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Determinants of Egypt's Food Imports Based on Vector Error-Correction Model (VECM)

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Abstract
The issue of food and the provision of society's needs have a priority in the Egyptian economic policy. Therefore, the state tends to import large quantities of these commodities annually from the global market to bridge the gap between consumption and domestic production. This study focuses on determining the main factors that affect Egyptian food imports during the period 1990–2019, using a Vector Error-Correction Model (VECM) that will help policymakers use the appropriate monetary, fiscal, and trade tools to manage Egypt's food imports and decrease the import cost. The empirical results revealed that the most important factors' effects on Egypt's food imports are population growth and inflation rate, but imported food prices and GDP per capita have an effect only in the long run. On the other hand, there are no significant effects of the foreign reserves, exchange rate, and agricultural production on food imports.

Keywords: Food Imports; Egypt; Vector Auto-Regression model (VAR); Vector Error-Correction Model (VECM), Variance decomposition

1. Introduction

Foreign trade is considered one of the main pillars of economic development, especially in developing countries, which increasingly depend on imports to decrease the deficit in basic food commodities (Zaghloul, 2011). Moreover, international trade has the power to stabilize markets, redistribute food from food surplus areas to areas with food deficits, and contribute to achieving food security (FAO, 2018).

The issue of food and the provision of society's needs have a priority in the Egyptian economic policy. The food problem in Egypt is the insufficiency of local production in meeting the consumption needs of the main food commodities. Therefore, the state tends to import large quantities of these commodities annually from the global market to bridge the gap between consumption and domestic production (Ramadan, 2017).

The ratio of Egyptian food imports to total imports during the period (1994-2019) was about 22% (World Development Indicator (WDI)). According to the FAO database, grains and pulses, apples from fruits, and tea are the most important of Egypt's food imports. It is concentrated in four countries, which are: the Russian Federation, the United States of America, Argentina, and Ukraine, by about 76%.

Therefore, the objective of this study is to analyze the main determinants of Egyptian food imports during the period 1990-2019 using a Vector Error-Correction Model (VECM) that will help policymakers use the appropriate monetary, fiscal, and trade tools to control Egypt's food imports and reduce the trade balance deficit. Today, the literature on the

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determinants of Egypt's agricultural and food imports is limited. Furthermore, most of previous studies have concentrated on the structure of the total Egyptian imports.
The paper is structured as follows: Section 2-overview of Egypt's food imports; Section 3-Literature Review; Section 4-Materials and Methods; Section 5-results and discussions, and Section 6-Conclusion.

2. Overview of Egypt's Food Imports

This part is concerned with studying the quantity and value of Egyptian food imports, the main food imports, in addition to identifying the trade partners for these imports. According to the World Development Indicator (WDI), the ratio of Egyptian food imports to total imports during the period (1994–2000) was about 25.8%, decreased to 21.4% during the period (2001:2010), and then to 20.4% during the period (2011–2019). Figure 1 shows the quantity and value of Egyptian food imports during the period (1990–2019). It is clear that the quantity of Egyptian food imports increased during the study period, as it reached its lowest level in 1993 by about 8.5 million tons, then increased to reach its maximum in 2019 of 33.7 million tons, with a general average of about 16.6 million tons. Also, the value of Egyptian food imports increased during the study period, as it reached its lowest level in 1993 by about 1.9 billion dollars, and then increased to reach its maximum in 2019 of about 14 billion dollars, with an average of about 6.4 billion dollars.

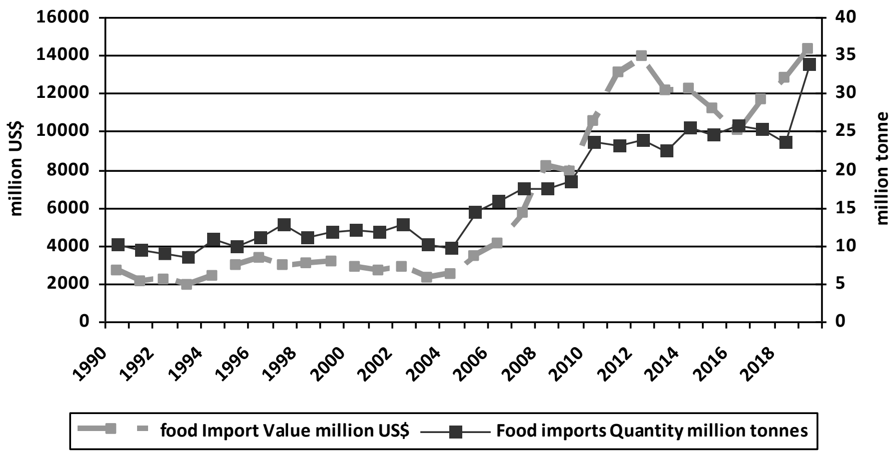

Figure (1): Value and quantity of Egypt's Food Imports during (1990:2019)
Sources: Food and Agriculture Organization of United State (FAO), Available at: http://www.fao.org/faostat/en/#data -

Figure (2) illustrates the main food imports of Egypt during the period (2010–2019). We find that wheat imports are the primary contributor to those imports by 42.14%, the second crop is maize with 28.75%, and then soybeans, chick peas, beans, apples, and tea by 8.64%, 1.76%, 1.31%, 0.80%, and 0.39%, respectively. Meanwhile, the grains and pulses group acquires about 82.6% of Egypt's food imports.

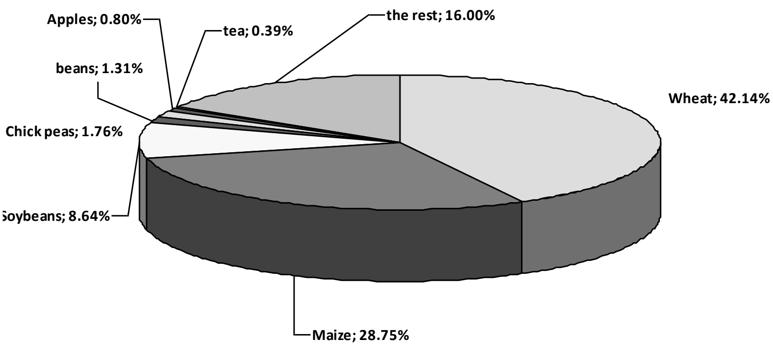

Figure (2): The Main Food Imports of Egypt during (2010:2019)
Sources: Food and Agriculture Organization of United State (FAO), Available at: http://www.fao.org/faostat/en/#data

Figure 3 shows the main Egypt's trading partners for food imports in 2019. The Russian Federation is the most important trading partner by about (34.62%), then Argentina (17.35%), the United States of America (13.97%), Ukraine (9.82%), France (2.58%), Italy (0.35%), the United Kingdom (0.34%), Kenya (0.30%), and the rest of the world (20.47%). Table 1 shows the main food imports of Egypt from its main trading partners.

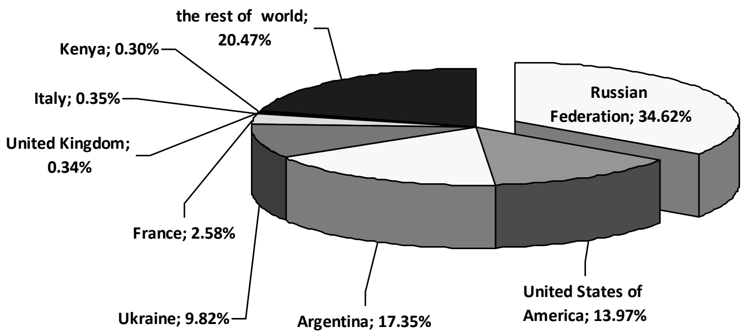

Figure (3): The main Egypt's Trading Partners for Food Import in 2019
Sources: Food and Agriculture Organization of United State (FAO), Available at: http://www.fao.org/faostat/en/#data

Table (1): The main food imports of Egypt from its main trading partners

United States of America	Russian Federation	Ukraine	Argentina	France	Italy	Kenya	United Kingdom
Soybeans Wheat Maize	Wheat Chick peas	Wheat Maize Soybeans	Maize Soybeans	Wheat	Apples	Tea	Beans

Sources: Food and Agriculture Organization of United State (FAO), Available at: http://www.fao.org/faostat/en/#data.

3. Literature Review

Various empirical studies have analyzed the determinants of agricultural and food imports in both developing and developed countries. Dao (2016) examined the determinants of imports using nonlinear regression in various samples of both developed and developing economies through the period 2000 to 2014. Seheda (2019) investigated the structure of agricultural imports in Ukraine during the period (2001-2018) and studied the mechanisms to increase domestic production and reduce the cost of importing. Mirdala (2018) used an Autoregressive Distributed Lags Model (ARDL) to investigate the main variables influencing trade balance in 21 European Union countries.

More emphasis will be placed on studies concerning developing countries. Gar El-nabey (2013) ensured that the major factors influencing Sudanese imports are GDP, relative prices, and the import tax over the period (1978 –2012) based on the three stage least squares (3SLS) model. While Opoku-Agyemang (2017) estimated Ghana's import demand function from 1960 to 2014 using the Johansen Co-integration test and the Vector Auto-regression (VAR) model.

Noureddine (2016) applied the co-integration and Error Correction Models to investigate the main factors affecting imports in Algeria from 1995 to 2014, and the empirical results revealed that the relative prices, exchange rates, and gross domestic product are significantly affecting Algeria's imports. Otherwise, Naja (2016) estimated the elasticity of demand for imports in Tunisia, Algeria, and Morocco through the period 1970–2010 using the Autoregressive Distributed Lags Model (ARDL) and Vector Error-Correction Model (VECM).

Alattabi *et al.* (2020) used Toda–Yamamoto causality to analyze the trend and determinants of agricultural imports in Iraq for the period 1991–2018. Whereas, Sadiq *et al.* (2020) examined the main factors' effects on food imports in the United Arab Emirate using an Almost Ideal Demand System during the period (1981–2017). The results confirmed that the effect of per capita income is more significant than the inflation rate on food imports. Sertoglu and Dogan (2016) revealed that the most important factors influencing the agricultural trade in Turkey are the exchange rate, agricultural producer prices, and GDP based on the bounds test approach during the period 1994:Q1-2012:Q3.

Essen (2017) examined the structure of agricultural imports in China during the period (1995–2014) from Sub-Saharan African countries, depending on the gravity model approach. The empirical results showed that the major determinants of China's agricultural imports are GDP, the infrastructure, trade agreements between China and Sub-Saharan African countries, and institutional quality, while the cost of transportation has no significant effect.

Other empirical studies focused on specific crops. Ouédraogo *et al.* (2018) used a Vector Error-Correction Model (VEC) to determine the explanatory factors of Burkina Faso's rice imports from 1965 to 2013. The study indicated that the decrease in domestic production and the high rise in the population are the essential factors that drive the increase in rice imports. Also, Onu *et al.* (2017) and Yusuf *et al.* (2020) analyzed the main variables' effects on Nigeria's rice imports in both the short and long runs depending on the co-integration mechanism and the Vector Error-Correction Model (VECM) through the periods (1970: 2016) and (1961: 2013), respectively.

Zikri *et al*. (2020) examined the main determinants of Indonesia's soybean imports through the period (2003: 2017). The empirical results revealed that international and domestic prices, domestic production, population, and trade barriers are significantly affecting Indonesia's imports of soybean.

Concerning the research papers related to Egypt, they can be summarized as follows: Al Kharboutly (2017) studied the influence of various explanatory variables on Egyptian imports using the Autoregressive Integrated Moving Average (ARIMA) model and Vector Error-Correction Model (VECM) over the period 1998–2016. Also, Shehab (2012) confirmed that the response of Egyptian imports to foreign reserves and GDP was clear and positive, while the response to the exchange rate was negative during the period (1980–2010) based on the Vector Error-Correction Model (VECM).

Diab (2010) aimed to determine the causes of the agricultural trade balance deficit during the period (1982–2009) based on the Two-Stage Least Squares model. The results of the study confirmed that consumption, open trade policy, and agricultural investment are the most important factors' effects on Egypt's agricultural foreign trade, while the effect of the GDP is not significant. Shiha (2012) used a co-integration approach to estimate the import demand function for major food goods in Egypt.

Some empirical studies, on the other hand, concentrate on specific crops: Mahmoud (2013) showed that the most important determinants of the demand for Egyptian imports of pulses are the imported price and the cultivated area. The quantity of Egyptian pulse imports decreases by 7.2% for every 10% increase in import price, and the quantity of imports decreases by 12% for every 10% increase in cultivated area. Whereas, Farid *et al.* (2020) explained that the main determinants of Egypt's wheat imports are domestic production and population, while the import price has no significant effect during the period (2001–2017).

Attia and Mousa (2017) analyzed the effect of the depreciation of the Egyptian pound on agricultural imports over the period (2000–2014). The empirical results indicated that the change in the exchange rate had a significant effect on the value of agricultural imports, as the increase in the exchange rate by 10% led to an increase in the value of agricultural imports, wheat imports, yellow corn imports and vegetable oil imports by 22%, 23.7%, 17.1%, and %35.9, respectively.

Meshref and Ahmed (2020), as well as Bahmani-Oskooee et al. (2015a), Bahmani-Oskooee et al. (2015b), EL-Rasoul et al. (2018); Helmy (2015), investigated the impact of devaluation on agricultural imports and agricultural trade balance in Egypt. The results concluded that the devaluation was an ineffective method to reduce food and agricultural imports and reduce the agricultural trade deficit.

4. Materials and Methods

4.1 The data

The study employs observations for the period (1990–2019) for eight variables that were fixed depending on the previous literature. The logarithmic forms of the variables were used in the analysis. The Food and Agriculture Organization (FAO), the International Monetary Fund, the World Development Indicator (WDI), and the Central Agency for Public Mobilization and Statistics (CAPMAS) provided secondary data for this study.

Table (2): Introduction of the model variables

Variable	Used sign
Food Imports Quantity	FOODM
Food Price Import	P
Agricultural Production	AGRI
GDP Per Capita	GDPPC
Inflation Rate	INF
Population	POP
Exchange Rate	EX
Foreign Reserves	RES

4.2 Methodology

The Vector Auto-regression (VAR) approach was applied in this analysis. The VAR method is similar to simultaneous-equation modeling, where multiple endogenous variables are taken into account at the same time. However, each endogenous variable is described in the model by the lagged values of it and all the other endogenous variables. (Kirchgässner and Wolters, 2008)

$$y_t = a + A_1 y_{t-1} + A_2 y_{t-2} \ldots\ldots\ldots + A_p y_{t-p} + Bx_t + e_t \quad (1)$$

Where

y_t : is a vector of endogenous variables.
a: is a vector of intercepts.
x_t :is a vector of exogenous variables.
A_1, ……., A_p, B coefficient matrices.
e_t: is a vector of innovations.

The co-integration will be evaluated based on the Johansen technique. In this method, the constraints imposed by co-integration on the unconstrained vector autoregressive system (UVAR) are tested. The co-integration test is conducted to determine the number of integrated vectors in the long run. This is done through two tests: The first is Maximum Eigen Value, and the second is tracing effect, each of them taking the following mathematical form: (Erickson, 2015)

$$T_r = -T \sum_{i=r+1}^{m} \log(1-\lambda_i) \quad (2)$$

If the original time series are not stationary separately but have the property of co-integration as a group, then the most suitable model for estimating the relationship between them is a Vector Error Correction Model (VECM), where the model takes into account the long-term relationship (by containing variables with a lagged value) and the short-term relationship (by including time-series differences). The Error Correction Model (VECM) is a vector autoregressive model (VAR) but is restricted. That can be expressed as follows: (Tsay, 2016)

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-1} + \varepsilon_t \quad (3)$$

Where

Δ: The difference coefficient.
Y_t: Vector of the model's variables.

$\Pi = \alpha\beta'$: Matrix of co-integration parameters.
Γ_i: Matrix of variables parameters.

5. Results and Discussions

5.1 Vector Autoregressive Model (VAR) Estimation

Time series analysis using a Vector Auto-regression model (VAR) requires a unit root test to ensure that all time series of the variables under study are stationary, in addition to the co-integration test between time series to show whether the study variables have an equilibrium relationship in the long run. (Opoku-Agyemang, 2017)

5.2 Results of Augmented Dickey Fuller (ADF) Test

The Augmented Dickey Fuller (ADF) test was used to determine whether variables were stationary; Table (3) shows that all the variables have unit roots in levels and are stationary in first-differences.

Table (3): Results of Augmented Dickey Fuller (ADF) test

	Augmented Dickey Fuller (ADF)			
	Log level		Log difference	
	Intercept	Trend and intercept	Intercept	Trend and intercept
FOODM	-0.056	-2.676	-4.779***	-4.743***
P	-1.280	-1.953	-4.677***	-4.554***
AGRI	-1.467	-2.839	-3.326**	-3.340*
GDPPC	-1.518	-2.659	-2.987**	-2.924
INF	-1.744	-2.237	-3.692**	-3.845**
POP	0.659	-2.467	-4.029***	-4.008**
EX	0.087	-2.005	-3.661**	-3.787**
RES	-2.613	-3.261	-3.867***	-3.667**

Sources: compiled by researcher from unit root test depending on the program E-Views, table (1) in appendix
*Note: *** indicates statistical significance at 1% level, **significance at 5%level, * significance at 10%level.*

5.3 Results of the Johansen Co-integration Rank Test

The number of co-integrating relationships between the variables was determined by the Johansen co-integration test. The results of the Johansen co-integration procedure are shown in Table 4. The results showed that the null hypothesis of no co-integration through four co-integrating relationships (r = 0, 1, 2, 3, 4) can be rejected at the 5% level, whereas the Johansen co-integration test revealed five co-integrating equations, as the Likelihood Ratio statistic was 26.072, which was less than the critical value at 5%, which equaled 29.68. Accordingly, we will use the Vector Error Correction Model (VECM) to estimate the model with five co-integrating equations. See table (1) in the appendix.

Table (4): Results of the Johansen Co-integration rank test

	Eigen value	Likelihood Ratio	5% Critical Values	1% Critical Values
H0:r=0	0.977549	328.3630	156.00	168.36
H0:r≤1	0.962169	225.8594	124.24	133.57
H0:r≤2	0.808226	137.4445	94.15	103.18
H0:r≤3	0.742142	92.85567	68.52	76.07
H0:r≤4	0.673100	56.26132	47.21	54.46
H0:r≤5	0.336979	26.07263	29.68	35.65

Source: Compiled by researcher depending on the program E-Views

5.4 Results of Variance Decomposition

The variance decomposition technique gives information about the relative significance of each random innovation to the variables in the VECM model (Silatchom, 2017). Table (5) shows the results of the variance decomposition of Egypt's food import quantity based on Vector Error Correction Model (VECM) results to identify the most important factors influencing it. We find that its shocks explain more than 43.73% of the forecast errors in year 2, but just 6.28% in year 10. The empirical results also revealed that the most important factors affecting Egypt's food imports are the population growth and the inflation rate. Moreover, imported food prices and GDP per capita have only a long-term impact. On the other hand, foreign reserves, the exchange rate, and agricultural production have little or no effect. Based on these results, we conclude the following:

- The demand for food imports is inelastic or insensitive to the import price in the short term, which indicates the importance of these imports to the Egyptian economy. On the other hand, this means the difficulty of relying on monetary policy to reduce food imports and reduce the deficit in the trade balance.
- The response of food imports to GDP per capita change is weak in the short run. Therefore, economic growth does not lead to an increase in food imports, but this response is more sensitive in the long run.
- The exchange rate effect on food imports is ineffective, as Egypt relies on importing basic food commodities. This means that the devaluation policy has no significant effect, and this situation applies to most developing countries. These are confirmed by many studies: Ahn *et al.* (2017); Akoto and Sakyi (2019); Dongfack and Ouyang (2019); Chebbi and Olarreaga (2019); and Yakub *et al.* (2019).
- The effect of foreign reserves on food imports is limited and ineffective, as food commodities are essential to achieve food security and have priority in import.
- The impact of agricultural production on food imports is ineffective as a result of the decline in the share of agricultural output to GDP and the low share of agricultural investment, so Egypt depends on importing the deficit of its food needs from abroad.
- Population growth is one of the most important factors affecting food imports, with an average of 22%.
- Inflation rates are considered one of the main factors that affect food imports, as the increase in domestic prices leads consumers to prefer imported goods, which means that prices play an important role in determining the volume of imports, so the fiscal policy must be used to control the price level.

Table (5): Variance Decomposition of Egypt's Food Imports Quantity

	FOODM	P	AGRI	GDPPC	INF	POP	EX	RES
1	100	0	0	0	0	0	0	0
2	43.73	0.34	15.86	1.01	6.42	23.25	0.76	8.59
3	24.73	4.31	9.31	3.66	27.02	22.36	2.02	6.55
4	16.23	15.45	6.70	3.25	25.40	25.85	1.34	5.75
5	13.52	13.38	8.14	7.96	22.78	27.41	1.81	4.95
6	8.03	21.40	4.97	15.54	13.49	28.80	3.89	3.84
7	7.26	24.01	4.29	16.13	12.13	25.91	5.80	4.44
8	6.73	23.81	3.76	14.94	14.51	21.91	6.99	7.32
9	6.81	22.19	4.05	12.81	16.10	21.64	6.36	10.00
10	6.28	20.60	3.77	12.38	17.51	24.06	5.64	9.71

Source: Compiled by researcher depending on the program E-Views, the results of Vector Error Correction Model (VECM)

6. Conclusion

The issue of food and the provision of society's needs have a priority in the Egyptian economic policy. The food problem in Egypt is the insufficiency of local production in meeting the consumption needs of the main food commodities. Therefore, the main objective of this study is to analyze the main determinants of Egyptian food imports during the period 1990–2019 using a Vector Error-Correction Model (VECM) that will help policymakers use the appropriate policies to control Egypt's food imports and reduce the trade deficit.

The results of the study showed that the quantity of Egyptian food imports increased during the study period (1990–2019), as it reached its lowest level in 1993 by about 8.5 million tons, then increased to reach its maximum in 2019 of 33.7 million tons, with a general average of about 16.6 million tons. Furthermore, the main trading partners for Egypt's food imports in 2019. The Russian Federation is the most important trading partner by about (34.62%), then Argentina (17.35%), the United States of America (13.97%), Ukraine (9.82%), France (2.58%), Italy (0.35%), the United Kingdom (0.34%), Kenya (0.30%), and the rest of the world (20.47%).

The empirical results of the VECM model and variance decomposition revealed that the most important factors affecting Egypt's food imports are population growth and inflation rate. Furthermore, the response of food imports to GDP per capita changes is weak in the short run, which means that substitution effect is more significant than income effect on Egypt's food imports. While the demand for food imports is inelastic or insensitive to the import price in the short term, which indicates the importance of these imports to the Egyptian economy. On the other hand, foreign reserves, and the exchange rate have little effect. Therefore, it is difficult to rely on monetary policy to reduce food imports and reduce the deficit in the trade balance. As well the impact of agricultural production on food imports is ineffective as a result of the decline in the share of agricultural output to GDP.

7. Recommendations

▪ Fiscal and trade policies must be used to limit food imports and encourage the use of the local alternative to them, as the study showed the ineffectiveness of monetary policies represented by the devaluation of the Egyptian pound.

▪ Increasing domestic production by expanding horizontally and vertically and by encouraging farmers to replace some currently cultivated varieties with newly developed ones that are more productive, better in specifications, and more compatible with climate change.

▪ Increasing investments directed to agriculture by improving the investment climate, formulating clear and specific laws, and directing more attention to smallholders, as these investments are the main determinant of agricultural development.

▪ Rationalizing food consumption through nutritional education for individuals in cooperation with media agencies and various social institutions.

▪ Reducing geographical concentration, diversifying agricultural commodity import sources, and opening new markets.

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Appendix

Table (1): Results of Vector Error-Correction Model (VECM)

Cointegrating Eq:	Coint Eq1	Coint Eq2	Coint Eq3	Coint Eq4	Coint Eq5
DLOG(FOODM(-1))	1.00	0.00	0.00	0.00	0.00
DLOG(P(-1))	0.00	1.00	0.00	0.00	0.00
DLOG(AGRI(-1))	0.00	0.00	1.00	0.00	0.00
DLOG(GDPPC(-1))	0.00	0.00	0.00	1.00	0.00
DLOG(INF(-1))	0.00	0.00	0.00	0.00	1.00
DLOG(POP(-1))	-17.9	-66.20*	5.46	-49.95*	-165.61*
DLOG(EX(-1))	0.65*	1.70*	1.00*	1.45*	1.14
DLOG(RES(-1))	-0.14	-0.55*	0.01	-0.38*	-1.81*
C	0.34	1.40	-0.23	1.02	3.84

Error Correction:	D(DLOG (FOODM))	D(DLOG (P))	D(DLOG (AGRI))	D(DLOG (GDPPC))	D(DLOG (INF))	D(DLOG (POP))	D(DLOG(EX))	D(DLOG(RES))
CointEq1	-1.60*	1.18*	0.04	0.09	2.12	-0.028**	0.61	1.11
CointEq2	0.09	-1.04*	0.87*	0.11	-0.21	-0.02*	-0.65**	-0.47
CointEq3	0.30	0.38	0.08	0.08	-2.97**	0.04*	-1.47*	0.72
CointEq4	0.14	0.82*	-0.51**	-0.50*	0.86	0.02*	-0.11	-0.79
CointEq5	-0.12*	0.14	-0.24*	0.06**	-0.004	0.01*	0.19	0.45**
D(DLOG(FOODM(-1)))	0.01	-0.27	-0.006	-0.08	-0.07	0.006	-0.50	-1.01
D(DLOG(P(-1)))	-0.12	0.11	-0.69*	-0.08	0.49	0.0005	0.44**	-0.34
D(DLOG(AGRI(-1)))	-0.13	0.65**	-0.20	0.21**	3.64*	-0.007	0.10	-1.37
D(DLOG(GDPPC(-1)))	-0.54*	-0.09	0.02	0.02	2.09*	-0.008	0.08	0.01
D(DLOG(INF(-1)))	0.01	-0.009	0.23*	-0.02	-0.53**	-0.002	-0.19*	-0.39*
D(DLOG(POP(-1)))	-8.51**	6.36	-8.60	-4.91*	20.71	-0.54*	9.55	33.98**
D(DLOG(EX(-1)))	0.48*	-0.30	-0.19	-0.06	0.95	-0.02*	0.34	0.07
D(DLOG(RES(-1)))	-0.17*	0.09	-9.29	-0.09*	0.50	0.006*	0.10	0.078
C	0.03*	-0.02	0.02	0.0002	-0.02	-0.0007	-0.01	-0.03
R-squared	0.95	0.88	0.64	0.95	0.86	0.88	0.86	0.57
Adj. R-squared	0.90	0.76	0.29	0.91	0.72	0.76	0.73	0.15
F-statistic	19.53*	7.45*	1.81	23.58*	6.197*	7.53*	6.47*	1.36

Source: Compiled by researcher depending on the program E-Views, and data of table (1) in appendix.
*Note: * indicates significance at 5% level, ** significance at 10% level.*