Pooled ordinary least-square, fixed effects and random effects modelling in a panel data regression analysis: a consideration of international commodity price and economic growth indicators in 35 Sub-Saharan African countries

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Abstract: This study looks at the Sub-Saharan African countries' experience in terms of commodity price fluctuation in different countries' corners such as in the market places, retail shops, wholesales shops, street selling, at the garden, etc. The main purpose of this study is to examine the impacts of commodity prices volatility on the economic growth of 35 countries in Sub-Saharan Africa from 2000–2018. The results generated by using panel data models are all statistically significant at 1% level and the coefficients of the variables fluctuated. This indicates that the results are inconclusive, showing that the previous growth of the economy being affected negatively by commodity prices fluctuation, the current growth of the economy being affected positively by commodity prices fluctuation and the growth of the economy in the future is expected to be affected negatively by commodity prices fluctuation, unless policy intervention takes place. Therefore, the quality of institutions and good governance associated with low level of corruption are identified as an implication of economic policy.

Keywords: Sub-Saharan Africa; commodity price; economic growth; price volatility; panel data models; policy intervention.

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1 Introduction

Africa is the continent that exports most primary commodities in the world considering as a hope and a cure for its economic development (Deaton, 1999). This high dependence on primary commodity exports has been associated with poor economic development results. Over the past decade and a half, Africa has experienced the strong economic growth accompanied by a global commodity price boom (Kedir et al., 2016). This was an opportunity for some African countries to access the international private financial markets, thus borrowing the money that served as investments increasing their growth rate (Deaton and Miller, 1996). In spite of this economic performance, African countries are in quest of economic development. In fact, the roots of Africa's slow development are also intimately linked to the quality of governance and the poor investment appraisal whether financed from commodity exports or not (Tiawara, 2015). The investments done in the economic sectors with the commodities exports were not able to procure a higher rate on return; thereby decreasing the volume of imports. Also, the commodity price boom in government revenue lead to hastily executed investment programs that involve low return and irreversible projects or to good but over ambitious projects that are abandoned when the commodity price fall.

In Sub-Saharan Africa, countries were based relatively upon the export of a small number of primary commodities whose world price is volatile. This volatility induces the fluctuations in real national incomes making difficult their macroeconomic management (Deaton and Miller, 1995). Therefore, many of them remain heavily dependent on

primary commodities as their major source of income. All of the commodities have been subject to high price volatility, and as a result, export earnings have been volatile. That has hindered investment, especially investment in human and physical capital, to be capable to diversify economies thereby influencing considerably the economic growth and the incidence of poverty away from their dependence on primary commodities (Addison and Ghoshray, 2013). That is what happened in Netherlands in the 1970s about the North Sea Oil discovered leading this country to the difficult situation called 'Dutch syndrome' when the commodities price collapse. Indeed, the Oil discovered raised suddenly the price of the commodities produced locally and the imports of diverts commodities due to the lack of diversification towards the manufacturing.

The diversity of evidence in terms of economic growth and commodities price in Africa has shown that certain countries have performed better than others. Thus, alongside the nature of governance, commodity prices have been a crucial factor in promoting economic growth (Addison and Ghoshray, 2013; Jayne et al., 2018). In this point of view, Collier and Goderis (2012) found that the boom of the commodity price has the positive effects unconditional on the production in short term but these gains are dominated by the negative effects in the long-term. However, according to Blattman et al. (2007) in their study on "the impact of terms of trade volatility on the growth performance in Sub-Saharan Africa between 1870 and 1939", revealed that the countries experiencing more volatile commodity prices tend to grow more slowly than countries experiencing relatively stable price movements. The study of Deaton (1999) on commodities price and growth in Africa highlighted the progress done in this subject but he added the fact that the well understanding of the commodities price boom is needed to construct good policy rules because the ability to forecast them remains inadequate.

Is international commodity price affecting Sub-Saharan African economic growth at its current stage? It future stage? And finally it previous stage? Thus, this study is interested in the case of Sub-Saharan Africa by questioning on the effects of international commodities price using panel data analysis from 2000 to 2018 but considering 35 Sub-Saharan Africa countries. Additionally, the focus is made on the factors that determine the economic growth when the commodities price volatile? Based on the experience of Sub-Saharan Africa countries, we postulate that the international commodities price has the effects on the economic growth but the sign of these effects changes according to the period (pass, present, and future).

1.1 Outline of the article

This article is structured as follows. In the second section, we briefly review the literature related to the object of the study. The third section is devoted to the presentation of the empirical model, the estimation method and the data. In the fourth section, the main results are reported and interpreted. A conclusion and policy implications are presented in the last section.

2 Literature review

Price boom promotes or derails economic growth. According to this theory, the commodity prices fall relatively to the manufactures prices that the exporting countries must import in the long run while assuming that the terms of trade of commodities

exhibits a downward trend. Since, a particular theoretically and empirically attention is focused on. According to Sachs and Warner (1999), the commodities boom price has been perceived as the source of laziness leading Africa countries late in terms of development because most countries became dependence and abandoned their industrialisation due to that. Therefore, this dependence has been noticed in 1980s, when the commodities price was collapsed, estimated to a real purchase power of 40% to 60% for many economies (Dutch syndrome). In 2006, Robinson et al. argued that this shortfall leads to inefficient redistribution by many governments who reduced if not cancelled the support in some social sectors in long term. Such a poor performance in the long term is explained in the literature by the corruption, the overconfidence, the misjudgement impending risk and overcommitting to projects leading to debt, the poor fiscal arrangements with no long-term investment to reap benefits; the undiversified. Therefore, these analyses show without doubting that the commodities price boom are a 'curse' or a 'blessing' for economic growth (Subramanian and Sala-i-martin, 2003; Raddatz, 2007).

The case study of Sub-Saharan Africa is a theoretical example which explained that the increase in public revenue might serve to the long term investment and lead to the economic growth. That is empirically confirmed by the study of Jayne et al. (2018) on Africa's unfolding economic transformation. They show that a period of high global commodity prices is one of main drivers of Africa's economic transformations guarantying economic growth. In the study of Mputu (2016) published in 2016 on 'Terms of trade, and economic growth in Sub-Saharan Africa', she found a positive and significant relationship between terms of trade and GDP in Sub-Saharan Africa. For this, the Solow's (1956) growth model has been used by including net barter terms of trade index. Likewise, Bleaney and Greenaway (2001) showed that economic growth is negatively affected by terms of trade volatility by using panel data model for 14 Sub-Saharan countries from 1980 to 1995 in their study entitled 'the impact of terms of trade and real exchange rate volatility on investment and growth in Sub-Saharan Africa'.

Addison et al. (2016) studied agriculture commodity price shocks and economic growth in Sub-Saharan Africa and confirmed in their finding that commodity price shock is external shocks and further revealed that, per capita GDP in Sub-Saharan Africa is asymmetry response to the commodity price shocks.

Bayramoğlu (2014) studied the whether agriculture commodity price rises will bring more employment in agriculture and revealed that as agriculture commodity price rises then employment in agriculture increases in the year 2006–2009.

From this literature, it is noticed that the international commodities price has the positive impact on the economic growth in Sub-Saharan Africa while some studies conducted in Africa recently showed that the effects of international commodities price on the economic growth can be slumped if not become negative in the long term (Collier and Goderis, 2012).

2.1 Research gaps

Our study is interested in the case of Sub-Saharan Africa by questioning on the effects of international commodities price using panel data analysis from 2000 to 2018 but considering 35 Sub-Saharan Africa countries. Is international commodity price affect African economic to growth at its current stage? It future stage? And finally it previous stage? Additionally, the focus is made on the factors that determine the economic growth when the commodities price volatile. volatile? The evidence is from the study Deaton and

Miller, 1996; Brückner and Ciccone, 2010; Subervie, 2011; Mallick and Sousa, 2013; Arezki et al., 2014; Lederman and Porto, 2016). The paper applied real added value of this paper is located at the different panel data models such as fixed effect, random effect, and pooled ordinary least square (OLS) that used in order to identify which ones can have biased results, which ones can have unbiased results, which method is the combination of all-biased or unbiased and which bring constant results.

3 Methodology

There is an interesting literature on the impacts of international or domestic commodities price on economic growth/development in Sub-Saharan African countries. In this paper, we attempt try to assess study the impact of commodities prices on growth by using different methods so that we can know which method gives biased results, which one gives unbiased results, which one is the combination of all-biased or unbiased and which one brings constant results. Therefore, three models are considered: the fixed effect, pooled OLS regression and random effect model to solve the problem of unobserved specific fixed effect and random errors factors in the model. Empirically, several estimation techniques were used to address this important phenomenon. We used the panel data techniques such as fixed effect, random effect and pooled OLS. As mentioned in the theoretical model section, we developed the production function in which we incorporated commodities prices and other determinants or control variables' of countries specific growth into Cobb-Douglas production function and after we use the function in order to derive the country pooled ols, random effect and fixed effect framework. The economic growth(Y) depends on the following variables in the models; trade (% of GDP)-trade, gross capital formation (current US$)-GCF, real effective exchange rate index-REER, agricultural raw materials exports (% of merchandise exports)-AGRME, CPIA property rights and rule-based governance rating (1 = low to 6 = high)-GOVN, Exports of goods and services (BoP, current US$)-EGS, imports of goods and services (BoP, current US$)-IMGS,GDP (current US$)-GDP current, energy use (kg of oil equivalent per capita)-EGU, coal rents (% of GDP)-COALRT, natural gas rents (% of GDP)-NGASRT, Ores and metals exports (% of merchandise exports)-OME, electricity production from natural gas sources (% of total)-ELCNGAS, Inflation, consumer prices index (annual %)-I, crops names and commodity price$-crop and denoted as C.

Furthermore, researchers' that used Cobb-Douglas production function is not limited to Hall and Mairesseb (1995) in which they added capital as another factor input into production function.

4 Analysis model

The paper adopts a model by Collier and Goderis (2012), Acemoglu et al. (2001), Menegaki (2011), Fowowe (2016), Rafiq and Bloch (2016) and Belford et al. (2020). To set out the cobb-Douglas production function for international commodities prices on economic growth in Sub-Saharan African countries' are as follows:

$$Y_{it} = Ab^{\beta} GCF_{it}^{\rho} L_{it}^{1-\rho-\sigma-\pi} C_{it}^{\sigma} X_{it}^{\pi} e^{\varepsilon} \tag{1}$$

Such that:

$$\rho + \alpha + \sigma + \pi = 1$$

where ρ, α, σ and π are positive parameters and are called coefficient elasticities or share assigned to gross capita formation (GCF), total labour force(L), producer commodity price (C) and others control variables (X) such, Trade (% of GDP)-trade, gross capital formation (current US$)-GCF, real effective exchange rate index-REER, agricultural raw materials exports (% of merchandise exports)-AGRME, CPIA property rights and rule-based governance rating (1 = low to 6 = high)-GOVN, Exports of goods and services (BoP, current US$)-EGS, imports of goods and services (BoP, current US$)-IMGS,GDP (current US$)-GDP current, energy use (kg of oil equivalent per capita)-EGU, coal rents (% of GDP)-COALRT, natural gas rents (% of GDP)-NGASRT, Ores and metals exports (% of merchandise exports)-OME, electricity production from natural gas sources (% of total)-ELCNGAS, and inflation, consumer prices index (annual %)-I. The aggregate output in our model can represent by GDP per capita, current U.S. dollars. This is motivated because we know that commodities prices affect the individual incomes most. It will indicate that when we use Economic growth will tell us how the total output depends directly on gross capita formation, total labour force, commodity price and control variables. The part of the aggregate output which cannot be explained by all of the independent variables above is explained by A, which is the efficiency or change in the level of technology or it is called total factor productivity (TFP). A is just like the residual or the error term in the model. ε is exponential, is the idiogratic error term, We incorporated commodity price and others control variables into the model to account for endogenous growth theory developed by Romer (1986, 1987) in which he incorporated human capita, innovation, knowledge spillover, Research and development into the AK production function so that they will be accounts for endogenous for those variables to contributes to long run macroeconomics analysis.

If we divided the equation by L and expressing each variable in above equation in per capita terms, we got:

$$y_t = Ab^{\beta} gcf^{\rho t} c^{\sigma t} x^{\pi t} e^{\varepsilon t} \tag{2}$$

Taking the natural logarithm from both sides of equation (2), we get;

$$\log(y_t) = \log(Ab^{\beta}) + \rho \log(gcf_t) + \sigma \log(c_t) + \pi \log(x_t) + \varepsilon_t \log e \tag{3a}$$

Note: exponential and log cancelled each other out and let $\log(b^{\beta}A) = \beta_0$, which yields:

$$\log(y_t) = \beta_0 + \rho \log(gcf_t) + \vartheta \log(c_t) + \pi \log(x_t) + \varepsilon_t \tag{3b}$$

Transforming the equation for the growth model at time t and individual i, we obtain the following model as follows:

$$g(Y)_{it} = \beta_0 + \tau_{i1} g(GCF)_{it} + \tau_{i1} g(C)_{it} + \tau_{i1} g(X)_{it} + a_i + \varepsilon_{it} \tag{4}$$

Taking the first difference or fixed effect transformation or within transformations, we obtain:

$$g(\overline{Y})_i = \beta_0 + \tau_{i1} g(\overline{GCF})_i + \tau_{i1} g(\overline{C})_i + + \tau_{i1} g(\overline{X})_i + a_i + \overline{\varepsilon}_i \tag{5}$$

We arranged the like terms together and subtract equation (4) from (5) obtaining;

$$\ddot{Y}_{it} = \tau_{it}\ddot{GCF} + \tau_{it}\ddot{C}_{it} + \tau_{i2}\ddot{X}_{it} + \ddot{\varepsilon}_{it} \tag{6}$$

This is the fixed effect transformation or within transformation. The unobserved factors in our model disappeared. This suggests that we should estimate the model by pooled OLS. The pooled OLS estimator is based on time demeaned variables is called fixed effect estimator or within estimator.

Assumption

$Cov(\varepsilon_{it}, C_{it}) = 0$, *uncorrelated with all the explanatory variables in the model* $\forall$ *REM*

$Cov(\varepsilon_{it}, C_{it}) \neq 0$, *correlated with all the explanatory variables in the model* $\forall$ *FEM*

REM random effect estimator

FEM fixed effect estimator

Cov covariance between the error term at time *t* and individual *i* and the commodity price at time *t* and individual *i*.

5 Data source and variables

This study uses annual data over the period from 2000 to 2018 from 35 Sub-Saharan Africa countries notably Angola, Benin, Botswana, Burundi, Cameroun, Central African Republic, Congo Democratic Republic, Congo Republic, Cote d'Ivoire, Equatorial Guinea, Entrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Togo, Zambia, Zimbabwe. The data are collected from FAOSTAT.

The dependent variable, in this study is GDP current US dollars. The explanatory variable of main interest is Producer commodity price based upon the commodities such as Bananas, cassava, maize, meat chicken, oil palm, potatoes, millet, rice paddy, yams, coffee green, beans dry, mangoes, guavas, tomatoes, cotton lint, onions dry, and sorghum. These commodities are selected according to the volume of the country main commodity's export.

The variables like trade (% of GDP)-trade, gross capital formation (current US$)-GCF, real effective exchange rate index-REER , agricultural raw materials exports (% of merchandise exports)-AGRME, CPIA property rights and rule-based governance rating (1 = low to 6 = high)-GOVN, exports of goods and services (BoP, current US$)-EGS, imports of goods and services (BoP, current US$)-IMGS,GDP (current US$)-GDP current, energy use (kg of oil equivalent per capita)-EGU, coal rents (% of GDP)-COALRT, natural gas rents (% of GDP)-NGASRT, Ores and metals exports (% of merchandise exports)-OME, electricity production from natural gas sources (% of total)-ELCNGAS, and Inflation, consumer prices index (annual %)-I are control variables.

Table 1 The descriptive statistic

Variable	*Observation*	*Mean*	*Std. dev.*	*Min*	*Max*
LnG	684	7.49368	0.4107972	6.711097	7.909721
LncommodityP	684	7.351212	0.432415	6.733439	8.06566

Source: Authors' own evaluation using data set from FAOSTAT

The descriptive statistics indicated the number of observation, the mean, the standard deviation, the minimum and the maximum. In the as above, the natural logarithms for control variables have highest mean, highest standard deviation, and highest minimum and highest maximum. This is followed by the rate of change of commodities prices in different countries in Sub-Saharan Africa. The paper used one commodity in each country in which they depend on that commodity to compare to other commodity. For example, Gambia depends more on paddy rice, so we selected paddy rice and its corresponding price level and we determined whether commodity prices have any influence to the growth in Sub-Saharan African countries. The average mean of change in commodity prices are 7.35 approximately compare to average economic growth, which stand at 7.49 approximately. The standard deviation which measures the risk of the volatility of fluctuation of commodity prices stands at 0.43.

Table 2 The correlation

	LnG	*LncommodityP_Lead1*	*LnX_Lead1*
LnG	1.0000		
LncommodityP_Lead1	0.6705	1.0000	
LnX_Lead1	–0.7881	–0.5292	1.0000

Source: Authors' own evaluation using data set from FAOSTAT

The correlation between the natural logarithm of economic growth and natural logarithm of producer commodity price is positive and stand at 0.6713. If we make natural logarithm of control variables constant, then a percentage increases in commodity prices, increases economic growth by 67%.The percentage increases in the natural logarithm of control variables will reduces both natural logarithm of producer commodity price and natural logarithm of economic growth at approximately 53% and 79%, respectively.

6 Econometrics results, interpretations and discussion

6.1 Pooled ordinary least-squared (method: based on OLS estimation)

In the pooled regression, the paper looks at both the lags and the lead of the variables and its current values by log-linearity of all the explanatory and explained variables.

From the p-values, the coefficients, the t-statistic and the standard errors of the explanatory variables, it indicated that growth of commodity price in Sub-Saharan African countries is highly significant and has positive sign with the growth of economic. As the growth in Africa changes to 15% meaning there is rises of commodity prices to

100%. Various commodity prices such as paddy rice, cassava, banana, maize, wheat, coffee, etc. influence positively to the growth in this 35 Sub-Saharan African countries, the study confirmed. For instance, the previous commodities price is significant with growth rate of the economy, but it has negative sign. The negative sign signifies that the previous commodity prices in Sub-Saharan African countries reduce growth by 7.5%, the study explained. Further, for the lead or forward or expectation of the commodity price in the long run in Africa will be similar to the previous because they will all reduces growth rate of economy until policy intervention take places but actually they have different standard errors of lag of commodity price is 0.014123 and 0.140667 for the lead of the same commodity prices. This is attributed to bad policy such as problems of institutions/governance, conflict, political instability, lack of investment strategies and quality of education and research and development about how changing the different commodity prices are in the markets.

The control variables such as what was explained above do not influence growth of economic in Sub-Saharan African countries. Meaning, if we change positive of those variables such as inflation, …will drastically reduce the growth rate of the economic by 0.33%.This is not good for the economic that want to have increase in growth in long term must avoid to rely more on those control variables, the study noted. The revise happened in the previous control variables have positive coefficient and statistically significant with the growth rate of African countries. Meaning before inflation is good for growth because before commodity price is bad for the growth, the study understand.

Table 3 Estimating pooled OLS results, the dept. variable LnG

Variable name	*Coefficient*	*Std. err*	*t-sta.*	*P* > |*t*|
LncommodityP	0.150	0.019	7.76	0.000***
LncommodityP_L1	–0.075	0.014	–5.33	0.000***
LncommodityP-lead1	–0.075	0.014	–5.35	0000***
Lnx	0.0033	0.0006	–5.37	0000***
LnG_lead1	0.50	0.0194	25.69	0000***
Lnx_L1	0.0017	0.0004	3.75	0000***
LnG_L1	0.50	0.0195	25.63	0000***
Lnx_lead1	0.0017	0.0004	3.73	0000***
Intercept	$-2.93e^{-14}$	0.022	–0.00	0000***

Source: Authors' own evaluation using data set from FAOSTAT

The one step back ward the growth rate of economic on its own lag is statistically significant and has positive sign. To look at the forward variables, the lead of the growth rate on its own lead is statistically significant and has positive sign. Increasing lead by 100, will rising the current growth rate to 50%, the study noted. The intercept term in the pooled OLS regression is not significant and associated with negative sign, the study noted. However, the R-squared is equal to 99.88% and the adjusted R-squared is equal to 99.88% of this model represents a better fit of the model.

Finally, all variables appear to have the correct signs except for the change of lag_1 and lead_1 of the commodity price. This may be attributed to that commodity price have due to changing in price level, due to inflation, due to exchange rate in the market, due to lack of good institution that should control the price stability, are previous contributed to low growth rate and is expected to contribute to low growth rate in Sub-Saharan African countries in the near futures, unless policy recommendations are clearly taking account.

6.2 Fixed effect estimation [method: based on GLS (cross-section weights estimation)]

In the fixed-effects model in the methodology, we assumed that all individual differences were captured by differences in the intercept parameter. The intercepts β_0 were considered to be 'fixed' parameters that we could estimate directly using the least squares estimator (OLS).

The fixed-effects model controls for all time-invariant differences between the individuals, so the estimated coefficients of the fixed-effects models cannot be biased because of omitted time-invariant characteristics such as countries, crops, gender, religious, tradition, culture, etc. Stock and Watson (2002) gave an insight that if the unobserved variable does not change over time then any changes in the dependent variable must be due to influences other than the fixed characteristics. One of the concerns practitioners raise about the fixed effect model is that it eats up too many degrees of freedom, resulting in shaky estimates (Nwakuya and Ijomah, 2017). In this study, fixed effect model is not appropriate, because of large sample and individual entities such as crops. If we run it with i.crops or i.countries, all those variables are eat up by the regression and hence removed them from the model. Hence, the results of fixed effect model are completely differed from random effect and pooled OLS regression.

Table 4 Estimating fixed effects results, the dept. variable LnG

Variable name	*Coefficient*	*Std. err*	*t-sta.*	*P > |t|*
LncommodityP	0.153	0.02	7.67	0.000***
Lnx	–0.0035	0.0006	–5.52	0.000***
LnG_L1	0.510	0.0201	25.32	0000***
LncommodityP_L1	–0.078	0.0146	–5.37	0000***
Lnx_L1	0.0018	0.00046	3.95	0000***
LnG_lead1	0.4898	0.02011	24.35	0000***
LncommodityP-lead1	–0.0746	0.0145	–5.14	0000***
Lnx_lead1	0.0017	0.00046	3.75	0000***
Intercept	–0.0020	0.0217	–0.09	0000***

Source: Authors' own evaluation using data set from FAOSTAT

The results of the fixed effect model differed significantly with that of the pooled regression model and random effect model. These may be due to the large sample sizes and too many individual cross sectional units across time and countries or crops. In particular, as in random effect model and pooled regression model, the growth rate of commodity price has positive and increases the economic growth rate in Sub-Saharan African countries. The previous change in the in growth rate of producer commodity

price decreased economic growth more than the expected commodity price will do. According to fixed effect model small improvement based on institutional setting but this might not be true because too many observations with too many degrees of freedom made the results of fixed effect not consistent with pooled regression and random effect model. This model predicted that in the future unless policy intervention take place, still institutional failures will contribute to lower growth in the context of commodity price.

The growth rate of control variables remains to be significantly different from zero at the 1% level of alpha and has negative sign. According to fixed effect estimation, the log of the lags and the log of the lead are all statistically significant and have positive coefficient with the growth rate of economic in Sub-Saharan African countries under investigation. Still, the R-squared and the adjusted R-squared of this model indicated that the model is good for the analysis of the data.

6.3 Random effect estimation [method: based on GLS (variance components estimation/error components model)]

In the random effects model we again assume that all individual differences are captured by the intercept parameters, but we also recognise that the individuals in our sample were randomly selected, and thus we treat the individual differences as random rather than fixed, The random individual differences ui, which are called random effects, are analogous to random error terms, and we make the standard assumptions about them – namely, that they have zero mean, are uncorrelated across individuals, and have a constant variance.

Furthermore, the reasoning behind random effects estimation is that the individual-specific effect or variation across entities is assumed to be a random variable that is uncorrelated with the regressor in the model. The important differential is that whether the unobserved individual effect exemplifies components that are correlated or uncorrelated with the explanatory variables in the model. A vital important of random effects model is that you can include time invariant variables like in our cases countries and crops. In the random effects estimation, individual's error term is uncorrelated with all the explanatory variables in the model, which allows time invariant variables to play a role as predictors'. The results for random effect model is almost the same for the results for pooled regression in terms of coefficients, standard errors, t-statistic, confidence interval, P-value and slightly contrast with the intercept terms in the models. The random effect model is more appropriate than fixed effect model because as indicated in the result obtained from Hausman specification test. The P-value from Hausman test is 0.4029, which is greater than 0.05(5%), therefore, the appropriate model for our analysis is random effect rather than fixed effect model, when we compared random effect to fixed effect model.

In particular, in the random effect model, We estimate that the price elasticity of producer commodity price is approximately 0.150: a 1% increase in producer commodity price is estimated to increase the elasticity of economic growth in the selected 35 countries in Sub-Saharan Africa by 0.150%. The results for this estimated is statistically significant at 1% level of alpha. On the other hand, when we considered the log of the lag of the producer commodity price in the selected countries in Sub-Saharan Africa, the results generated is that, the price elasticity for the change in the past and future commodity price are approximately –0.7522: a 1% increase in previous and future commodity price is estimated to reduce economic growth rate by 0.7522%. This may be

attributed to bad governance and institution, conflict and political instability, instability of the currencies and the exchange rate fluctuation, dishonesty in the informal sector markets, lack of good roads and markets, climate change effects on agriculture, high inflation, environmental pollution, supply for most of these commodities are low and the demands are high and the prices obviously will be higher as well. These occurred in the past and also expected to occur in the future unless policy intervention prevents it.

Though, the current producer commodity price, the past and future are all statistically significant different from zero at 1% level. The logs of the lags and the leads of the commodity price have negative sign and not good for economic growth in the past and future, only present commodity price is good for growth in Africa. It means that future for Africa is still blind for the relationship between producer commodity price and economic growth. Henceforth, this study can conclude that the producer commodity price hypothesis based on random effect model at the present is a key determinant of economic growth in the Sub-Saharan African countries.

Table 5 Estimating random effects results, the dept. variable LnG

Variable name	*Coefficient*	*Std. err*	*t-sta.*	*P > |t|*
LncommodityP	0.150	0.1938	7.67	0.000***
Lnx	–0.0033	0.0006	–5.37	0.000***
LnG_L1	0.50	0.0195	25.63	0000***
LncommodityP_L1	–0.07522	0.014	–5.33	0000***
Lnx_L1	0.00167	0.00045	3.75	0000***
LnG_lead1	0.50	0.0295	25.69	0000***
LncommodityP-lead1	–0.07522	0.0141	–5.35	0000***
Lnx_lead1	0.00167	0.0004	3.73	0000***
Intercept	$-2.75e^{-12}$	0.0215	–0.00	0000***

Source: Authors' own evaluation using data set from FAOSTAT

6.4 Hausman specification test (which method is more appropriate for our analysis?)

To decide between fixed or random effects we run a Hausman test where the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects (see Green, 2008, chapter 9). It basically tests whether the unique errors (ui) are correlated with the explanatory variables; the null hypothesis is they are not. In that, we run a fixed effects model and save the estimates, then run a random effects model and save the estimates, then perform the Hausman specification test. Thus, our decision rule for which estimate is more appropriate after Hausman test was random effect, because the probability of chi-square is 0.4029, which is greater than 0.05. So, random effect is more suitable for the analysis of the relationship between producer commodity price, other control variables and economic growth in 35 Sub-Saharan Africa countries.

Hence, the effects are uncorrelated with the explanatory variables and results rejected the null hypothesis of not correlated, the random effects (RE) estimator is consistent and efficient and appropriate.

Table 6 Estimating Hausman test

Hausman fixed				
	Coefficients			
	(b)	*(B)*	*(b-B)*	*sqrt(diag(V_b-V_B))*
	Fixed	*Random*	*Difference*	*S.E.*
LnX_Lead1	0.0017375	0.0016686	0.0000689	0.0001228
Lncommodi~d1	–0.0746294	–0.0752254	0.000596	0.0036347
LnG_lead1	0.4898061	0.5	–0.0101939	0.0050766
LnX_L1	0.0018151	0.0016686	0.0001465	0.0001124
Lncommodi~L1	–0.0784157	–0.0752254	–0.0031903	0.0037625
LnG_L1	0.5104941	0.5	0.0104941	0.0050811
LnX	–0.0035463	–0.0033372	–0.0002091	0.0001648
LncommodityP	0.1529288	0.1504507	0.0024781	0.004909

Notes: b = consistent under Ho and Ha; obtained from xtreg.
B = inconsistent under Ha, efficient under Ho; obtained from xtreg.
Test: Ho: difference in coefficients not systematic
chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 8.32
Prob > chi2 = 0.4029.

Source: Authors' own evaluation using dataset from FAOSTAT

5 Testing for random effects: Breusch-Pagan Lagrange multiplier

The Lagrange multiplier (LM) test helps you decide between a random effects regression and a simple OLS regression. The null hypothesis in the LM test is that variances across entities are zero. This is no significant difference across units (i.e., no panel effect). The command in Stata is xttset0 type it right after running the random effects model. It ran for dependent variable LnG.

Table 7 Breusch-Pagan LM result for random effect

xttest0		
Breusch and Pagan Lagrangian multiplier test for random effects		
LnG[c, t] = Xb + u[c] + e[c, t]		
Estimated results:		
	Var	*sd = sqrt(Var)*
LnG	0.1682938	0.4102363
e	0.000198	0.0140705
u	0	0
Test: Var(u) = 0		
chibar2(01) = 0.00		
Prob > chibar2 = 1.0000		

Source: Authors' own evaluation using data set from FAOSTAT

Here we failed to reject the null and conclude that random effects are not appropriate, when we compared with the Pooled OLS. This is, no evidence of significant differences across countries and crops, therefore we also run a simple OLS regression.

6 Discussion of results

The study that employed panel data model such as fixed effect and random effect to find the relationship between commodity price and economic growth in Africa are not many. Most of the study employed panel VAR, Panel VECM and panel Granger casuality test. This study employed panel fixed effect and panel random effect model to account for the countries unobserved fixed effect and random error term to be correlated or uncorrelated with the predictors or explanatory variables in the model. In our results, we found out that current growth of commodity price has positive influence on growth of the economy in the 35 Sub-Saharan African countries. This is confirmed by Deaton (1999), in his study economic growth and commodity price by using pooled OLS and showing that the growth of commodity price has the positive coefficient and the lags have also positive sign. The results confirmed that current growth of commodity price have positive impact on growth of the economy in Sub-Saharan African countries, but the lags and the leads according to the pooled OLS, random effect and fixed effect model have negative impacts on the growth of the economy in this region. We attribute it to bad governance, poor institution, exchange rate fluctuation, high inflation, failures in informal sectors, corruption, conflict and lack of regulation to monitor price changing in the market for various commodities that we used in this study. Commodity can be an important determinant of a country's growth and wealth. An account by Deaton (1999) illustrated how a plant such as cotton could bring wealth to few, and poverty to almost all because of bad governance. This study still does not clearly understand this persistently problems of commodity price have on the past and expected to have in the futures unless policy intervention takes places. These results are similar to those of Tiawara (2015) used panel fixed effect estimation to examine how commodity prices affect African economic welfare for 49 African countries from 1994 to 2014. He found also inconclusive results and the estimates are statistically insignificant about the effects of commodity price on growth in Africa. However, the panel fixed effect model is not appropriate for the analysis due to the fact that too many degrees of freedom, i.crops are all eating up by the regression. Hence, Bleaney and Greenaway (2001) estimate a panel data model for a sample of 14 SSA countries over the period 1980–1995 and show that growth is negatively affected by terms of trade volatility, and investment by real exchange rate instability. In addition, Deaton (1999) examined commodity prices and growth in Africa; he believed that the African markets are promising, but at the same time, problems persist and they can also be worse. According to Hausman specification test, random effect is more appropriate and growth of commodity price increases the growth of economic in Sub-Saharan African countries according to our analysis. These results are not 100% conclusive because when we conduct a test on random effect; Testing for random effects: Breusch-Pagan LM, the results confirmed that, here we failed to reject the null and conclude that random effects are not appropriate, when we compared with the Pooled OLS. This is, no evidence of significant differences across countries and crops, therefore we also run a simple OLS regression.

Study by Deaton and Miller (1996) examined the empirical consequences of commodity price booms in a cross section of African countries and challenged the conventional understanding that commodity price booms are so mismanaged that they are harmful. The results for commodity prices and other controls variables have positive effects on economic growth now but in the futures growth of commodity prices may hurt Sub-Saharan African countries growth because bad governance, climate change effects. This is confirmed by Belford et al. (2020), that agriculture sector and temperature have negative impacts on growth of GDP in Anglophone West African countries. However, the empirical evidence regarding the impact of natural resource prices on economic growth is mixed evidence., with some confirming Sachs and Warner's (1999) results of a negative effect on growth (see Rodriguez and Sachs, 1999; Gylfason, 2006; Brunnschweiler et al., 2006; among others). On the other hand, a growing number of papers provide evidence against the resource curse hypothesis (see Brunnschweiler and Bulte, 2008; Alexeev and Conrad, 2009). This is true for the results in this study, the pooled OLS and the random effect model are better and appropriate and the fixed effect is not appropriate for the analysis. The results for pooled OLS and random effects are very similar and they are extremely differed from fixed effect model due to heterogeneity issues, too many degrees of freedom, large sample, fixed effect eat up all *i*. Crops when we run the regression. When we also compared random effect with pooled OLS, the results from random effect test said pooled OLS is better and appropriate. For the pooled OLS results as do the random effect model, growth of commodity price is significant at 1% and have impacted positively with growth. The results further analysis that, the logs of the lags and the logs of the lead of the commodity price have reduced the growth of the economy in Sub-Saharan African countries during the periods in which the study was conducted.

7 Conclusions and policy implications

Most of the countries in Sub-Saharan Africa are affected, affect and affecting by commodity's price volatilities. In these countries, the price of commodity selected is all statistically significant and all have negative impacts on the growth of the economy. As the livelihoods and the overall standard of living depend on the commodity price (Mallick and Sousa, 2013), the consumption and investment associated with commodity price volatilities in Sub-Saharan Africa make investment and consumption to have poor contributions to economic growth. This paper investigated the impact of commodity price on economic growth in 35 Sub-Saharan African countries for the period 2000–2018. Firstly, for the pooled OLS results as do the random effect model, growth of commodity price is significant at 1% and has impacted positively the growth of the economy. Secondly, the results further analysis that, the logs of the lags of the commodity price have reduced the growth of the economy in Sub-Saharan African countries during the period in which the study was conducted. Thirdly, the logs of the lags of expected commodity price will also reduce the growth of the economy in Sub-Saharan African countries until policy implications is well follows.

7.1 Policy implications

Quality of governance and institution and thereby reduce the level of corruption.

To solve the problems of heterogeneity issues associated with countries specific fixed effects is to deals with cartels, Deflated the price level to control inflation, Reduces taxes burden on food price commodity and regulation of exchange rate.

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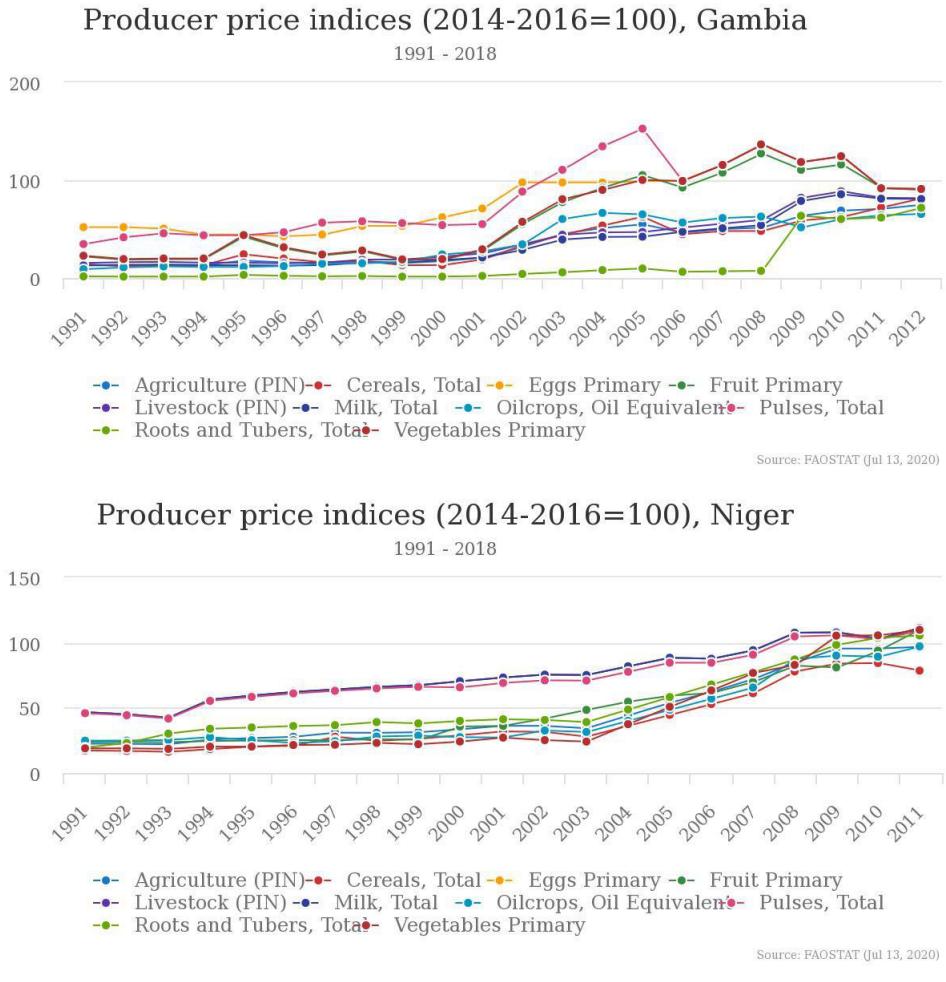
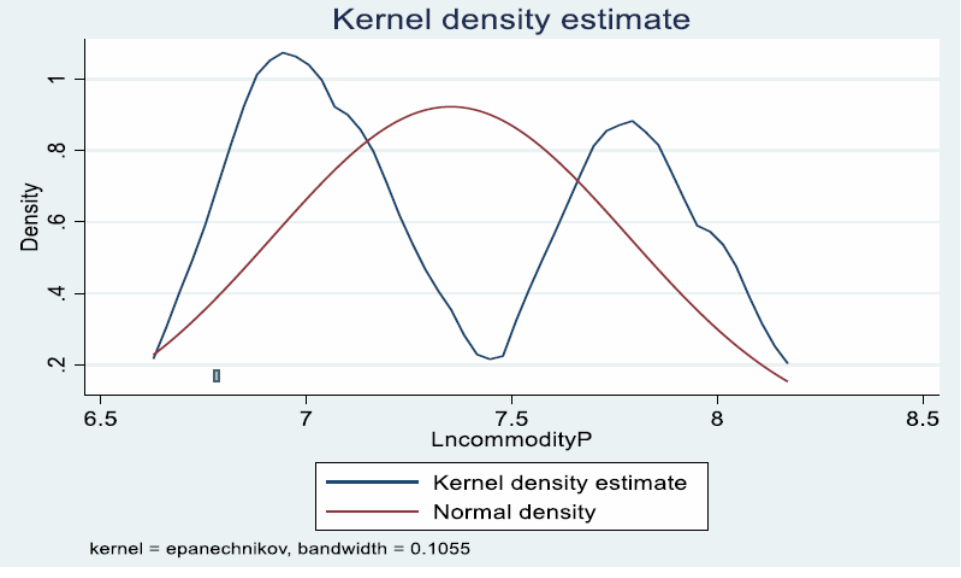
Appendix

Figure 1 Producer price indices (see online version for colours)



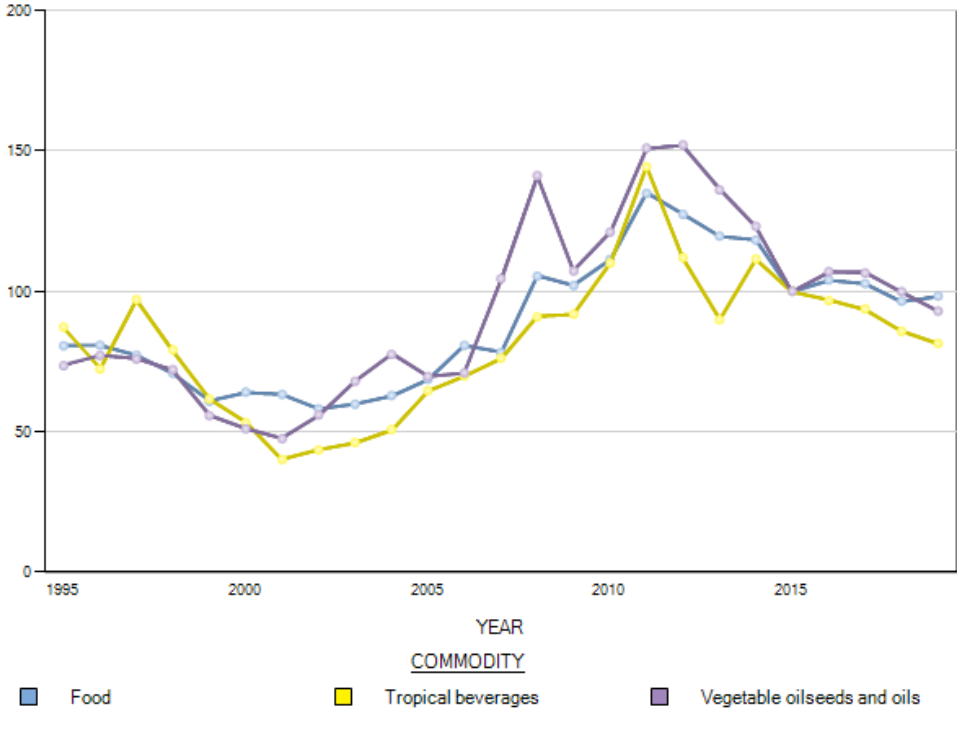
Source: Authors' evaluation using data set from FAOSTAT

Figure 2 K density of log of commodity price (see online version for colours)



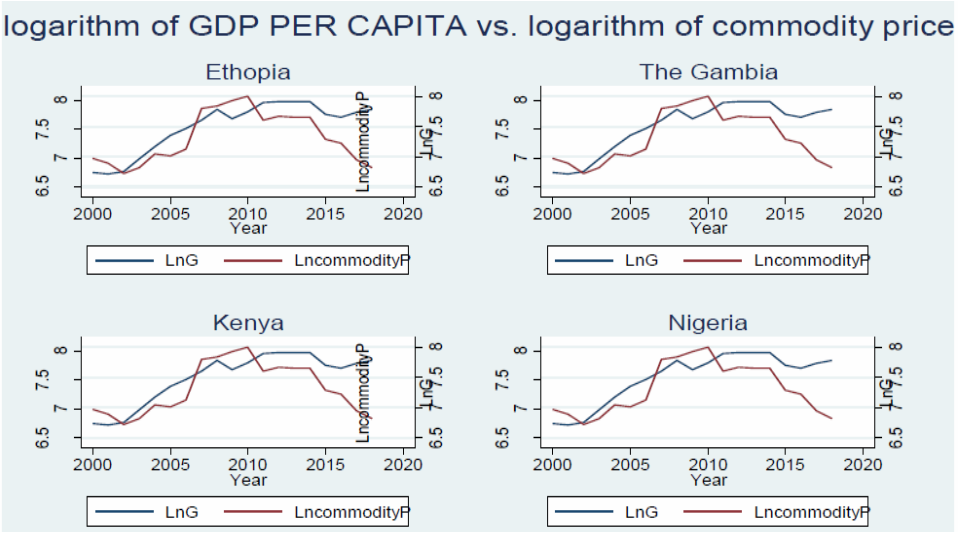
Source: Authors' evaluation using data set from FAOSTAT

Figure 3 Different commodities (see online version for colours)



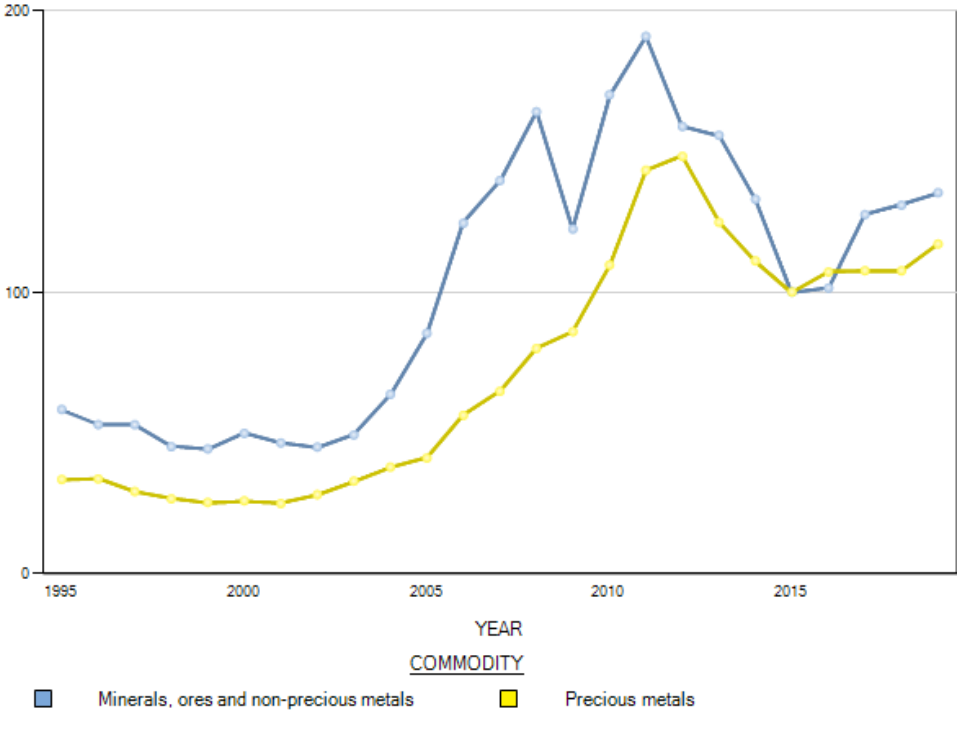
Source: Authors' evaluation using data set from FAOSTAT

Figure 4 Log of GDP per capita versus log of commodity price (see online version for colours)



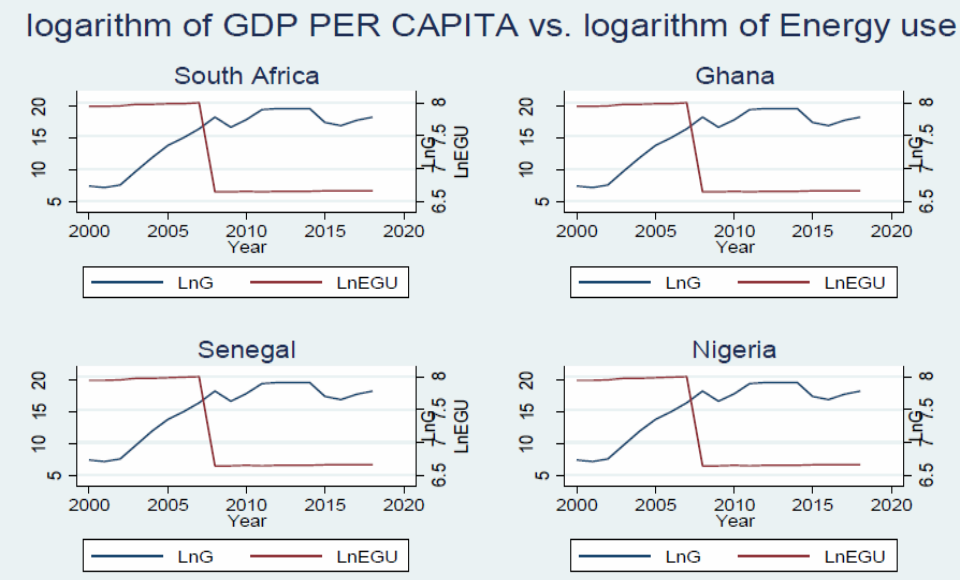
Source: Authors' evaluation using dataset from FAOSTAT and Data from the World Development indicator

Figure 5 Commodity price (see online version for colours)



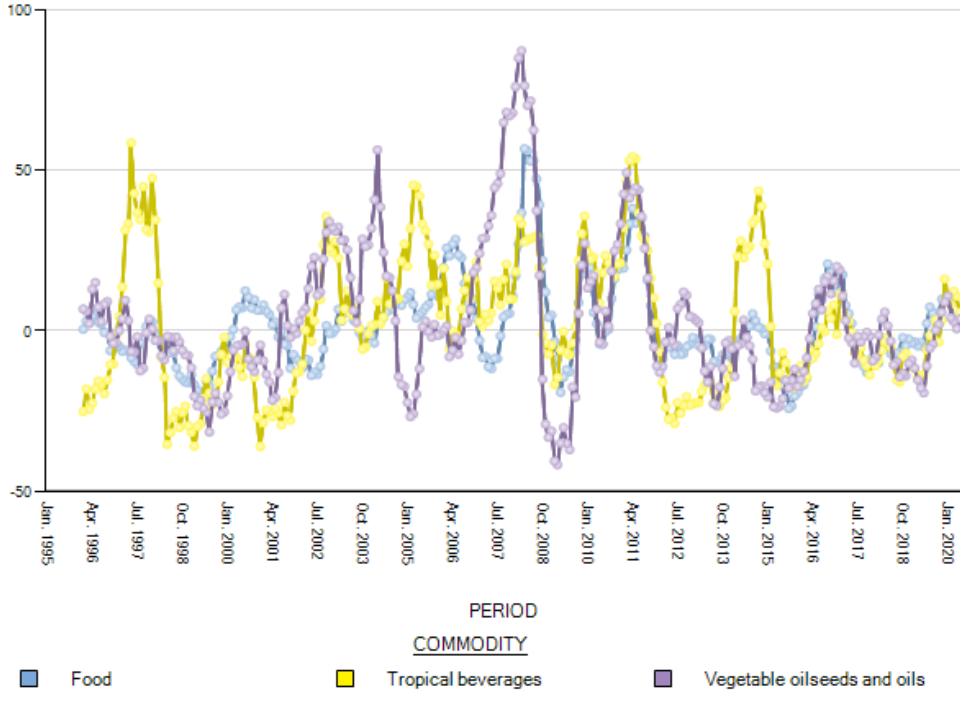
Source: Authors' evaluation using data set from FAOSTAT

Figure 6 Log GDP per capita and log of commodity price (see online version for colours)



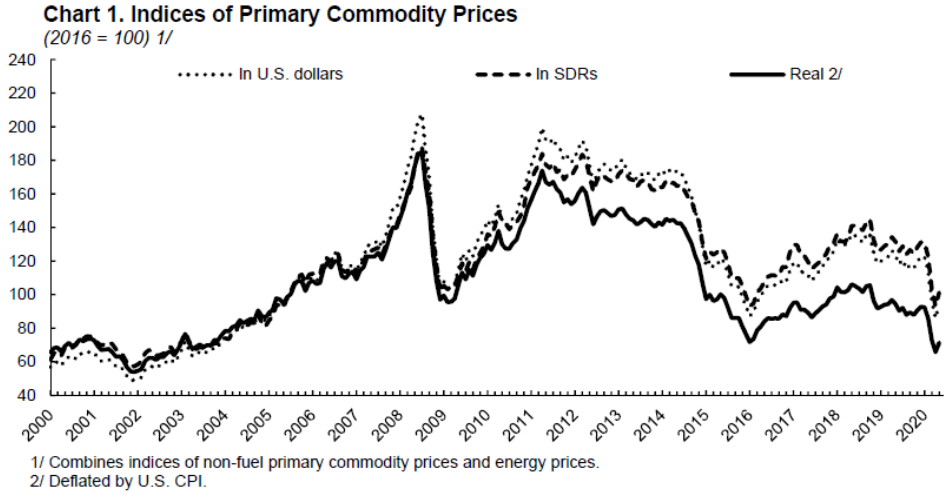
Source: Authors' evaluation using data set from FAOSTAT and data from the World Development indicator

Figure 7 Monthly fluctuation of commodity price (see online version for colours)



Source: Authors' evaluation from UNCTA

Figure 8 Primary commodity price



Source: Authors' evaluation from IMF