10. Cumulative responses of metal price volatilities to oil shocks

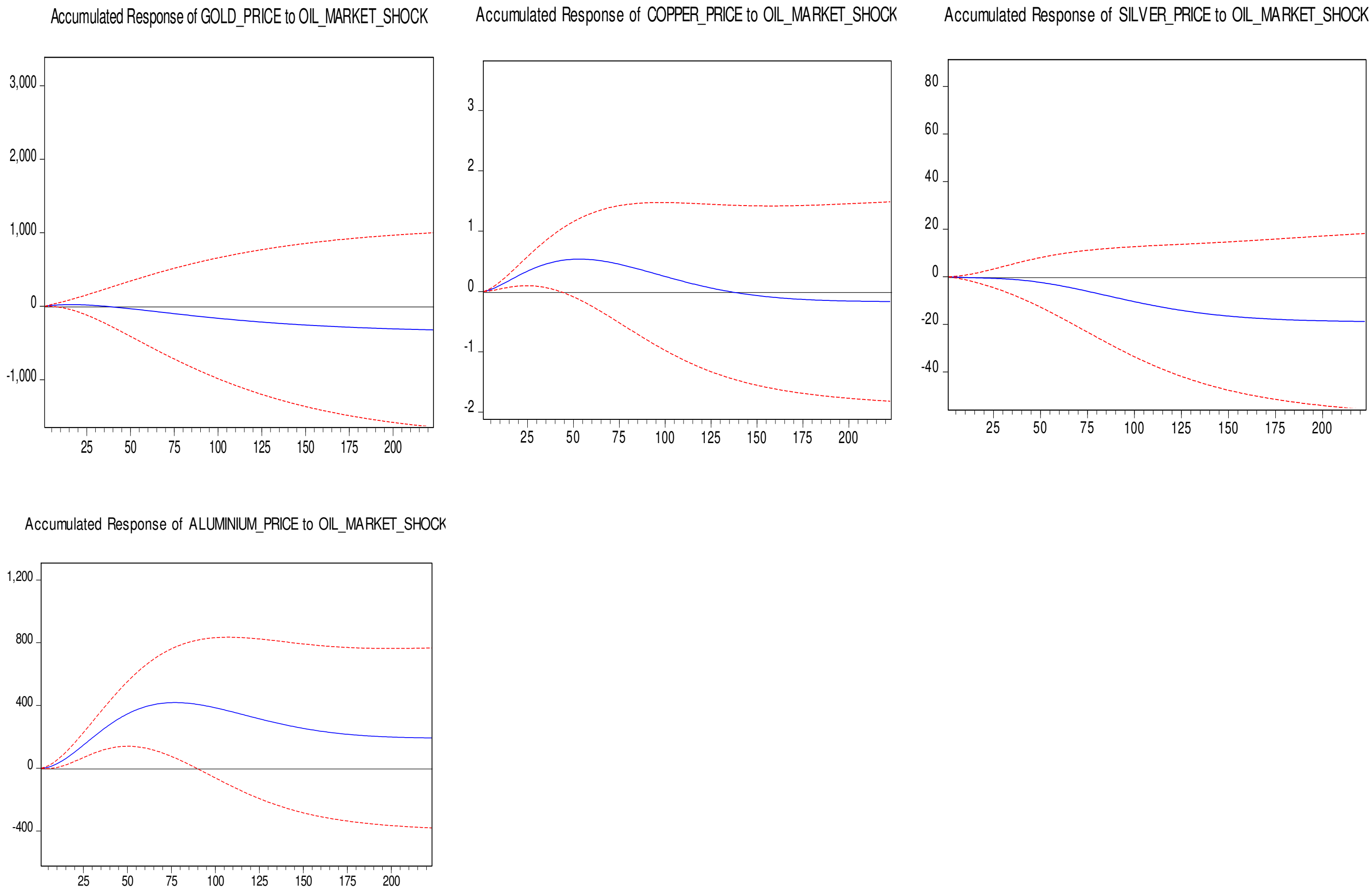
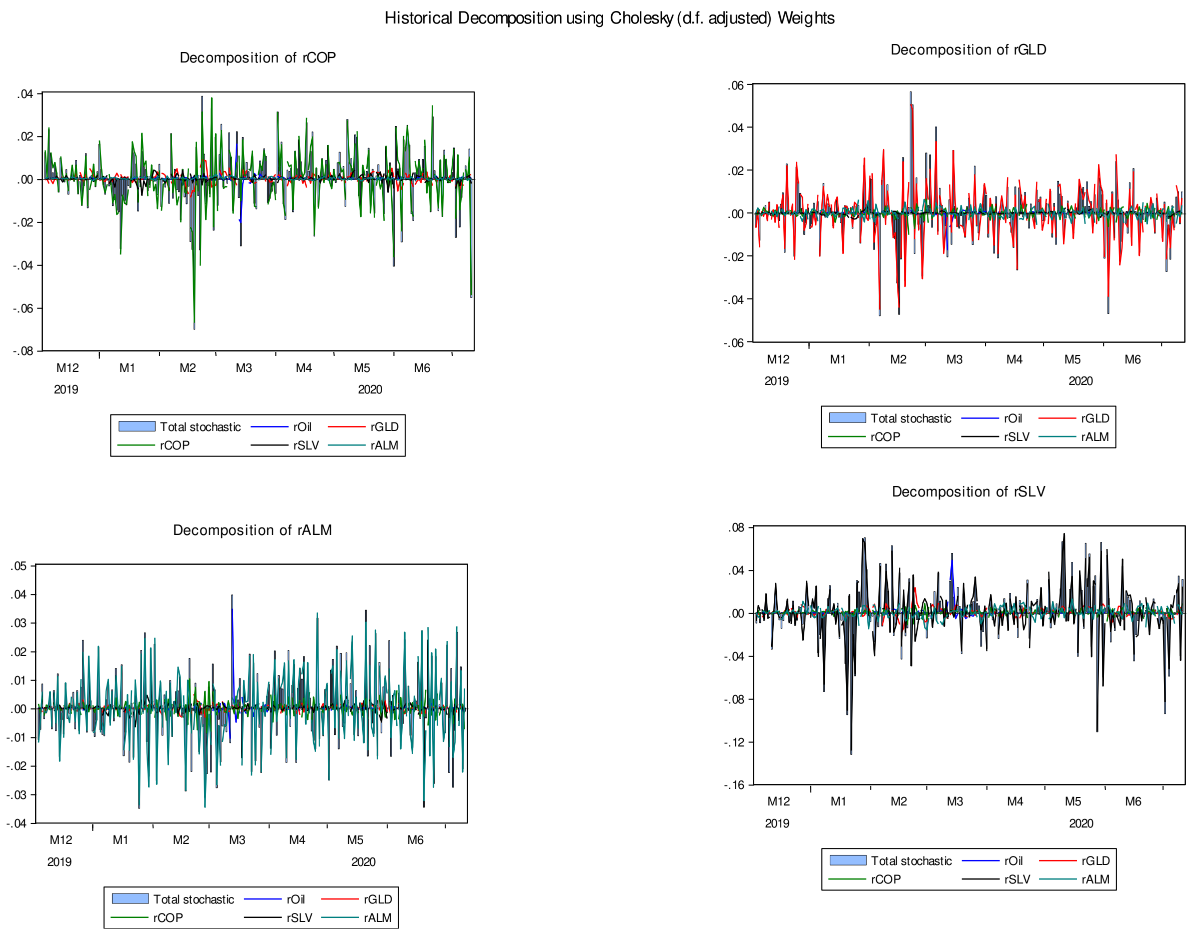
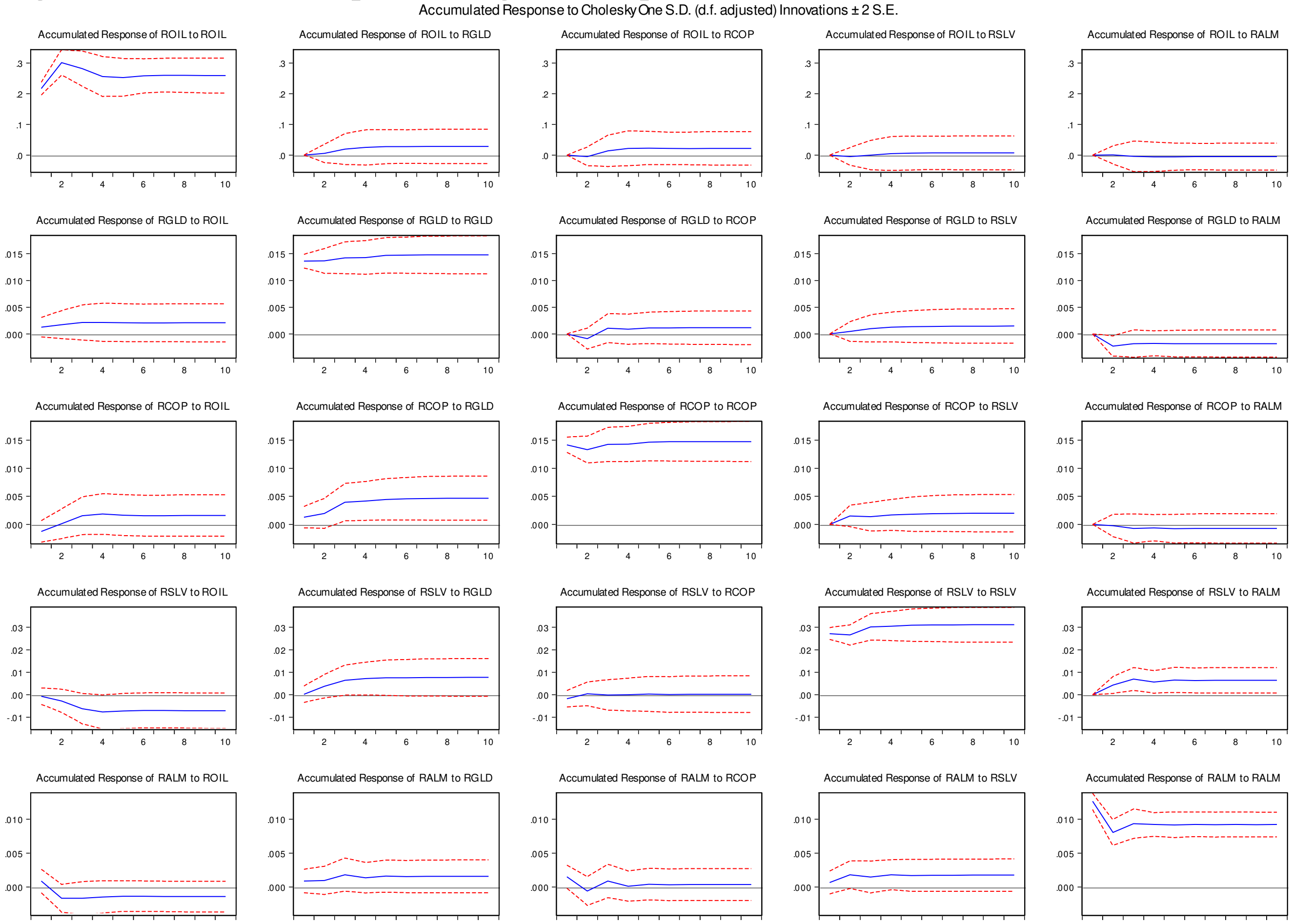


Figure 11. Historical Decomposition of metal price returns from Oil price Volatility



Note: rOIL: return on crude oil price; rCOP: return on copper price; rGLD: return on gold price; rSLV: return on Silver price; rALM; return on Aluminium price.

Figure 12. Cumulative responses of agriculture price volatilities to oil shocks



Note: rOIL: return on crude oil price; rCOP: return on copper price; rGLD: return on gold price; rSLV: return on Silver price; rALM; return on Aluminium price

Table 5. Variance decomposition of metal price returns

Period	S.E.	rOIL	rGOLD	rCOPPER	rSILVER	rALM
1	0.216708	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.232955	99.86649	0.051304	0.040359	0.041185	0.000660
3	0.235090	98.79714	0.417263	0.665529	0.079444	0.040628
4	0.236703	98.59927	0.462431	0.771041	0.120305	0.046951
5	0.236747	98.58064	0.472852	0.772538	0.126665	0.047303
6	0.236803	98.57687	0.472862	0.775916	0.126711	0.047641
7	0.236814	98.57682	0.472997	0.775843	0.126699	0.047642
8	0.236815	98.57644	0.473083	0.776085	0.126747	0.047646
9	0.236816	98.57624	0.473138	0.776190	0.126781	0.047648
10	0.236816	98.57623	0.473145	0.776190	0.126788	0.047648

Note: rOIL: return on crude oil price; rCOP: return on copper price; rGOLD: return on gold price; rSLV: return on Silver price; rALM; return on Aluminium price.