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Measurement and Analysis of the Stability of the Egyptian Agricultural Output Growth Rate

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Abstract
The research aims to measure and analyze the stability of the growth rate of the total Egyptian agricultural product through its three components, which are the value of plant production, the value of animal production and the value of fish production, and to determine the effects of fluctuations in agricultural production on economic growth in the Egyptian agricultural sector, in addition to estimate the impact of fluctuations in those Components besides inflation and agricultural employment on the growth rate of the Egyptian total agricultural product during the period 1987-2020. The research used the instability coefficient proposed by Cuddy-Della Valle (1978), simple correlation, simple regression, inverse roots of characteristic polynomial, cointegration test, and the fully modified ordinary OLS (FMOLS). The most important results of the FMOLS indicated that all the signs are logical and that the regression coefficients are significant. and the growth rate of the total value of agricultural output during the study period is affected by fluctuations in the growth rate of the value of plant, animal and fish production, annual inflation rate, agricultural employment, fluctuations in the growth rate of the total value of Egyptian agricultural output with a delay of one period. The volatility in the growth rate of the value of plant, animal and fish production have a significant negative impact on the growth rate of the agricultural sector, while the inflation rate and agricultural employment have a significant a positive impact on the growth rate of the agricultural.
Keywords: Volatility in the value of agricultural output, Cuddy-Della Valle index, Growth rate, Inflation, Unit Root, Cointegration, FMOLS.
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1. Introduction

The relationship between the average growth rate and volatility in growth rates, over time and in different countries, has important implications, which critically depend on the nature of the direction of this relationship (Ramey and Ramey, 1995), and it is widely accepted that achieving development depends on a stable economy. Through the steady growth of the GDP, maintaining a low level of unemployment and inflation is an important and main goal of any economy. Macroeconomic stability is also necessary to reform policies in developing countries and to achieve sustainable economic growth (Fischer, 1992), as economic stability allows achieving several macroeconomic goals, such as price stability and stable and sustainable growth, and reducing the possibility of economic shocks, including side shocks. Supply and demand side shocks. It also creates the appropriate environment to increase employment opportunities and improve the balance of payments, because stability to a large extent creates a state of certainty and confidence, which in turn increases incentives for private investment, and leads to attracting capital, which encourages investment in technology and human capital, and creates unstable social aspects in society, where the economic stability and growth complement each other.

For many developing countries, agriculture is the largest sector in terms of its share of gross domestic product (GDP) and employment. Agriculture plays a vital role in the economy of these countries, not only since it provides food for the entire population, but also because it is linked to and interacts with all related industries in the country. Agriculture represents one of the most important main productive sectors in the Egyptian economy, as the value of agricultural output represents about 10.12% of Egypt's GDP in 2020, so Egypt needs to maintain high growth for the agricultural sector, with an average contribution rate of plant, animal, and fish production about 56.50%, 35.30%, and 8.20%, respectively, of the total value of Egyptian agricultural product during the period 1987-2020. (Central Agency for Public Mobilization and Statistics).

The importance of the stability of the growth rate of agricultural output stems from the harmful effects and consequences of sharp fluctuations in the total output as a main measure and indicator of the economic situation in the agricultural sector. The instability of the growth rate results in many mechanisms that negatively affect the agricultural sector. It increases the risks involved in agricultural production, affects farmers' income and their decisions to invest in agriculture. It also affects price stability, food management and increases the exposure of low-income families to market risks. Based on the importance of the agricultural sector, the stability or instability of the growth rate of agricultural output and its components means, the stability or instability of the economic growth rate in Egypt. Therefore, the stability of agricultural output growth is an important topic for research because it is related to the ability of the agricultural sector to absorb and adapt to external and internal shocks and crises.

1.1. Research Objective

Measuring and analyzing the stability of the growth rate of the total Egyptian agricultural product through its three components, which are the value of plant production, the value of animal production and the value of fish production, in addition to determining the effects of volatility in agricultural production on economic growth in the Egyptian agricultural sector, as well as estimating the impact of volatility in those components along with each of inflation and agricultural employment on the growth rate of the Egyptian agricultural gross product during the period 1987-2020

2. Literature Review

A number of studies have been conducted to estimate the growth rate instability indicator, whether at the macroeconomic level or in the agricultural sector. Blanca (1998) study confirmed the beneficial effect of the stability of economic growth on the overall economy, and that macroeconomic stability and market liberalization are two prerequisites for economic growth. The objective of the study of McConnell, Mosser, and Quiros (1999) was to analyze the stability of GDP growth, and it was found that the growth rates of all major components of GDP took a stable path despite the presence of fluctuations in real estate investment and trade. It was also found that GDP growth and its components were more stable in both periods of stagnation and expansion.

Clausen and Kim (2000) analyzed aggregate demand for money in Europe during the period 80-1996 (quarterly data). The study used the error correction model (ECM) and the fully modified ordinary least squares method (FMOLS), and the stable functions of money demand in Europe were estimated (using cointegration) for both Ml and M3, and the stability of the estimated parameters over time. The results of the study did not find evidence of structural instability in demand Total on money in Europe.

Sirimaneetham and Temple (2009) found a strong relationship between growth and macroeconomic stability for a sample of 70 developing countries. Safdar et. al. (2012) presented the nature of fluctuations in the agricultural sector in Pakistan and knew the extent to which volatility, production and employment in the agricultural sector are related to economic growth, by applying conditional autoregressive analysis (ARCH) family models to detect the volatility of the agricultural sector in Pakistan, applying the unit root test, and showing all variables are integrated of the first degree, and the co-integration test is applied to identify the long-term impact of the study's variables on economic performance. The results showed that productivity and employment in the agricultural sector are positively and morally related to economic growth, while agricultural instability contributes negatively to economic growth in Pakistan.

Kumar and Jain (2013) study estimation of growth trends and instability in Indian agriculture at the district level. The productivity of the crop sector showed significant differences in the provinces. It turns out that there is a mixed performance of the crop sector, which needs to develop strategies to ensure sustainable and inclusive agricultural growth. It also confirmed the instability of productivity across different regions. She pointed out the important role of modern inputs in enhancing the productivity of the crop sector. Shadid (2014) estimated the impact of inflation and unemployment on economic growth in Pakistan by analyzing time series data for the period 1980-2010. The unit root test showed that economic growth is stable at the level as well as at the first differences, but unemployment and inflation are stable at the first differences.

Ali and Ur Rehman (2015) attempted to answer the question “Does macroeconomic instability have a detrimental effect on Pakistan’s GDP over the period 1980-2012?” To review macroeconomic instability, a comprehensive macroeconomic instability index was created by integrating the inflation rate, unemployment rate, trade deficit, and budget deficit. Distributed Autoregressive Model (ARDL) and VEC Error Correction Vector Model were used, and Granger's causality test was applied to verify the causal relationship between model variables. The results of the study confirmed the existence of a co-integration between macroeconomic instability and GDP in Pakistan, and that macroeconomic instability has a significant and detrimental impact on the GDP of Pakistan. Thus to achieve the required level of GDP, Pakistan should make a stable macroeconomic environment.

Özpençe (2017) study examined how inflation and unemployment affect economic growth in Turkey, and it was found, according to the Johansen Cointegration Test, that there is a long-term relationship between the industrial production index as an indicator of economic growth, and the product price index and unemployment, and the paper recommended that to ensure economic growth In Turkey, policies that reduce unemployment should be preferred. Kehinde and Oladipo (2017) examined the impact of agricultural production instability on economic growth in Nigeria using time series data for the period 1970-2013. The OLS method was used with the application of the conditional autoregressive analysis model (EGARCH), and the unit root test was applied using ADF, and the results revealed that agricultural production and labor force have a positive effect on economic growth, although not statistically significant, while the volatility of agricultural production has Negative effect on growth. The study recommended policies that focus on stabilizing the economy and providing an appropriate infrastructure that would lead to an increase in agricultural production.

Anjum and Madhulika (2018) aimed to study the growth, regional instability, production and productivity of major crops in India. The Cuddy Della Valle index was used, and it was noted that there were many fluctuations in the growth pattern of area, production and productivity of crops in the study. A pattern of instability in areas, production and productivity of major crops was also observed. Liew (2018) et al. showed that macroeconomic instability has a negative impact on economic performance and per capita GDP in Malaysia for the period 1984-2016.

Altarawneh, Mahmoud and Al-Tarawneh (2020) study measured and analyzed economic stability in Jordan at the levels of GDP, sector level (agricultural, mining, industrial, construction, and services), and aggregate demand components. Using data for the period 1976-2018, the results indicated the ability of the Jordanian economy to adapt and absorb shocks from abroad. The results also showed that instability increases with the economy facing external crises. And that the stability of GDP growth is linked to the stability of the services sector.

3. Data and Methodology

3.1. Data

The research relied on secondary data in the form of time series covering the period 1987-2020, which were issued by many government agencies such as the Ministry of Agriculture and Land Reclamation, the Central Agency for Public Mobilization and Statistics, the World Bank, and the data were collected since 1985 to cover the entire period at an aggregate level. Agricultural domestic product, and its three components, the value of plant production, the value of animal production, and the value of fish production.

3.2. Methodology

Volatility or instability is a statistical measure of the dispersion of output or any economic indicator during a certain period, the higher of the fluctuations means the higher of the risk. Researchers often use the standard deviation or coefficient of variation (CV) as a tool to measure volatility or instability, but it does not properly explain the component of trend inherent in time-series data, so the research used the coefficient of instability proposed by Cuddy and Della Valle (1978), which is calculated from the following equation**:**

$$I_x = CV\sqrt{1 - R^2}$$

Where I_x is the instability index (%), CV is the coefficient of variation (%), R^2 is the coefficient of determination and is estimated from the time-trend regression of the variable under study according to the degrees of freedom.

The research was also based on the use of descriptive statistical analytical methods, which were represented in the arithmetic and geometric mean, with the use of tabular and graphic displays, estimating the equation of the time trend, and the annual growth rate, Unit Root Test to identify the stability of the time series of the data under study, the Cointegration Test, and the FMOLS (Fully Modified OLS) method was used, which is a method for analyzing data of multiple time series models that directly estimate the long-term effect of variables. The independent on the dependent variable after correcting the homogeneity problem and taking the autocorrelation problem in the time series into consideration, The FMOLS method is a partial alternative to the ECM. The FMOLS method is preferred in terms of the convergent behavior of the variables. FMOLS is also referred to as the cointegration equation model (Phillips and Hansen, 1990) & (Phillips 1993).

The study model includes the annual growth rate in the total value of Egyptian agricultural output GrGDPTotal as a dependent variable, while the independent variables are volatility in the annual growth rate in the total value of agricultural output (with one lagged period), VolatilityGrGDPTotal, volatility in the annual growth rate in the value of plant production VolatilityGrGDPPlant, and volatility In the annual growth rate of the value of animal production VolatilityGrGDPAnimal, volatility in the annual growth rate of the value of fish production VolatilityGrGDPFish, annual inflation rate and agricultural employment AgLabor. The correlation matrix between the independent variables under study was estimated to ensure the absence of the problem of multicollinearity, and it was found that the values of the estimated correlation coefficient between those variables did not exceed 0.6, so all independent variables were dealt with in the model.

4. Results and Discussion

4.1. Descriptive Statistics of the total value of Egyptian agricultural output and its components:

The descriptive statistics has been displayed in table (1) and figure (1), it was found that the total value of plant production during the period 1987-2020 ranged between a minimum value of 10.07 billion LE in 1987, and a maximum value of 290.23 billion LE in 2020, with mean value of 96.54 billion LE, and the instability coefficient of Cuddy and Della Valle amounted to 32.61%. While the total value of animal production ranged between a minimum value of 4.75 billion LE in 1987, and a maximum value of 204.17 billion LE in 2020, with mean value of 60.28 billion LE, and an instability coefficient of about 39.40%. The total value of fish production ranged between a minimum value of 0.65 billion LE in 1987 and a maximum value of 68.32 billion LE in 2020, with mean value of 14 billion LE, and an instability coefficient of about 69.67%. The total value of Egyptian agricultural product ranged between a minimum value of 15.47 billion LE in 1987, and a maximum value of 562.71 billion LE in 2020, with mean value of 170.82 billion LE, and an instability coefficient of about 37.49%.

- **The development of agricultural employment**: during the period 1987-2020, it was found that it ranged between a minimum of about 4.45 million workers in 1988, and a maximum of about 6.81 million workers in 2011, with an annual average of about 5.43 million workers, and an instability coefficient of about 6.23%.

Table 1. Descriptive analysis of the development of the components of Egyptian agricultural production in during the period 1987-2020 (billion LE)

Variables	Mean	Min.	Max.	CDVI
GDPPlant	96.536	10.069 Year 1987	290.226 Year 2020	32.61
GDPAnimal	60.283	4.754 Year 1987	204.165 Year 2020	39.40
GDPFish	13.995	0.648 Year 1987	68.321 Year 2020	69.67
AGDPTotal	170.815	15.472 Year 1987	562.713 Year 2020	37.49
AgLabor	5.430	4.451 Year 1988	6.810 Year 2011	6.23

Source: Collected and calculated from the statistical analysis of the study data using Eviews 10.

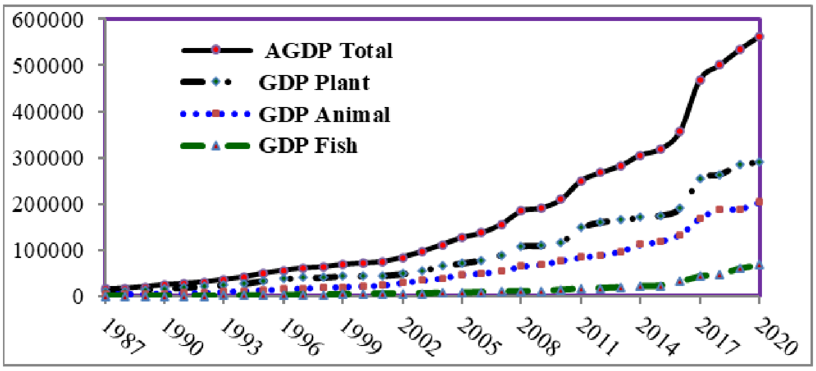

Figure 1. The total value of Egyptian agricultural output and its components during the period 1987-2020

4.2. Descriptive Statistics of the growth rate of the total value of Egyptian agricultural output and its components:

The data in Table (2) and Figure (2), showed that the growth rate in the value of plant production during the period 1987-2020 ranged between a minimum of about 0.33% in 2000, and a maximum of about 33.96 % in 2017, with geometric mean 7.60%, and an instability coefficient of 110.94%. While the agricultural labor growth rate ranged between a minimum of about -6.17% in 2012, and a maximum of about 9.61% in 2010, with geometric mean 1.03%, and an instability coefficient about 326.23%. The inflation rate ranged between a minimum of 2.27% in 2001 and a maximum of about 29.51% in 2017, with geometric mean 9%, and with an instability coefficient of 69.75%. The Jarque-Bera test was found not significant, which indicates that all these variables are subject to a normal distribution during the study period.

Table 2. Descriptive analysis of the annual growth rate of the components of agricultural

Variables	Mean$_G$	Min.	Max.	CDVI	Jarque-Bera	
					Value	Prob.
GrGDPPlant	7.60	0.33 Year 2000	33.96 Year 2017	110.94	0.709	0.701
GrGDPAnimal	10.72	0.85 Year 2019	26.86 Year 2017	52.64	2.299	0.304
GrGDPFish	11.20	0.53 Year 2008	38.62 Year 1990	96.46	1.297	0.458
GrAGDPTotal	10.25	3.33 Year 2009	31.44 Year 2017	61.55	2.961	0.227
AgLabor	1.03	-6.17 Year 2012	9.61 Year 2010	326.23	0.235	0.889
Inflation	9.00	2.27 Year 2001	29.51 Year 2017	69.75	0.098	0.952

<u>Source</u>: Collected and calculated from the statistical analysis of the study data using Eviews 10.

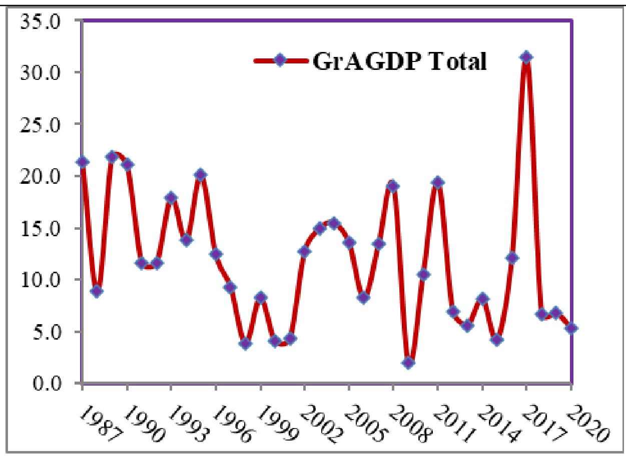

Figure 2. Annual growth rate (%) of the total value of Egyptian agricultural product during the period 1987-2020

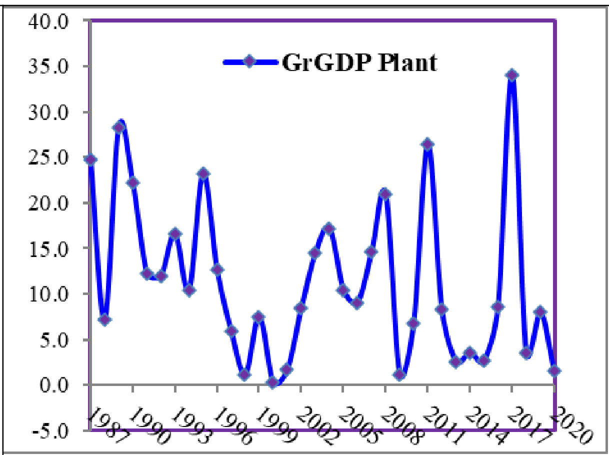

Figure 3. Annual growth rate (%) of the value of plant production in Egypt during the period 1987-2020

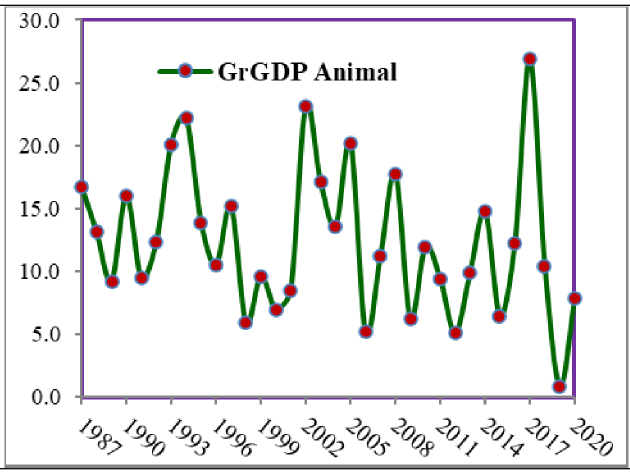

Figure 4: Annual growth rate (%) of the value of livestock production in Egypt during the period 1987-2020

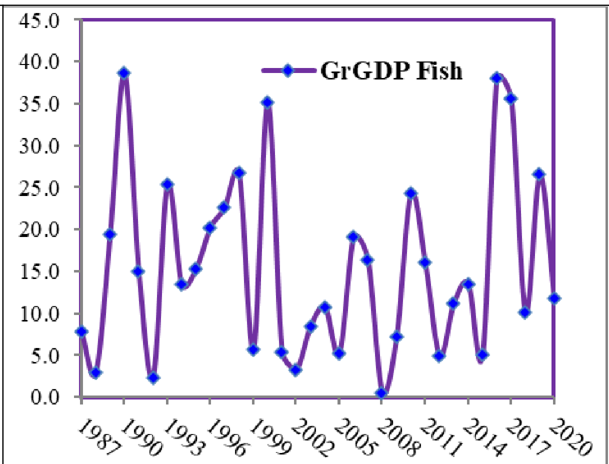

Figure 5: Annual growth rate (%) of the value of fish production in Egypt during the period 1987-2020

4.3. Descriptive Statistics of the volatility in the total value of Egyptian agricultural output and its components:

The rate of volatility in the value of plant production ranged between a minimum value of -0.96 in 1999, and a maximum of about 5.39 in 1998, with a geometric mean about 0.76, and an instability coefficient about 237.69%. The volatility in the value of animal production ranged between a minimum value of -0.92 in 2018 and a maximum value of 8.18 in 2019, with a geometric mean about 0.38, and an instability coefficient about 389.15%. The rate of volatility in the value of fish production ranged between a minimum value of -0.97 in 2007 and a maximum value of 12.56 in 2008, with a geometric mean about 1.28, and an instability coefficient about 248.31%. While the rate of volatility in the total value of Egyptian agricultural product ranged between a minimum value of -0.89 in 2008, and a maximum value of 4.17 in 2009, with a geometric mean of 0.28, and an instability coefficient about 372.23%. Table (3) and Figures (6 & 7).

Table 3. Descriptive analysis of volatility in the annual growth rate of the components of agricultural output during the study period

Variables	Mean	Min.	Max.	CDVI
VolatilityGrAGDPPlant	0.76	-0.96 Year 1999	5.39 Year 1998	237.69
VolatilityGRGDPAnimal	0.38	-0.92 Year 2018	8.18 Year 2019	389.15
VolatilityGRGDPFish	1.21	-0.97 Year 2007	12.56 Year 2008	248.31
VolatilityGRAGDPTotal	0.28	-0.89 Year 2008	4.17 Year 2009	372.23

Source: Collected and calculated from the statistical analysis of the study data using Eviews 10.

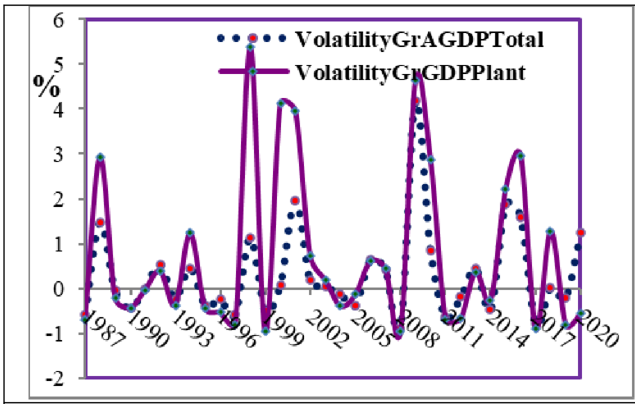

Figure 6. The volatility in the annual growth rate of the total value of agricultural output and the value of plant production in Egypt during the period 1987-2020

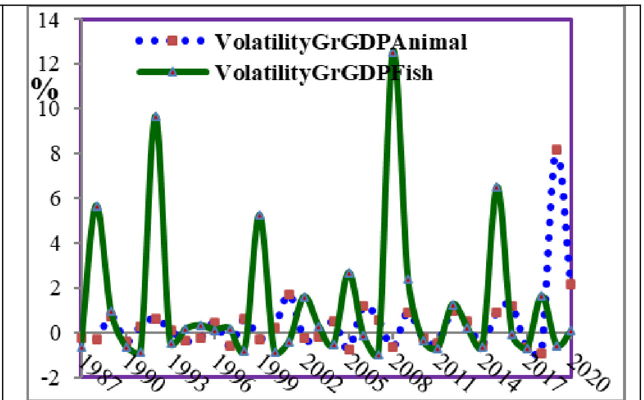

Figure 7. The volatility in the annual growth rate of the total value of animal and the value of fish production in Egypt during the period 1987-2020

4.4. Results of estimation of simple regression relationships between study model variables:

Table 4 shown the simple regression relationship between the annual growth rate in the total value of agricultural production and its three components as dependent variables and each of agricultural employment (in double logarithmic form), inflation, volatility in the annual growth rate in the total value of agricultural production and its three components as independent variables. The regression is acceptable and consistent with economic logic, as it is significant, whether at the 5% or 1% level. It is also noted that the negative impact of volatility in the annual growth rate in the total value of agricultural production and its three components as independent variables on the annual growth rate in the total value of agricultural production and its three components as dependent variables. Therefore, the study model includes the annual growth rate in the total value of Egyptian agricultural production as a dependent variable, and the volatility in the annual growth rate in the total value of agricultural production (with one lagged period), its three components, the annual inflation rate and agricultural employment as independent variables.

Table 4. Results of simple regression analysis of the variables included in the study model

Dep. Variable	Indep. Variable	Constant	Coefficient	R^2	F
LNGDPPlant	LNAgLabor	2.712 n.s	5.987**	0.849	179.521**
LNGDPAnimal		0.247 n.s	5.048**	0.850	181.298**
LNGDPFish		0.011**	4.914**	0.804	131.454**
LNAGDPTotal		2.050 n.s	6.454**	0.847	177.627**
GRGDPPlant	Inflation	1.143 n.s	0.948**	0.666	27.905**
GRGDPAnimal		9.320**	0.279*	0.593	3.642*
GRGDPFish		12.009**	0.313*	0.534	4.114*
GRAGDPTotal		4.350*	0.702**	0.547	25.879**
GRGDPPlant	VOLatilityGrAGDPTotal	13.376**	-2.749**	0.622	15.192**
GRGDPAnimal		13.040**	-2.034**	0.593	13.248**
GRGDPFish		17.761**	-1.941**	0.623	15.282**
GRAGDPTotal		12.759**	-3.318**	0.669	11.761**

Source: Collected and calculated from the statistical analysis of the study data using Eviews 10.

4.5. Testing the stationarity of the variables under study:

To test the stationary of the time series under study to identify the existence of long-term relationships between them, a Unit Root test was conducted. The results, based on ADF & PP Table (5), indicated the stationary of some of these series at level and others at the 1st difference. By using the criteria for determining the length of the lag length, it was found that all criteria (LR, FPE, AIC, SC, HQ) agreed that the length of the delay period for the study variables was one period. (Table 6).

Table 5. Results of the unit root test for the stationarity of the variables under study during the period 1987-2020

Variable	ADF		PP		
	Intercept	Trend and Intercept	Intercept	Trend and Intercept	Stationary at
GrGDPPlant	-5.20**	-5.36**	-5.19**	-5.36**	Level
GrGDPAnimal	-3.55*	-4.14*	-5.06**	-5.18**	Level
GrGDPFish	-5.64**	-5.54**	-5.64**	-5.64**	Level
GrGDPTotal	-5.08**	-5.23**	-5.06**	-5.21**	1st Difference
AgLabor	-4.63**	-4.56**	-4.65**	-4.58**	1st Difference
Inflation	-7.28**	-7.16**	-8.29**	-8.21**	1st Difference
VolatilityGrGDPPlant	-5.93**	-5.82**	-5.93**	-5.82**	Level
VolatilityGrGDPAnimal	-5.27**	-6.17**	-7.58**	-8.02**	Level
VolatilityGrGDPFish	-6.77**	-6.72**	-7.71**	-7.62**	Level
VolatilityGrGDPTotal	-6.27**	-6.14**	-6.37**	-6.23**	Level

Source: Collected and calculated from the statistical analysis of the study data using Eviews 10.

Table 6. Results of the unit root test for the stationary of the time series under study during the period 1987-2020

Lag Order Selection Criteria Included observations: 33

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-543.462	NA	726743.6	33.361	33.679	33.468
1	-422.581	183.153*	9983.654*	29.005*	31.544*	29.859*

* Indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error AIC: Akaike information criterion
SC: Schwarz information criterion HQ: Hannan-Quinn information criterion

Source: Collected and calculated from the statistical analysis of the study data using Eviews 10.

Then it was tested whether the model suffers from the problem of autocorrelation, using the LM test, a number of periods that take 12 periods, and it was shown from Table (7) that it is possible to hypothesize that there is no autocorrelation problem, as all test outputs up to period 12 have no autocorrelation. In the next stage, the variance of the variables was tested to identify the extent of the variance difference problem, using the White Heteroscedasticity test, and it was shown from Table (8) that the null hypothesis can be accepted that there is no variance problem, as the calculated chi-square value is not significant.

Table 7. Autocorrelation results using LM Test

Lag	LM-Stat.	Prob.	Lag	LM-Stat.	Prob.
1	51.704	0.369	7	53.238	0.314
2	60.142	0.132	8	43.901	0.679
3	59.291	0.149	9	61.326	0.111
4	44.934	0.639	10	56.485	0.215
5	56.537	0.214	11	50.944	0.397
6	50.337	0.420	12	60.628	0.130

Source: Collected and calculated from the statistical analysis of the study data using Eviews 10.

Table 8. Results of Variance Using White Variance Test

Chi^2	df	Prob.
806.160	784	0.2839

Source: Collected and calculated from the statistical analysis of the study data using Eviews 10.

In order to ensure the stability condition of the model used as a whole, the Roots of Characteristic Polynomial test was applied, the stability condition of the model is, that all roots fall within the limits of the unit circle, and it is clear from Figure (8) that the stability condition is met. The model used in the study, which indicates the possibility of relying on the results of the estimated model using those variables.

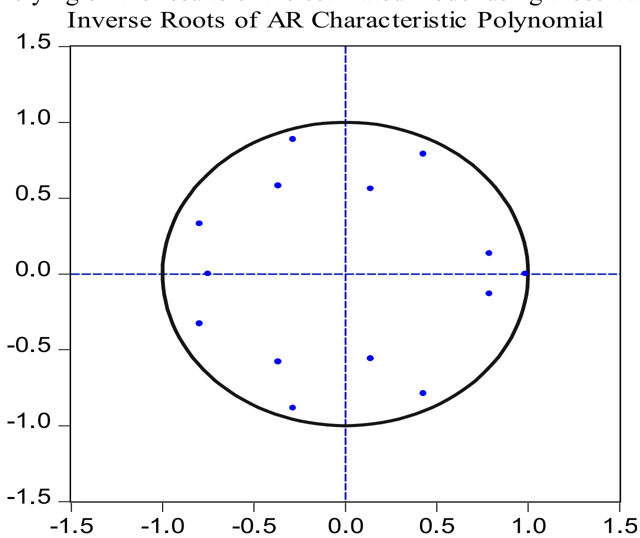

Figure 8. Results of the unit root test for the stationarity of the time series under study

4.6. Results of Cointegration Test:

The cointegration test was performed on the same set of variables using Johansen's test, and the results in Table (9) indicate that it is possible to reject the original hypothesis that there is no cointegration between the set of variables under study, as a result of the presence of 4 vectors of co-integration between these variables at the 0.01% level, either according to the value of Trace Statistic or the value of Max-Eigen Statistic. Thus, it is possible to reject the null hypothesis which says that there is no co-integration relationship between those variables, and to accept the alternative hypothesis which says that there is at least one vector of cointegration among the set of variables under study in the long term, which indicates the existence of a static linear combination between those variables, and this result confirms the possibility of a long-term equilibrium relationship between these variables, which means that these variables do not move away from each other in the long run.

Table 9. Results of cointegration tests using Johansen's test during the period 1987-2020

Eigenvalue	**Trace Static**	Max-Eigen Statistic	Prob.	H_0	**Result**
0.948	262.874	91.616	0.000	None**	Reject H_0 at 1%
0.889	171.259	67.018	0.000	$r \leq 1^{**}$	Reject H_0 at 1%
0.718	104.240	39.249	0.000	$r \leq 2^{**}$	Reject H_0 at 1%
0.655	64.991	33.006	0.000	$r \leq 3^{**}$	Reject H_0 at 1%
0.464	31.985	19.329	ns	$r \leq 4$	Accept H_0
0.262	12.656	9.403	ns	$r \leq 5$	Accept H_0

** Significant at 0.01

Source: Collected and calculated from the statistical analysis of the study data using Eviews 10.

4.7. Empirical Results of Model Using Fully Modified Least Squares Method (FMOLS):

The FMOLS method results presented in Table (10), indicated that all signs are logical and the regression coefficients are significant, and that changes in the growth rate of the Egyptian agricultural sector (the growth rate of the total value of agricultural output) during the study period are significantly affected by: The volatility in the growth rate of the value of plant, animal and fish production; annual inflation rate; agricultural employment; and the volatility in the growth rate of the total value of the Egyptian agricultural output with lagged time of one year. The value of the adjusted coefficient of determination was about 0.786, which means that those independent variables included in the model explain about 78.6% of the volatility in the growth rate of the total value of the Egyptian agricultural output during the period 1987-2020. The effect of volatility in the growth rate of the three components can be arranged according to the strength of their impact as follows: volatility in the growth rate of the value of plant product, the animal product, the volatility in the growth rate of the value of fish product.

From the estimated parameters in the previous model, it shows that when the volatility in the growth rate of the value of plant, animal, and fish production increase by 1%, it is expected to reduce the growth rate in the agricultural sector by 1.278%, 0.669%, and 0.353% respectively. It is also noted that the increase in the annual inflation rate by 1% leads to an increase in the growth rate of the agricultural sector by 0.253%, as the agricultural sector is one of the most important productive sectors that provide real added value, and the decline in agricultural production leads to a shortage in the supply of agricultural commodities; which in turn leads to an increase in prices, as well as imported inflation due to the high ratio of food imports to food exports in Egypt. This positive relationship leads us to think about the reason for the existence of a stable relationship between the rate of economic growth and the rate of inflation, so that the faster the rate of inflation, the faster the rate of economic growth, assuming the stability of the rest of the variables, and this result is consistent with the results contained in Table (4) , and also agree with the findings of Kumar, and Jain (2013) & Ali and Ur Rehman (2015) & Özpençe (2017). It was also found that an increase in agricultural employment by 1% leads to an increase in the growth rate of the agricultural sector by 1.719%.

Table 10. FMOLS Model Results

Dependent Variable: GRAGDPTOTA
Method: Fully Modified Least Squares (FMOLS)
Sample (adjusted): 1989 2020
Included observations: 32 after adjustments
Cointegrating equation deterministic: C @TREND
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.000)

Variable	Coefficient	t-Statistic	Prob.
VOLatilityGrGDPPlant	-1.278	-8.055	0.000
VOLatilityGrGDPAnimal	-0.669	-3.166	0.004
VOLatilityGrGDPFish	-0.353	-3.001	0.006
INFLATION	0.253	9.018	0.000
AGLABOR	1.719	3.938	0.000
VOLatilityGrAGDPTotal(-1)	1.308	5.341	0.000
C	7.224	5.088	0.000
@TREND	0.222	2.088	0.047
R-squared 0.817		Adjusted R-squared 0.786	

* Significant at 0.05 ** Significant at 0.01

Source: Collected and calculated from the statistical analysis of the study data using Eviews 10.

In addition, the increase in the growth rate of the total value of agricultural output in the previous year by 1% is expected to lead to an increase in the growth rate of the agricultural sector by 1.308% in the current year, which indicates the ability of the Egyptian agricultural sector to adapt, absorb shocks and crises, adapt to them and recover from the adverse effects of sharp volatility in total output.

5. Conclusion

In general, the results of the FMOLS model of the changes in the growth rate of the value of the Egyptian agricultural GDP estimated in this study are free from estimation problems, and therefore, agricultural policy makers and researchers can use these results to know the effect of volatility in the components of the value of agricultural gross product, the impact of inflation and agricultural employment on the stability of the growth rate of the value of the total agricultural output in Egypt, and consequently the stability of the Egyptian agricultural sector. The study recommends adopting policies to enhance stability, promote sustainable growth, develop human capital, and develop infrastructure in the agricultural sector and agricultural markets.

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