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The Nexus between Some Agricultural Products and Economic Growth in Saudi

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Abstract In its Vision 2030, Saudi Arabia adopted a strategy to reduce dependence on oil and diversify the economy. Given the importance of the agricultural sector in accelerating economic growth, Saudi Arabia has focused on the agricultural sector among other targeted sectors. The study pointed to amount the degree of the relationship between some agricultural products (dates, cucumbers, chicken meat and tomatoes) in the Kingdom of Saudi Arabia and the AGDP during the period from 1990 to 2020. Johansson test for common Integration aimed to test the long-term equilibrium relationship between agricultural products and the AGDP. Additionally, it employed the Granger causality test to achieve the specified objectives of testing the presence and direction of a causal relationship between agricultural products and AGDP. The results demonstrated the presence of a long-term equilibrium integrative relationship between the study variables, as well as a causal relationship between the study variables. The results of the regression analysis also indicated a lack of a significant relationship between the agricultural GDP and cucumber, despite the large quantities cultivated, this could be attributed to the increase in production costs. Therefore, the study recommends conducting a scientific study to measure the competitiveness of cucumber production.

Keywords Cointegration Analysis, Multiple Regression, Agricultural Gross Domestic Product, Chicken Meat, Dates

1. Introduction

Food is a fundamental pillar upon which human life is built. Hence, the importance of agriculture cannot be overstated, as it serves as a primary source of food. This is why countries worldwide invest in the development of the agricultural sector through expanding agricultural areas, land reclamation, and the introduction of modern technology to achieve self -sufficiency, which in turn ensures food security and contributes significantly to the economy. Indeed, with the rapid population growth and urban expansion worldwide, accompanied by an increase in needs, countries find themselves in an urgent need of a greater increase in agricultural growth. This is essential for setting developmental goals and plans for their countries [1]. It is crucial for countries to have indicators that measure progress in achieving their economic, social, and environmental goals. Various measures are used to assess economic growth, and one of these indicators is the Gross Domestic Product (GDP), which is one of the most important tools for evaluating economic activity performance. The contribution of each sector to the country's total income is measured by GDP to evaluate the role of each sector in economic growth. To achieve balanced economic growth, countries seek to diversify their sources of income, avoiding the risk of relying on a single natural resource. Such reliance can lead to instability or even economic collapse if the price of this primary resource drops in the global market. It's true that the Kingdom of

Saudi Arabia primarily relies on its oil-based economy. Therefore, economic diversification is crucial for achieving stable economic growth. Consequently, the Kingdom has sought to achieve a more diversified economy since 1970 through 10 development plans, each covering five years, aimed at diversifying the economy [2].

It's impressive to see how the Kingdom has achieved self -sufficiency in dates and milk production through intensive agriculture. Additionally, the rates of self-sufficiency in vegetable (80%), fruit (60%) and fish (59%) production have increased [3]. However, due to water scarcity, the Kingdom has reduced the production of some crops that consume a large amount of water, such as wheat and barley.

The vision of Saudi Arabia 2030 focused on setting strategic goals, including economic development and economy diversification [4]. Saudi Vision 2030 ropes agricultural development to attain water and food security beside ecological balance. Thus, Food security is one of the aims of Vision 2030 [4]. In the agricultural sector, several programs have been established, among them is increasing the production and marketing capacity in the agricultural sector [5].

The Kingdom of Saudi Arabia produces some important and diverse agricultural crops, which are considered essential food for the Saudi community, achieving self-sufficiency in some of them. Among the most prominent agricultural products are dates, cucumbers, tomatoes, and chicken meat.

The research covers a range of agricultural products, including dates, cucumbers, chicken meat and tomatoes and their relationship with the agricultural gross domestic product in the Kingdom of Saudi Arabia for the period from 1991 to 2020. To understand the key requirements and results, it was necessary to refer to literature sources that addressed this topic.

The study investigated the impact of some agricultural products on the Gross Domestic Product (GDP) in Bangladesh [6], using Dickey-Fuller test, the Phillips-Person test, the Johansen test and the Fully Modified Least Squares method for testing time series data from 1971 to 2017. The results indicated a significant and positive impact of rice production on the GDP. However, fish production showed a contribution, however, to a lesser degree compared to rice production.

Other study focused on determining the contribution of corn, rice, and wheat production to the agricultural GDP in Pakistan for the period 1970-2017 [7]. The data was analyzed using the cointegration test and the Granger causality test. The cointegration results showed that the production of rice, corn, and wheat had a significant impact on the agricultural GDP in Pakistan. Additionally, the results indicated a one-way causal relationship between rice and corn production and the agricultural GDP, while wheat did not have a causal relationship with the agricultural GDP.

The study aimed to explore the long-term relationship between some fruit products, such as mango, apple, and peach, and the Pakistani agricultural GDP for a time series ranging from 1961 to 2015, which was explored by earlier study [8]. Authors employed the Johansen cointegration test and the Dickey-Fuller and Phillips- Perron tests to verify the data's stability. Results indicated the presence of both long-term and short-term relationships between the agricultural GDP and fruit production (mango, peach, and apple). Moreover, the three selected fruits have a significant impact on the agricultural GDP. Based on the results, increases in production by 1% resulted in increases of the agricultural GDP by 0.06%, 0.03% and 0.03%, respectively.

Autoregressive Distributed Lag (ARDL) approach was used in previous research to investigate the long-term relationship between meat products, including beef, mutton, and chicken, and the agricultural GDP [9]. Authors employed the Dickey-Fuller test to test for unit roots in the time series data from 1982 to 2018 in Pakistan. One of the key findings was the presence of a long-term relationship between beef production and the agricultural GDP. The results also indicated the absence of a long-term relationship between mutton, chicken, and the agricultural GDP.

The study examined animal production and its relationship with the agricultural GDP in Pakistan through standard economic analysis [10]. They utilized the Johansen cointegration test, Dickey-Fuller test (ADF) and Ordinary Least Squares (OLS) method as methods of analysis, using time series data during the period 1980-2015. The most prominent findings indicated a significant positive relationship between milk, fat, egg, bone, and mutton production, while the relationship was negative and insignificant for the agricultural GDP in the case of beef, chicken, wool, hair, and leather.

Other study investigated chicken production and its relationship with the agricultural GDP in Nigeria during the period 1975-2016 [11]. They used standard economic analysis through the Ordinary Least Squares (OLS) method and cointegration test. The results revealed the presence of two cointegrating equations, indicating a long- term relationship between the variables. The ECM test revealed a negative relationship between chicken production and the agricultural GDP, while the impact of chicken egg production on the agricultural GDP was minimal. On the other hand, chicken meat production seemed to have a significant positive effect on the agricultural GDP through its contribution to the animal husbandry sub-sector. The error correction model also indicated that any short-term deviations could be corrected in the long run by 39%.

From the appraised literature, it is clear that diverse analytical tools were applied in the analysis of the time series data connected to the issue of the study. Some instances of those methods are multivariate analysis, Johansen co-integration test, ARDL, regression analysis, VECM and ANOVA. However, it is worth noting that there are specific requirements of the selection of specific model in the analysis of each study. For instance, Johansen test is the best-fit model when dealing within significant data at level but becomes significant when first differenced. It is also observed that none of the stated studies has roofed all of the variables applied in the study; equally, no one of them was run in KSA background.

This research pointed at probing the short-run relationships and long-run speed of adjustment between AGDP and designated agricultural subsector production (tomato, cucumber, dates and chicken meat) in KSA. It also targeted at detecting the chief subsector that potency significantly donated to the development of AGDP. Tomato, cucumber, dates and chicken meat are considered as main agricultural products (among others) in Saudi.

2. Materials and Methods

2.1. Data Collection Methods

The research relied on secondary data collected from various sources related to the research topic, such as the Saudi Statistical Agency, the World Bank, and the FAO. The data represented the Saudi agricultural GDP (in Saudi Riyal) and the quantities produced (in tons) of dates, cucumbers, tomatoes, and chicken meat. The study covered the period from 1990 to 2020.

2.2. Methods of Data Analysis

2.2.1. Descriptive Statistical Analysis Test

The study used descriptive statistical analysis to understand the nature of the data distribution, relying on the Jarque-Bera test. Time series are considered to have a normal distribution if the probability of the Jarque-Bera coefficient is greater than 0.05. Curves for the general index of the time series were also plotted to provide initial insights into the possibility of a long-term equilibrium relationship. This method serves as a simple analytical approach to understanding this relationship and allows for further testing of cointegration.

2.2.2. Cointegration Test

The concept of cointegration is based on the economic idea of the statistical properties of time series and tests for time series with unit roots [12]. The concept of cointegration between two or more variables was clarified from a statistical perspective, indicating a long-term equilibrium relationship between these variables, even if the time series may not be stationary in the short term. Indeed, the equilibrium relationship between variables in the long term may deviate slightly from each other, but this deviation from equilibrium is corrected by strong economic forces that work to restore it in the long run .There are standard methods and approaches that can be used to test for cointegration of time series, among them is Johansen test.

Johansen Test for Cointegration

The cointegration analysis identifies the true relationship between variables in the long run, unlike traditional statistical models. The concept of cointegration is based on the idea that in the short term, the time series X and Y may be non-stationary, but they integrate in the long term, indicating a stable relationship between them. This relationship is called cointegration, and to express the relationships between these non-stationary variables, it is necessary to remove the non-stationarity through unit root tests. The Johansen test is conducted in the following steps [13] "(1,2)":

$$X_t = \alpha + +ZX_{t-1} + e_t \quad (1)$$

$$\Delta X_t = \alpha + \beta_t + ZX_{t-1} + e_t \quad (2)$$

Where:

Z represents the coefficient to be estimated in the ADF test, t represents time, a represents the constant, ß represents the overall trend Testing:

H_O: X is unstable (non -stationary) (presence of unit roots)

H_1: X is stable (absence of unit roots)

When comparing the calculated (t) for the ADF coefficient with the tabulated t, the alternative hypothesis H_1 is accepted when the calculated (t) for the ADF coefficient is greater than the tabulated t, indicating the time series' stability at a significance level at the 1% or 5%.

Johansen test for cointegration involves checking the stability of time series of the same order using the previous ADF test, and a lag is statistically selected. Then, the Johansen test analysis is conducted based on the selected lag.

Johansen relied on the maximum likelihood function using the trace test and the Maximum Eigenvalue test. For the tests, the null hypothesis of no integration was tested opposing to co-integration. To determine the number of cointegration vectors of the both tests are presented as follows:

1- Trace test: The test is conducted according to the following equation "(3,4)":

$$\lambda trace(r) - \mathrm{T} \ \textstyle\sum_{i=r+1}^{n} In(1-\lambda_{r+1}\ ) \quad (3)$$

or

$$\lambda trace(r) - \mathrm{T} \ \textstyle\sum_{i=r+1}^{n} log(\lambda_i\ ) \quad (4)$$

Where:

T: Sample size.

r: Number of cointegration vectors (r=0,1,2,3….)

1. Maximum Eigenvalue tes (Value Eigen Maximum): The test statistic is calculated according to the following equation"(5,6)":

$$\lambda \max(r, r+1) = Tln\ \ (1-\lambda_{r+1}) \quad (5)$$

or

$$\lambda \max - Tlog\ \ (1-\lambda_i) \quad (6)$$

In both cases, the interpretation of the result is as follows:

The critical value of the trace test is compared to the tabulated value .If the critical value of the trace test is greater than the tabulated value, it indicates the presence of cointegration. Similarly, the critical value of the maximum eigenvalue test is compared to the corresponding tabulated value .If the critical value of the maximum eigenvalue test is greater than the corresponding tabulated value ,it indicates the presence of cointegration at the 1% or 5% significance level.

2.3. Lag Specification

In order to apply error correction model, lag must be specified. Akaike Information Criterion (AIC) can be charity in choosing lag orders which are deliberated as widely recycled one [14].

2.4. Error Correction Model (ECM)

Co-integration results appeared in the long-run association between the variables. The ECM was used to examine the short-run relationship among the variables and discover the speed of adjustment to the long-run equilibrium from that of the short-run disequilibrium [15,16]:

Short- run stability among agricultural gross domestic product (*AG*), dates (*D*), cucumber *(Cu)*, chicken meat quantities (*M*), and tomatoes production quantities (*T*) were valued by ECM as specified the subsequent equation [17] "(7)":

$$l(AG) = b_1 lAG_{-1} + b_2 lD_{-1} + b_3 lCu_{-1} + b_4 lM_{-1} + b_5\ lT_{-1} + b_6\ V_{t-1} + U \qquad (7)$$

Where,

AG: Agricultural Gross Domestic Product (in Saudi Riyal), D: The quantity of produced dates, Cu: Quantity of cucumbers, M: Quantity of chicken meat, T: Quantity of tomatoes. The quantities of agricultural products were in tons.

All variables were transformed to logarithm form.

V_{t-1} = Error correction term- one period lag of residual obtained from the OLS estimation (equation 1). U = Error term. The adjustment parameter (b_6) signifies speed of adjustment toward long- run equilibrium between the variables. The sign of b_6 should be negative and significant [18]. Also, impulse analysis was run to disclose the key variable (among the study variables).

2.5. The Method of Granger Causality Test

Granger causality test is used to analyze the causal relationship between variables (agricultural GDP and the quantities produced of selected agricultural products), where the test is based on the idea that changes in the current and past values of one variable cause changes in another. Based on this concept, it can be considered that the change in values X_t causes changes in Y_t through its current and past values, in addition to the current and past values of Y_t. Also, the values of Y_t are estimated to cause changes in X_t through its current and past values. The following equations are applied [19] "(8,9)":

$$X_t = \sum_{i=1}^{m} \alpha_i X_{t-i} + \sum_{j=1}^{n} \beta_j Y_{t-j} + U_t \qquad (8)$$

$$Y_t = Y_0 + \delta_0 Y_t + \sum_{i=1}^{m} Y_i X_{t-i} + \sum_{j=1}^{n} \delta_j Y_{t-j} + V_t \qquad (9)$$

Where: m and n are the number of lags, Null Hypothesis (H_{O}): No causality.

The null hypothesis is rejected when the statistic (F) is at a probability of 0.05, indicating the presence of a causal relationship between the variables.

2.6. Multiple Regression Analysis

To assess the impact of products (dates (D), cucumbers (Cu) chicken meat (M) and tomatoes (T)) on the Agricultural Gross Domestic Product (AG) multiple regression analysis was used. Below is the model used in the multiple regression analysis "(10)":

$$L(AG) = C + \propto_1 L(D) + \propto_2 L(Cu) + \propto_3 L(M) + \propto_4 L(T) + \propto_5 \qquad (10)$$

Where

All variables are illustrated in equation 7.

$\propto_1$ ... $\propto_4$ represent coefficients to be estimated.

$\propto_5$: The constant term in the autoregressive equation

L= logarithm.

To check the model steadiness, Cusum of square test was fixed to determine the stability of the cumulative sum of the recursive residuals. The test discovers unsystematic movements and unnecessarily arises from a structural change in coefficients [20]. The test practices the sum of squared recursive residuals. If the cumulative sum of the recursive residuals sees inside the zone among the two critical lines, the model will be steady. Consequently, the multiple regression model is elected.

This research pointed at probing the short-run relationships and long-run speed of adjustment between AGDP and designated agricultural subsector production (tomato, cucumber, dates and chicken meat) in KSA. It also targeted at detecting the chief subsector that potency significantly donated to the development of AGDP. Tomato, cucumber, dates and chicken meat are considered as main agricultural products (among others) in Saudi.

3. Results and Discussion

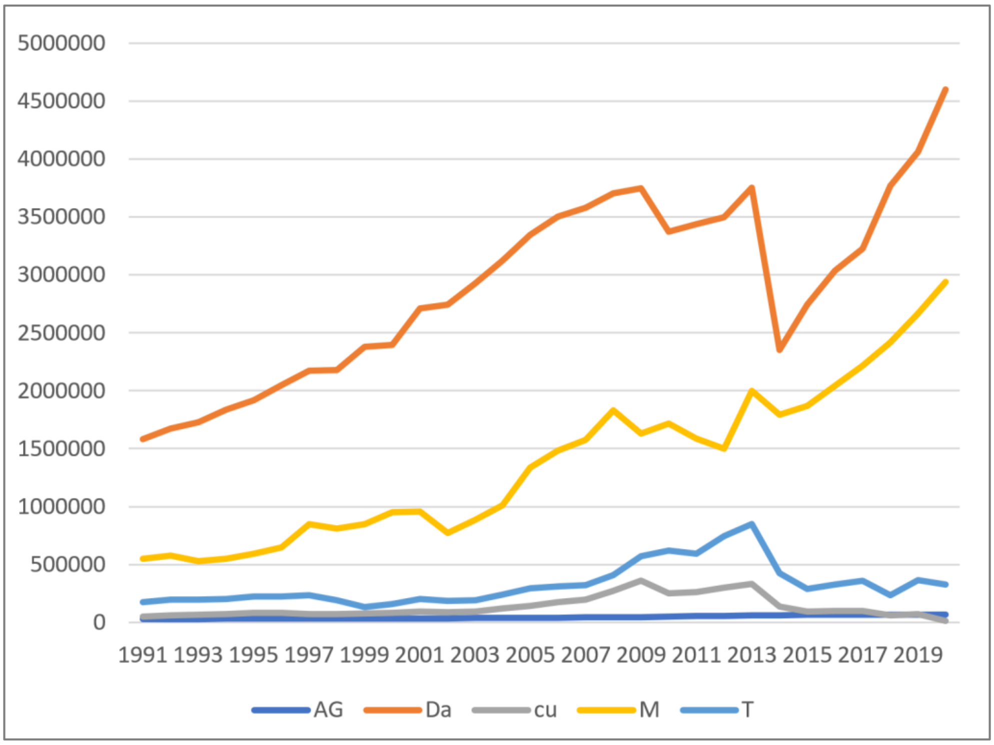
3.1. Descriptive Statistics Results

Table 1 shows the results of the descriptive analysis of the data, indicating that the average GDP for the study years was 45.34 billion riyals. The average quantity of dates produced was approximately 2905.42 thousand tons, while the average quantity of cucumbers produced was around 132.15 thousand tons, and the average tomato yield was 326.49 thousand tons. The chicken meat production was 1370.52 thousand tons.

It seems that the Skewness values for agricultural GDP, dates and chicken meat are 0.41, 0.00, and 0.51, respectively, indicating a nearly symmetrical distribution close to normal distribution. It's fascinating to see how the data distribution reflects balance.

The Jarque-Bera values for agricultural GDP 3.32, dates 1.22 and chicken meat are significant at 5% level. This means that the null hypothesis, stating that the data is normally distributed, is accepted. On other hand, indicated by the Probability values for agricultural GDP, dates and chicken meat, while for cucumbers and tomatoes, their values are less than 5%.

Figure 1 initially indicates the presence of a long-term equilibrium relationship between the study variables, which are agricultural GDP, date yield, cucumber yield, tomato yield, and chicken meat. This is a good indicator of progress towards the cointegration analysis.



Source: Drawn by authors

Figure 1. The relationship between agricultural GDP and some selected agricultural products. AG: Agricultural GDP, D: Dates, Cu: Cucumbers, M: Chicken meat, T: Tomato

Table 1. Descriptive statistics results

	AGDP	**D**	**C**	**M**	**T**
Mean	45.34	2905.42	132.15	1370.52	326.49
Median	40.63	2983.15	90.86	1410.31	263.93
Skewness	0.41	0.00	1.18	0.51	1.43
Kurtosis	1.59	2.05	3.18	2.32	4.28
Jarque-Bera	3.33	1.12	7.04	1.91	12.40
Probability	0.90	0.57	0.03	0.38	0.002
Observations	30	30	30	30	30

Source: data was collected and analyzed.

3.2. The Unit Root Tests Results

It appears from Table 2 that the agricultural GDP, date, cucumber, tomato, and chicken meat are all non- stationary at their levels unless it was at a constant limit (intercept) or at a constant limit and trend (intercept and trend), where the calculated "t" value was smaller than the tabulated "t" value, leading to the acceptance of the null hypothesis, indicating the presence of a unit root (H_0: X is not stable). Based on the obtained results, the first difference (first lag) of the time series for all variables was taken.

It is evident from Table 3 that the variables of agricultural GDP, date, cucumber, tomato, and chicken meat are stable at the constant limit (intercept) and stable at the intercept and trend. The calculated "t" value is greater than the tabulated "t" value, leading to the rejection of the null hypothesis (H_O: X is not stable) and acceptance of the alternative hypothesis (H_1: X is stable), indicating that the time series are integrated at the first degree 1 (1). This is one of the conditions that must be met in the Johansen cointegration test that the time series are stable at one degree. Accordingly, this is considered an indicator of the possibility of a long-term relationship between the study variables.

3.3. Lag Number Identification

The results in Table 4 indicated that the optimal time lags for the study model are two time periods according to most criteria in the table and nominated by Vector Autoregression (VAR) model.

Table 2. Results of Augmented Dickey Fuller (ADF) unit root Test (at level)

Time series	Intercept	Intercept and trend	Stationarity
LAG	-0.27	-1.41	Non stationary
L D	-0.72	-2.4	Non stationary
LC	-1.27	-2.03	Non stationary
LM	-0.21	1.56	Non stationary
LT	-0.33	-2.81	Non stationary

Source: data were collected and analyzed.

Table 3. Results of Augmented Dickey Fuller (ADF) unit root Test (at first difference)

Time series	Intercept	Intercept and trend	Stationarity
L*AGDP*	-4.40*	-4.31*	Stationary
L *D*	-3.91*	-3.83*	Stationary
LC	-5.99*	-5.88*	Stationary
LM	-3.05*	-3.93*	Stationary
LT	-5.72*	-5.63*	Stationary

Source: data were collected and analyzed.

* Critical value at1% level of significance.

Table 4. Lag number (VAR model)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	2.14	NA	8.44e-07	0.21	0.44	0.28
1	139.13	215.27**	2.93e-010	-7.80	-6.37**	-7.36
2	169.51	36.89	2.41e-10**	-8.18**	-5.56	-7.38**

Source: data were calculated and analyzed.

** Significant at 5% level.

* Indicates lag order selected by the criterion.

LR: sequential modified LR test statistic (each test at 5% level). HQ: Hannan-Quinn information criterion, SC: Schwarz information criterion, AIC: Akaike information criterion and FPE: Final prediction error.

3.4. Results of Co-Integration Test: Johansen Method

In mandate to recognize the quantity of co-integration vectors, trace and max Eigen value tests were applied to assess null hypothesis= no long- run association among chains. The results in Table 5 indicate that at levels "0" and "1", the value of the trace tests statistics (120.8 and 70.85) are greater than the critical values at the "0.05" level .This proposes the existence of two cointegrating equations. Also, the results in Table 6 show that at levels "0" and "1," the Max-Eigen values (49.94 and 42.68) are greater than the critical values at the "0.05" level. This concludes that there are two cointegrating equations, signifying a long-run stable relationship among the study variables. Subsequently, it is determined that long- run balance arises between the chains. This outcome matches with the preceding study [21]. The study was conducted in the KSA and showed that there is a long- run relationship among some agricultural products and agricultural gross domestic products. Also, the study harmonized with other previous studies [6,7,8]. Such studies recorded a long- run association between agricultural products and agricultural gross domestic product. In addition, former studies disagree with results of the study [9,10]. Such studies discovered non long- run relationship between agricultural gross domestic product and chicken meat.

3.5. Results of ECM

Testing the validity of the model (Table 7): H1= there is autocorrelation among the residuals. If the probability values for lags 1 and 2 equal to 0.30 and 0.23, are greater than 0.05, then we accept the null hypothesis that there is no autocorrelation among the residuals.

The hypotheses for testing the common homoscedasticity among the residuals are= HO. The residuals have common homoscedasticity=H1. The residuals do not have common homoscedasticity. The Table shows that the probability of Chi-squared value equals 0.29 is greater than 5%, so we accept the null hypothesis that the residuals have homoscedastic variance. Therefore, the model does not suffer from the issues of autocorrelation and non- homoscedasticity of the residuals.

The hypotheses for testing the normal distribution are=HO. The residuals are normally distributed against H1. The residuals are not normally distributed. The model is not statistically significant, as p= 0.75, which is greater than 0.05. Therefore, we accept the null hypothesis that the residuals in the model are normally distributed. Hence, the model is free from measurement errors, and we can proceed with interpreting the model results. From Table 7 the coefficients of the error correction model are positive and insignificant, meaning that there is no short-term relationship between the variables.

Table 5. Results of co-integration test (Lags interval in first differences): Trace Statistic

Hypothesized No. of CE(s)	Trace Statistic	Critical Value (5%)	Prob.**
None *	120.8	69.82	0.00
At most 1	70.85	47.86	0.00
At most 2	28.16	29.80	0.07
At most 3	11.71	15.5	0.17
At most 4	0.77	3.84	0.38

Source: data were collected and analyzed.

** Rejection of the null hypothesis at 5% level of significance.

Table 6. Results of co-integration test (Lags interval in differences): Max-Eigen Statistic

Hypothesized No. of CE(s)	Max-Eigen Statistic	Critical Value (5%)	Prob.**
None *	49.94	33.88	0.00
At most 1	42.68	27.58	0.00
At most 2	16.45	21.13	0.20
At most 3	10.94	14.26	0.16
At most 4	0.77	3.84	0.38

Source: data were collected and analyzed.

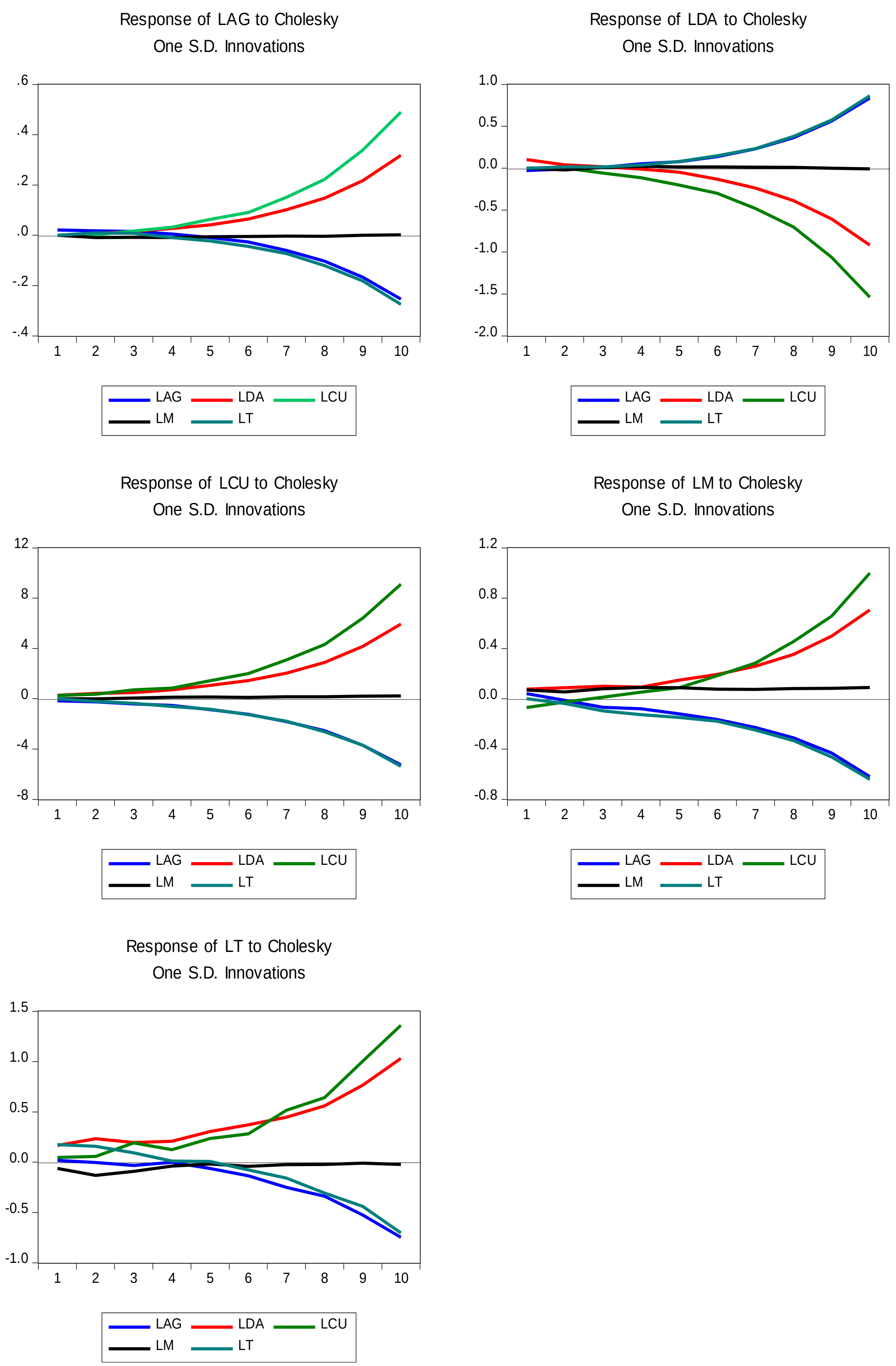
** Rejection of the null hypothesis at 5% level of significance.

Table 7. Results of ECM

Error Correction:	D(LAG)	D(LDA)	D(LCU)	D(LM)	D(LT)
CointEq1	0.07	-0.27	1.07	0.31	0.34
	[1.75]	[-1.42]	[1.43]	[1.32]	[0.73]
D (LAG (-1))	-0.17	0.50	4.63	-0.47	2.03
	[-0.68]	[0.39]	[0.92]	[-0.30]	[0.66]
D (LAG (-2))	0.15	-0.55	0.85	-1.41	1.71
	[0.59]	[-0.44]	[0.17]	[-0.92]	[0.57]
D (LD (-1))	0.06	-0.27	3.23	0.39	2.07
	[0.63]	[-0.62]	[1.87648]	[0.72]	[1.96]
D (LD (-2))	-0.05	-0.19	0.59	0.45	0.44
	[-0.6]	[-0.51185]	[0.40307]	[0.98]	[0.50]
D (LC (-1))	-0.07	0.13	-0.54	-0.13	-0.47
	[-1.37]	[0.51]	[-0.55]	[-0.42]	[-0.77]
D (LC (-2))	0.04	0.13	0.97	6.53E-05	0.72
	[1.08]	[0.70]	[1.37]	[0.000]	[1.66]
D (LM (-1))	-0.005	-0.51	-0.14	-0.10	-0.72
	[-0.10]	[-2.28]	[-0.17]	[-0.35]	[-1.35]
D (LM (-2))	0.08	0.03	1.06	0.20	0.42
	[1.48]	[0.11]	[0.95]	[0.57]	[0.62]
D (LT (-1))	0.08	-0.004	-0.92	-0.12	0.01
	[2.24]	[-0.03]	[-1.39]	[-0.57]	[0.02]
D (LT (-2))	-0.03	-0.18	-1.19	-0.26	-1.10
	[-0.65]	[-0.89]	[-1.53]	[-1.08]	[-2.30]
C	0.02	0.08	-0.38	0.10	-0.15
	[1.75]	[1.17]	[-1.39]	[1.15]	[-0.92]

R-squared= 0.61, Adj. R-squared= 0.32, F- statistic =2.10
LM- statistics (serial correlation of residual)
Lag 1 =F= 28.06 with Prob.= 0.30, Lag 2 =F= 29.79 with Prob.= 0.23
VEC Residual Heteroscedasticity statistic= 343.79 with prob.=0.29
VEC Residual Normality Tests=0.57 with prob. 0.75

Source: data were collected and analyzed.
Figures in [ ] represent t-value. All series were defined in "(7)"



Source: Drawn by authors.

Figure 2. Impulse test

Moreover, impulse analysis was used to reveal the vital variable (between the study variables) that potency disturbed or changed meaningfully to other variables in the long-run (Figure 2).

The Figure shows that when a positive random shock occurs in the agricultural GDP, the agricultural GDP rises, then falls, (explain) and tomatoes move in a similar direction, while dates and cucumbers take almost the opposite direction in subsequent periods. As for chicken meat, the change is negligible.

From the Figure, the shock for the dates variable starts positively and gradually decreases to the negative, while the cucumber variable moves in the same direction. However, the agricultural GDP and tomatoes take the opposite direction and move together side by side. The chicken meat variable shows a very simple movement.

The Figure shows the movement of the variables when a shock occurs in the cucumber variable. If the random shock to the cucumber increases positively, the date product moves in the opposite direction, while the agricultural GDP moves slightly, and the chicken meat product moves in a simple manner.

The Figure illustrates the movement of the variables when a shock occurs in the chicken meat product .Despite the weakness of the shock, the change in the movement of the variables is significant, as both dates and cucumbers move upwards, while both the agricultural GDP and tomatoes move downwards.

The Figure clarifies the shock in the tomato product, which starts with a positive value and continues to decrease downwards, along with the agricultural GDP. Meanwhile, dates and cucumbers continue to rise with it, and chicken meat decreases downwards at a steady pace.

3.6. Granger Causality Test Results

From the results of the Granger causality test and based on the Prob. results (Table 8), the relationship between the dependent variable represented by agricultural GDP and the independent variables is as follows:

It appears like there is a causal relationship between the date crop and the agricultural GDP at a significance level of 10%. This means that dates affect the agricultural GDP, but conversely, there is no causal relationship between the agricultural GDP and the date crop, as the Prob. value is 0.2, which is greater than 0.05

It means that there is a causal relationship originating from the cucumber crop towards the agricultural GDP, and likewise, there is a relationship originating from the agricultural GDP towards the cucumber crop, as the Prob. value is 0.01.

It seems that there is no causal relationship originating from the chicken meat product towards the agricultural GDP, and likewise, there is no relationship originating from the agricultural GDP towards the chicken meat product, as the Prob. value is 0.16, which is greater than 0.05

It looks like there is a causal relationship originating from the tomato product towards the agricultural GDP, and conversely, there is no relationship in the opposite direction, as the Prob. value is 0.8, which is greater than 0.05.

Table 8. Results of the pair-wise Granger Causality Test

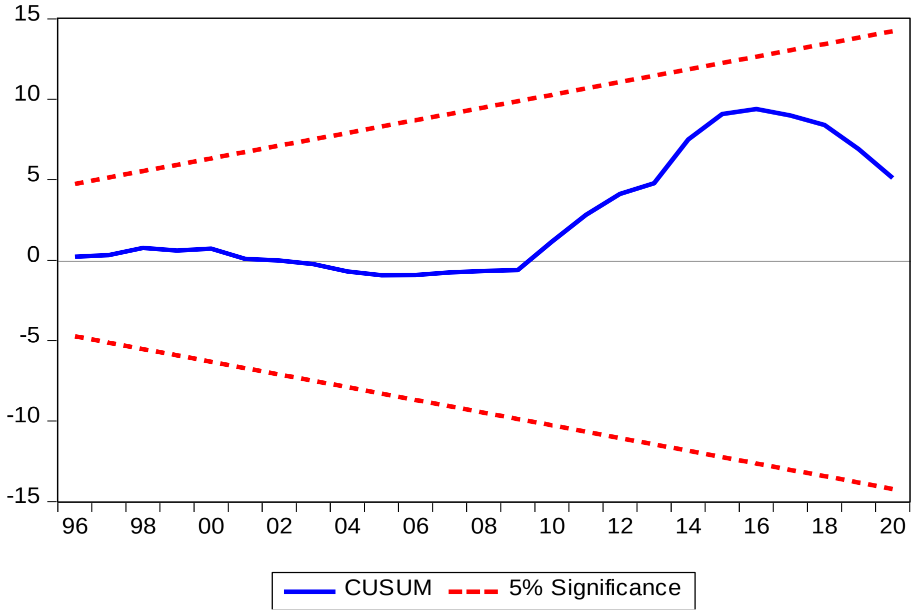
Null Hypothesis	F-Statistic	Prob.
LAG does not Granger Cause LD	3.11	0.06
LD does not Granger Cause LAG	1.41	0.26
LC does not Granger Cause LAG	9.59	0.001
LAG does not Granger Cause LC	4.82	0.02
LM does not Granger Cause LAG	1.96	0.16
LAG does not Granger Cause LM	1.93	0.17
LT does not Granger Cause LAG	8.77	0.002
LAG does not Granger Cause LT	0.20	0.82
LC does not Granger Cause LD	6.57	0.01
LD does not Granger Cause LC	2.98	0.07
LM does not Granger Cause LD	1.54	0.24
LD does not Granger Cause LM	0.51	0.61
LT does not Granger Cause LD	4.02	0.03
LD does not Granger Cause LT	2.29	0.61
LM does not Granger Cause LC	3.63	0.04
LC does not Granger Cause LM	0.27	0.77
LT does not Granger Cause LC	8.90	0.001
LC does not Granger Cause LT	1.83	0.18
LT does not Granger Cause LM	0.18	0.84
LM does not Granger Cause LT	0.91	0.42

Source: Author's calculations based on collected data.

All series were defined in "(7)"

3.7. The Results of Multiple Regression Analysis

The multiple regression analysis outcomes were existing in Table 9. Various scenarios were applied to choose the steady model. The Table presented no autocorrelation between successive values of the disturbance term which has a constant variance (homoscedastic). To exam the model steadiness, Cusum of square test was directed to identify the steadiness of the cumulative sum of the recursive residuals. Meanwhile the cumulative sum of the recursive residuals is established inside the area among the two critical lines, the model is steady. Therefore, the multiple regression model was elected (Figure 3). Thus, multiple regression model was selected and accepted to assess the effects of dates, cucumber, chicken meat and tomatoes on the agricultural gross domestic product. This result agrees with previous study [21].



Source: Drawn by authors.

Figure 3. CUCSUM of Square test

Table 9. Results of multiple regression analysis (L*AG* as dependent variable)

Variable	Coefficient	t-Statistic	Prob.
LD	-0.33	-2.76	0.01
LC	-0.038	-1.12	0.2
LM	0.64	8.61	0.00
LT	0.13	2.13	0.04
C	5.44	3.35	0.000

R-squared = 0.93

Adjusted R-squared = 0.92

F-statistic= 87.01, Prob. (F-statistic) = 0.000

Durbin Watson (Autocorrelation) = 1.80

LM- statistics (Breusch-Godfrey serial correlation of residual) F= 2.160190 with Prob.= 0.1323

Source: Author's calculations based on collected data.

The selected model gives an R-squared value of 0.93, indicating the strength of the model in explaining 93% of the variation in agricultural GDP, with the remaining 7% attributed to other factors. Looking at the p- value, the model as a whole appears to be statistically significant that the p-values indicate the significance of dates, chicken meat and tomatoes, while cucumber does not have a significant impact on agricultural GDP. The variables are interpreted as follows: 1% increase in dates, chicken meat and tomatoes lead to a 0.33%, 0.64% and 0.13% increase in agricultural GDP. As increasing in production through expansion of investment leads to agricultural GDP and economic growth [22], cucumber has an insignificant effect on agricultural GDP, and this result may be related to the competitiveness of cucumber. It's clear that chicken meat has the most significant impact among the crops on agricultural GDP "(11)":

$$LAG = 0.33\ \ LDA - 0.03LCU + 0.64\ \ LM + 0.13\ \ LT \quad (11)$$

4. Conclusions and Policy Recommendation

This research aimed to measure the extent of the integrative relationship between some agricultural products in the Kingdom of Saudi Arabia and the AGDP during the period from 1990 to 2020.The Agricultural products consisted of: dates, cucumbers, tomatoes, and chicken meat. The research relied on secondary data collected from various sources, such as: the Saudi Statistics Authority, the Food and Agriculture Organization of the united Nations, and the World Bank, and the study also utilized the Johansson test for common Integration to test the long-term equilibrium relationship between agricultural products and the AGDP, Additionally it employed the Granger causality test to achieve the specified objectives of testing the presence and direction of a causal relationship between agricultural products and AGDP. The results demonstrated the presence of a long-term equilibrium integrative relationship between the study variables, as well as a causal relationship between the study variables. To enhance the contribution of dates and chicken meat to AGDP, the study recommends increasing the production of dates and chicken meat. Additionally, the causal relationship originating from dates to the agricultural gross domestic product is weak, possibly due to its use for domestic consumption rather than as an economic source or its limited production for economic purposes. Therefore, the study recommends increasing its production. The results of the regression analysis showed a significant relationship between dates, tomatoes and chicken meat with agricultural GDP, therefore, this relationship supports realization of the Vision 2030 (diversification and increasing of agricultural products). Also, the results indicated a lack of a significant relationship between the agricultural GDP and cucumber, despite the large quantities cultivated, this could be attributed to the increase in production costs. Therefore, the study recommends conducting a scientific study to measure the competitiveness of cucumber production. Also, the study recommends increasing the production of dates, tomatoes and chicken meat so as to increase agricultural GDP.

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