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EMPIRICAL INVESTIGATION OF AGRICULTURE EXPORTS AND GROWTH IN EGYPT: COINTEGRATION AND CAUSALITY ANALYSES

The study investigates the cointegration and causality between exports and agriculture sector growth in Egypt. It uses DF-GLS unit root test to verify the integration level, ARDL cointegration technique – to ensure the long-run equilibrium relationship in the model and Granger causality – for causality analysis. The study finds that, exports, labour and capital have positive contribution to agriculture growth. The feed-back hypothesis has been proved in case of exports and growth and labour and growth in agricultural sector. The study suggests the Government of Egypt to promote agriculture exports as it enhances economic growth, and economic growth, in turn, enhances exports as well.

Keywords: *agriculture; exports; economic growth; Egypt.*

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ЕМПІРИЧНЕ ДОСЛІДЖЕННЯ ВЗАЄМОЗВ'ЯЗКУ СІЛЬГОСПЕКСПОРТУ ТА ЕКОНОМІЧНОГО ЗРОСТАННЯ: ТЕСТИ НА КОІНТЕГРАЦІЮ ТА КАУЗАЛЬНІСТЬ ЗА ДАНИМИ ЄГИПТУ

У статті тести на коінтеграцію та каузальність застосовано до даних щодо експорту та розвитку сільського господарства Єгипту. Методом одиничних коренів перевірено коінтеграцію між змінними, авторегресія тестує довготривалість залежності, а тест Гренджера – причинно-наслідкові зв'язки між змінними. Дослідження виявило, що змінні експорту, праці та капіталу позитивно впливають на зростання сільського господарства. Також доведено двосторонність зв'язку між експортом та розвитком сільського господарства, а також між трудовими ресурсами та розвитком даної галузі. Уряду Єгипту рекомендовано просувати розвиток сільгоспекспорту, оскільки це сприяє економічному зростанню, яке, у свою чергу, сприяє подальшому розвитку експорту.

Ключові слова: *сільське господарство; експорт; економічне зростання; Єгипет.*
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ЭМПИРИЧЕСКОЕ ИССЛЕДОВАНИЕ ВЗАИМОСВЯЗИ СЕЛЬХОЗЭКСПОРТА И ЭКОНОМИЧЕСКОГО РОСТА: ТЕСТЫ НА КОИНТЕГРАЦИЮ И КАУЗАЛЬНОСТЬ ПО ДАННЫМ ЕГИПТА

В статье тесты на коинтеграцию и каузальность применены к данным по экспорту и развитию сельского хозяйства Египта. Методом единичных корней проверена коинтеграция между переменными, авторегрессия тестирует долгосрочность зависимости, а тест Гренджера – причинно-следственные связи между переменными. Исследование выявило, что переменные экспорта, труда и капитала позитивно влияют на рост сельского хозяйства. Также доказано двусторонность связи между экспортом и развитием сельского хозяйства, а также между трудовыми ресурсами и развитием данной отрасли. Правительству Египта рекомендовано продвигать развитие сельхозэкспорта, т.к. это способствует экономическому росту, который, в свою очередь, способствует дальнейшему развитию экспорта.

Ключевые слова: *сельское хозяйство; экспорт; экономический рост; Египет.*

Introduction. The impact of international trade on growth has been a concern for classical economists. As the father of economics, A. Smith argued that specialization

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in trade could enhance economic growth and nations' welfare. Similarly, the classical economist, D. Ricardo augmented this view with a description of specialization and remained in favor of trade for economic growth. Afterwards, the neoclassical economists extended this view with a two-factor model, relative endowment and comparative cost. Although, the description of trade has been changed over the development of trade-growth theories but all the views are the same: trade can enhance productivity and economic growth of nations (Iyoha, 1995). Today's trade theories also emphasize the importance of trade in enhancing productivity, national income, consumption and welfare. Therefore, trade restrictions may hamper economic growth of a particular country and welfare too (Agiebenebo, 1995). In endogenous growth-models, freer trade nations can grow much faster than the closed ones. Therefore, trade openness, terms of trade and export efficiency are been the major points of concern in many growth theories (Edwards, 1998).

At the early stages of development, agriculture/primary sector has geared up the pace of development and has feed the surplus of its trade to the growth of industrial sector. The concept of value addition has been the starting point of in the history of industrialization. Today's growth and development are possible due to agriculture's trade-surplus in the early path of development. Today agriculture sector still supports the exports of developing economies, their foreign exchange and investing in technology to reach faster growth rates in the agro-export sector and other sectors as well. The surplus trade theory suggests the agrarian economies use their resources to produce for foreign markets, if demand is less at domestic markets. Then trade is becoming the opportunity for underdeveloped nations to utilize their idle resources, to move towards higher employment and achieve productive efficiency. By this, opened world market and agro-export opportunities help developing nations grow and utilize their unemployed labor and land. This theory shows the importance of agricultural trade and guide the development path for developing nations (Todaro, 1977).

The importance of trade and specifically exports has been proved by high economic growth rates and better balance of payment conditions of China, Hong Kong, Taiwan, Singapore and Korea. These countries' growth majorly relies on their exports and liberal market approach towards exports (World Bank, 1993). On the other hand, those countries that have focused on import substitution policies instead of export promotion have slower growth rates and sometime zero growth progress i.e. Latin America (Barro and Sala-i-Martin, 1995). Therefore, most of progressive countries rely on export-promotion strategy, instead of import substitution, through rebates and tax holidays on exports. The export-led growth policy is observed in most of the world economy's wisdom.

Egyptian economy has a great reliance on agriculture in term of its GDP and exports. The agri-export sector is playing a dynamic role in the growth process of Egyptian economy. Figure 1 shows a scatterplot of agriculture exports and output. It shows a strong positive relationship between agriculture exports and output except some outlier values. The figure also shows that the rate of output growth has been observed as very fast with an increase in agriculture exports and a positive slope tends towards Y-axis. Therefore, there is an urgent need to test exact contribution of agri-exports into economic growth of this particular sector. There has not been a single study on this important issue before. Therefore, the present study is going to fill this gap by investigating a contribution of agri-exports into agriculture output and growth of Egyption economy. For this purpose, the present study adopts reasonable econometric techniques to investigate long-run relationships and causality. It is also very important to know whether agri-export is causing growth, economic growth is causing agri-export or both are causing each other.

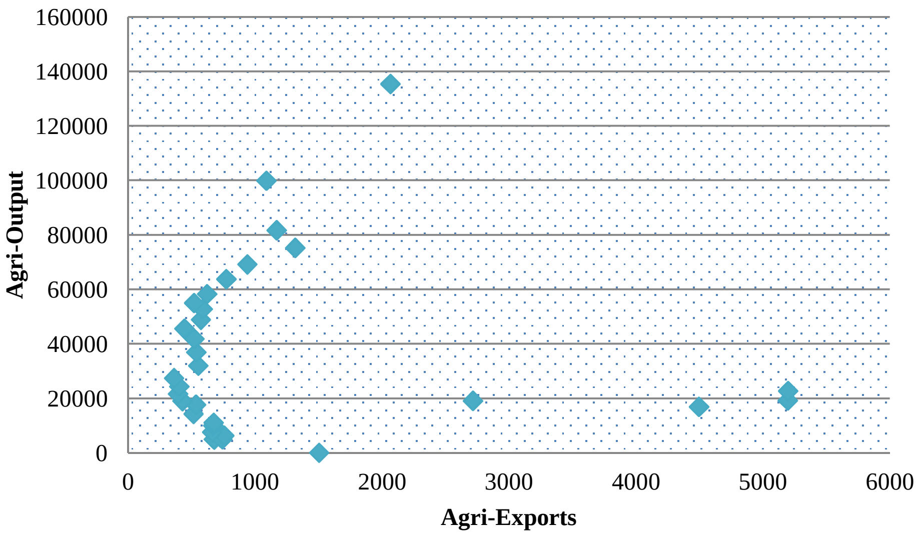

Figure 1. **Scatterplot of agriculture exports and output,**
mln of Egyptian Pounds

Literature review. For the discussion of relationship between export and economic growth, theoretical literature is available with different explanations. There can be a possibility of 4 types of competing hypotheses in empirical literature to define exports-growth nexus. First, there can be an Export-Led Growth (ELG) hypothesis, when only export is causing economic growth but economic growth does not cause exports. Secondly, Growth-Led Export (GLE) hypothesis, when only economic growth is causing exports but not vice versa. Thirdly, there is a feed-back hypothesis, in which both variables are causing each another showing thus a complementary behavior. Lastly, a neutral hypothesis shows no causality at all.

B. Balassa (1978) found a positive link between export and economic growth in 11 industrial developing countries and claimed that export had a positive impact under large productions. He also claimed that developing countries adopting export-promotion policies. Exports of developing countries have positive impact on growth performance. W.S. Jung and P.J. Marshall (1985) also proved a positive effect of exports on economic growth in 37 developing economies after conducting the causality analysis. R. Ram (1987) found a positive contribution of exports to performance through causality analysis and argued that it is due to maximum capacity utilization in the export sector due to large world market demand.

Some literature has emphasized the importance of exports for economic growth. As exports may have higher productivity level due to large-scale production for world market and spillover effect, i.e., technology transfers, skill transfer and investments in export sector due to large world market. Therefore, export-producing industry may use local physical and human resources in large amounts. It can also help reduce unemployment. By investing in agro-export sector, the unused land can be used to contribute to GDP (Grossman and Helpman, 1990).

M. Bahmani-Oskoee et al. (1991) found causality from exports to economic growth in less developing countries and claimed it was due to greater productivity in export production sector than that of non-export-production sector. A.H. Khan and N. Saqib (1993) studied a link between export and economic growth through multiple equations and proved a positive relationship between them. But N. Mutairi (1993) did not find any evidence for causal relationship between export and economic growth in Pakistan and ended up with concluded a neutrality hypothesis. A. Levin and L.K. Raut (1997) explained the complementary relationship between export and human capital formation: export might increase economic growth through greater labor productivity.

Analysis causality between export and growth for Asian countries (Ahmad et al., 2000). Only Bangladesh's data has given evidence for ELG hypothesis and for the rest of the countries no causality was been found. T.N. Srinivasan and J. Bhagwati (2001) claimed that manufacturing exports have low elasticity with respect to change in income level than that of primary/agriculture exports. Therefore, in the days of prosperity, agriculture exports are increasing at a very high rate and contribute more to country's GDP and in the days of recession, agriculture exports are falling at high rates negatively effecting economic growth. So, trade cycle has greater impact on local economic growth due to trade in primary exports. P. Ruiz-Napoles (2001) proved the neutrality hypothesis for the relationship between exports and economic growth in Mexico. This non-relationship is due a fact that revenue from export expansion in Mexico has been used for industrialized imported product and net effect on economic growth remains insignificant.

J. Crespo-Cuaresma and J. Worz (2003) found a positive association between exports and economic growth. They stated that agriculture exports remain more elastic with change in income. Therefore, trade cycle affects agriculture export more than industrial exports. A. Sharma and T. Panagiotidis (2005) found a cointegration/long run equilibrium between exports and economic growth and also a feed-back causality between export-growth relationships in the case of India. F. Abou-Stait (2005) did the cointegration and causality analyses to investigate the relationship between export and economic growth for Egypt. They found a long-run relationship and a bi-directional causality for the variables under discussion. D.Q. Xu et al. (2009) discussed the importance of export-led growth policies in economic growth. But, its consequences have remained inconclusive in their study. A. Iqbal et al. (2012) investigated the Granger causality between real exports and GDP for Pakistan and found a one-way causality from economic growth to exports.

It is observed that there is no absolute consensus regarding the relationship of export and economic growth. Some studies find one-way relationship, some find two-way and the rest find no relationship. Secondly, there is no single study which has discussed the direction of causality between agri-exports and agri-growth for Egypt to further formulate particular agri-export policy. Therefore, it seems pertinent to see the exact direction in relationship between Egyptian agri-exports and agri-growth. The present study is going to fill this gap by investigating this important issue and confirming the cointegration and causal relationship between agri-export and agri-growth.

Theoretical framework and model of this study. G. Feder (1983) introduced an export-growth model, formally known as Neo-Classical Supply-Side model. The model elaborates that exporters have greater knowledge about new inventions, market tact and face greater competition. That is why, export sector uses better technology and has better productivity than that of local other industry and better output growth rates as well. The export sector has also spillover effects on domestic industries. The overall growth rate of a country may accelerate with the existence of export-sector and due to better productivity in the export sector and its positive spillover on the non-export sector as well. In such a way, exports are helping raising the economic growth of an economy.

In the balance of payments constraint growth models and cumulative growth models, trade has been advocated as a component of GDP. Specifically, export is an additive component and import is an subtractive component of GDP. (Exports – Imports) is net export component which must be positive to contribute something to GDP. Negative net exports will reduce GDP. This means GDP has financed some amount out of it to sustain the net-export deficit. Therefore, economic growth requires the net export surplus or at least balance. If net export deficit as percentage of GDP exceed 3%, then it becomes a serious problem of foreign exchange and thus country has to depend on foreign loans. Foreign loans create continues pressure of financing of its principle and interest, which is again a burden on GDP. Hence, exports growth may help improving economic growth. If we hypothesize a balance of payment equilibrium model then we may have to consider that the model is depending on national income as imports are depending on domestic income. By solving such models, we can easily elaborate that the balance of payment equilibrium and the national income equilibrium depend on each other and export can enhance economic growth (McCombie and Thirlwall, 1994).

In virtuous models, it is a challenge raised on the growth models and trade theories, if export is a component of GDP and economic growth. Then why this relationship is only proved and promoted in specific countries and not in the whole world. This argument raises a challenge on the convergence hypothesis as well, which assume the convergence in the consumption and standards of living of nations. But still, we can see the convergence hypothesis is only a theoretical phenomenon and can be proved in a very specific environment (Thirlwall, 1999). This argument raises the question about the empirical causal inquisition of exports and economic growth as well for a particular country.

Based on the above theoretical discussion and standard growth models, the relationship of exports and economy is very clear but it needs attention to verify and confirm its exact magnitude and significance for a particular country after an empirical investigation. Therefore, the present study aims to confirm the relationship between agri-exports and agri-growth for Egypt and particularly, this study wants to make focus only on agriculture. This will be checked through a contribution of agro-exports to agro-growth in Egypt with a standard growth model.

The present study starts with Cobb-Douglas Production Function for Egyptian agriculture sector:

$$AY_t = A_t AK_t^{\alpha} AL_t^{\beta} e^{ut}, \tag{1}$$

where AL is labour in agriculture; AK is capital in agriculture sector; AY is output in agriculture sector, that is a proxy for agriculture growthl t is time period. A_t is productivity parameter. Here, we assume that productivity in agriculture sector comes from exports of agricultural products. The study has already done a comprehensive debate about economies of scale due to large market for exportable agriculture product and technology spillovers due to competition can enhance the efficiency of agriculture sector. Productivity parameter can be defined as:

$$A_t = \delta AX_t^{\gamma}, \tag{2}$$

where AX is agriculture exports. Now we substitute (2) into (1):

$$AY_t = \delta AX_t^{\gamma} AK_t^{\alpha} AL_t^{\beta} e^{ut}. \tag{3}$$

We take natural logarithm to make it linear and run the linear econometric techniques on the function.

$$LAY_t = \phi + \gamma LAX_t + \alpha LAK_t + \beta LAL_t + u_t, \tag{4}$$

where L is a natural logarithm and ϕ is a natural log of δ, ϕ, γ, α and β are long run elasticity parameters.

Data and estimation procedure.

1. Data. The study has collected the annual data on agriculture exports, agriculture output, agriculture labour and agriculture capital from FAOSTAT (2015), National Bank of Egypt (2015) and Central Agency for Public Mobilization and Statistics (2015) for the period of 1980–2012.

2. Estimation procedure. The study aims at finding the order of integration, cointegration and causality between agriculture output, agriculture exports, agriculture capital and agriculture labour. First, the normality and stationarity of variables are required to proceed for cointegration and causality. The study uses the DF-GLS test to find the unit root problem in the variables and to check the order of integration. DF-GLS is developed by G. Elliot et al. (1996). It has greater efficiency due to the utilization of detrended data in analysis. The equation for the test is as follows:

$$\Delta z_t^d = \gamma z_{t-1}^d + \sum_{k=1}^{m} o_k \Delta z_{t-k}^d + e_t. \tag{5}$$

Here, the variable under consideration (z) is detrended and for our analysis it assumes agriculture output, agriculture exports, agriculture capital and agriculture labour one by one. The null hypothesis will be of a non-stationary series and the rejection of null hypothesis will ensure the stationarity of a particular series.

After ensuring the order of integration, the cointegration can be utilized. We will use ARDL conitegration test for this purpose. This test is efficient and parsimonious in taking the lag length and saving the degree of freedom. It was developed by M.H. Pesaran et al. (2001). The framework of the ARDL model to test the model in our case is as follows:

$$\begin{aligned}\Delta LAY_t = a_1 + a_2 LAY_{t-1} + a_3 LAX_{t-1} + a_4 LAL_{t-1} + a_5 LAK_{t-1} + \sum_{i=1}^{n} a_{6i} \Delta LAY_{t-i} \\ + \sum_{i=0}^{n} a_{7i} \Delta LAX_{t-i} + \sum_{i=0}^{n} a_{8i} \Delta LAK_{t-i} + \sum_{i=0}^{n} a_{9i} \Delta LAL_{t-i} + \varepsilon_{1t};\end{aligned} \tag{6}$$

$$\Delta LAX_t = b_1 + b_2 LAY_{t-1} + b_3 LAX_{t-1} + b_4 LAL_{t-1} + b_5 LAK_{t-1} + \sum_{i=0}^{n} b_{6i} \Delta LAY_{t-i} + \sum_{i=1}^{n} b_{7i} \Delta LAX_{t-i} + \sum_{i=0}^{n} b_{8i} \Delta LAK_{t-i} + \sum_{i=0}^{n} b_{9i} \Delta LAL_{t-i} + \varepsilon_{2t}; \quad (7)$$

$$\Delta LAK_t = c_1 + c_2 LAY_{t-1} + c_3 LAX_{t-1} + c_4 LAL_{t-1} + c_5 LAK_{t-1} + \sum_{i=0}^{n} c_{6i} \Delta LAY_{t-i} + \sum_{i=0}^{n} c_{7i} \Delta LAX_{t-i} + \sum_{i=1}^{n} c_{8i} \Delta LAK_{t-i} + \sum_{i=0}^{n} c_{9i} \Delta LAL_{t-i} + \varepsilon_{3t}; \quad (8)$$

$$\Delta LAL_t = d_1 + d_2 LAY_{t-1} + d_3 LAX_{t-1} + d_4 LAL_{t-1} + d_5 LAK_{t-1} + \sum_{i=0}^{n} d_{6i} \Delta LAY_{t-i} + \sum_{i=0}^{n} d_{7i} \Delta LAX_{t-i} + \sum_{i=0}^{n} d_{8i} \Delta LAK_{t-i} + \sum_{i=1}^{n} d_{9i} \Delta LAL_{t-i} + \varepsilon_{4t}, \quad (9)$$

where Δ is used as difference operator, n is the optimum lag length that would be selected by AIC. The error terms ε_{it} are considered as normally distributed. All other notations are already described above (H_0: $a_2 = a_3 = a_4 = a_5 = 0$), ($H_0$: $b_2 = b_3 = b_4 = b_5 = 0$), ($H_0$: $c_2 = c_3 = c_4 = c_5 = 0$) and ($H_0$: $d_2 = d_3 = d_4 = d_5 = 0$) are null hypothesis of cointegration in the above equations and rejection of any null hypothesis will be an indication for cointegration/long-run relationship in the system of equations. The rejection of null hypothesis will depend on the Wald test and its calculated F-statistics. If estimated F-statistics is larger than upper limits of critical F-statistics, then we would be able to reject the null hypothesis. The critical F-value will be taken from (Narayan, 2005). Because this is efficient for small samples as we are facing the same problem (1980–2012). The existence of cointegration will also lead us to long-run/short-run causality analysis. Vector Error Correction Mechanism (VECM) can be applied if we find a cointegration in our model. Otherwise, vector auto-regressive mechanism should be used for causality analysis.

Once, cointgeration is proved in the model, we can proceed for VECM mechanism to find the causality in the model. Assuming the all the models with a proved cointegration, the VECM mechanism is given below to perform causality analysis in the models.

$$\Delta LAY_t = e_1 + \sum_{j=1}^{m} e_{2j} \Delta LAY_{t-j} + \sum_{j=1}^{m} e_{3j} \Delta LAX_{t-j} + \sum_{j=1}^{m} e_{4j} \Delta LAK_{t-j} + \sum_{j=1}^{m} e_{5j} \Delta LAL_{t-i} + e_6 EC_{Yt-1} + \zeta_{1t}; \quad (10)$$

$$\Delta LAX_t = f_1 + \sum_{j=1}^{m} f_{2j} \Delta LAY_{t-j} + \sum_{j=0}^{m} f_{3j} \Delta LAX_{t-j} + \sum_{j=0}^{m} f_{4j} \Delta LAK_{t-j} + \sum_{j=0}^{m} f_{5j} \Delta LAL_{t-j} + f_6 EC_{Xt-1} + \zeta_{2t}; \quad (11)$$

$$\Delta LAK_t = g_1 + \sum_{j=1}^{m} g_{2j} \Delta LAY_{t-j} + \sum_{j=0}^{m} g_{3j} \Delta LAX_{t-j} + \sum_{j=0}^{m} g_{4j} \Delta LAK_{t-j} + \sum_{j=0}^{m} g_{5j} \Delta LAL_{t-j} + g_6 EC_{Kt-1} + \zeta_{3t}; \quad (12)$$

$$\Delta LAL_t = h_1 + \sum_{j=1}^{m} h_{2j}\Delta LAY_{t-j} + \sum_{j=1}^{m} h_{3j}\Delta LAX_{t-j} + \sum_{j=1}^{m} h_{4j}\Delta LAK_{t-j} + \sum_{j=0}^{m} h_{5j}\Delta LAL_{t-j} + g_6 EC_{Lt-1} + \zeta_{4t}. \quad (13)$$

Here, the optimum lag length will be taken from AIC to determine the number of coefficients, to be restricted for blocked erogeneity Wald tests and finally find Granger causality. The significant coefficients of error correction terms will be the indication of long run causality in the model and Wald restriction test on the coefficients of difference lagged variable will be guiding us about short-run causality.

Data analyses and discussions. Table 1 shows the integration analysis for agri-output, agri-labour, agri-capital and agri-exports. All the variables remain nonstationary when tested on their level. These are first difference stationary at the 1% level of significance. Therefore, we can conclude that its order of integration as one. Further, we can apply the cointegration test for the long-run relationship.

Table 1. **DF-GLS unit root test,** *author's calculations*

Series	H_0 (DF–GLS): Series has a unit rot	
	C	C&T
LAY_t	-1.3923 (1)	-2.8043 (0)
LAX_t	0.4170 (0)	-1.0014 (0)
LAL_t	3.2737 (8)	0.9831 (8)
LAK_t	-0.5619(0)	-0.9289 (0)
ΔLAY_t	-7.3739 (1)***	-7.4720 (1)***
ΔLAX_t	-7.1429 (0)***	-8.5733 (0)***
ΔLAL_t	-2.9223 (8)***	-3.7027 (8)***
ΔLAK_t	-6.2494(0)***	-7.4003 (0)***

*** represents the rejection of non-stationarity at the 1%.

Table 2 shows the tests for the selection of optimum lag length in the cointegration analysis. ARDL cointegration chooses the lag length of each variable separately to save the degree of freedom and make the analysis parsimonious. But the optimum lag is required even before ARDL is running on the Micro-fit econometric software. Here, the study follows AIC which is most efficient in our case and we are choosing optimum lag length is 2 for further analysis.

Table 2. **Optimum lag selection criterions,** *author's calculations*

Lag	HQ	HQ	AIC	FPE	LR	LogL
0	5.353537	5.353537	5.293221	0.002339	NA	-78.0449
1	-0.79376	-0.79376	-1.09534	3.98E-06	192.9413	36.97777
2	-1.029174*	-1.029174*	-1.572012*	2.61e-06*	33.19646*	60.36619

* shows the optimal lag length.

Table 3 shows the F-statistics based on the selected ARDL framework. The results show that $F_{LAYt} = f(LAY_t/LAX_t, LAK_t, LAL_t) = 9.1459$, $F_{LAXt} = f(LAX_t/LAY_t, LAK_t, LAL_t) = 6.4521$, $F_{LAKt} = f(LAK_t/LAY_t, LAX_t, LAL_t) = 8.6384$ and $F_{LALt} = f(LAL_t/LAY_t, LAX_t, LAK_t) = 10.5239$. The estimated F-statistics are remained larger than the upper limit critical value (Narayan, 2005), which is an evidence of cointegration. Therefore, the present study can proceed with causality analysis based on VECM given in Table 6.

Table 3. **F-Statistics based on selected ARDL,** *author's calculations*

ARDL Function	Optimal lag length	F-statistics
$F_{LAYt} = f(LAY_t/LAX_t, LAK_t, LAL_t)$	2, 2, 0, 2	9.1459***
$F_{LAXt} = f(LAX_t/LAY_t, LAK_t, LAL_t)$	2, 1, 1, 2	6.4521***
$F_{LAKt} = f(LAK_t/LAY_t, LAX_t, LAL_t)$	1, 2, 0, 2	8.6384***
$F_{LALt} = f(LAL_t/LAY_t, LAX_t, LAK_t)$	2, 2, 0, 1	10.5239***
Significance level	F-Values	
	Lower	Upper
1%	4.245	5.823
5%	3.253	4.624
10%	2.624	3.724

*** shows the rejection of H_0 at 1%.

Before presenting the causality results, the study focuses on the long-run regression equation results based on the selected ARDL model when agri-output/growth is taken as a dependent variable. Table 4 shows that agri-capital is impacting agri-output positively and significantly (at the 1% level of significance). Its coefficient is greater than one also showing an elastic behavior of the relationship between agri-output and agri-capital. Similarly, agri-labor has a positive, significant and elastic impact on agri-output. Now, we will interpret our major variable of concern that is agri-exports. It has a positive and significant impact on agri-output. The coefficient is less than one showing inelastic behavior. But, a 1% increase in agri-export contributes 0.91% agri-output.

Table 4. **Long-run estimates based on the selected ARDL,** *author's calculations*

Predictors	Values	S.E.	T-value	P-value
LAK_t	1.3614	0.1368	9.9454	0.0000
LAL_t	7.1777	1.4735	4.8713	0.0000
LAX_t	0.9146	0.3029	3.0195	0.0070
Intercept	47.9407	8.1951	5.8499	0.0000

After the discussion of the long-run results, the study analyses short-run results based on the selected ARDL model. In the short run, agri-labor is negatively contributing to agri-output and lagged agri-capital is also negatively contributing to agri-output. The rest of variables are showing insignificant behavior. The most important here is the ECM coefficient. It remains negative and highly significant at 1%. This result confirms the existence of short-run relationship in the model and also shows the speed of adjustment. The coefficient (-2.2542) shows a 225.42% correction of a short-run fluctuation in a year. It means any disequilibria in the model will be set out (100%) in 5 months and 9 days approximately in a long-run equilibrium.

Table 6 reports that agri-output/growth is caused by agri-labour and agri-exports. Agri-export is only caused by agri-output. In this way, agri-exports and agri-output/economic growth have bi-direction causality/feed-back effect. Our results confirms the feed-back hypothesis for the case of Egypt by short-run causality results among the 4 competing hypotheses in the relationship of agriculture growth and exports. Our results are matching the (Abou-Stait, 2005), but the latter did the analysis on the aggregate level and we are focusing on the agriculture sector only. In the agri-output equation, the long-run causality is also proving. Further, agri-labour is caused by agri-output, agri-capital and agri-exports. A bi-directional causality is also found between agri-output and agri-labour. Which is again an interesting result as agri-output growth helps generating employment in the agriculture of Egypt. And in turn, agri-labour helps raising its growth through rising productivity over time.

Table 5. **Short-run coefficients based on ARDL,** *author's calculations*

Predictors	Values	S.E.	T-value	P-value
ΔLAY_{t-1}	0.3261	0.1905	1.7114	0.1000
ΔLAK_{t}	0.4657	0.8708	0.5347	0.5980
ΔLAK_{t-1}	-1.5367	0.8859	-1.7346	0.0960
ΔLAL_{t}	-16.1803	3.4040	-4.7534	0.0000
ΔLAX_{t}	0.0046	0.9724	0.0047	0.9960
ΔLAX_{t-1}	-1.2922	0.9186	-1.4067	0.1730
ECM(-1)	-2.2542	0.3154	-7.1452	0.0000

Table 6. **Granger causality test based on VECM Model,** *author's calculations*

Variable	Short-run causality				Long-run causality
	ΔLAY_{t-j}	ΔLAX_{t-j}	ΔLAL_{t-j}	ΔLAK_{t-j}	ECT_{t-1}
ΔLAY_{t}	--	6.5057 (0.0387)	9.7106 (0.0078)	0.9718 (0.6152)	-2.6983 [-2.9673]
ΔLAX_{t}	6.5208 (0.0384)	--	0.3819 (0.8262)	1.5561 (0.4593)	-0.1092 [-0.5698]
ΔLAL_{t}	88.1937 (0.0000)	34.9749 (0.0000)	--	10.8177 (0.0045)	-0.1229 [-6.1805]
ΔLAK_{t}	0.7165 (0.6989)	0.1556 (0.9251)	1.1997 (0.5489)	--	-0.1803 [-0.7542]

() shows probability values based on Chi-Sq. test.

The causality analysis has confirmed the direction of relationship. Now, the strength of this relationship has been observed by variance decomposition analysis through the innovative shock of particular variable with 10 years innovative accounting on the other variables. Table 7 reports the results. In case of agri-output, 5.49%, 28.72% and 14.43% shocks in agri-output are stemming from agri-exports, agri-labour and agri-capital respectively. The 51.34% of shocks in agri-output are stemming from its own shock. In case of agri-exports, 10.25%, 45.09% and 1.73% shocks in agri-exports are stemming from agri- output, agri-labour and agri-capital respectively. The 42.92% shocks in agri-exports is stemming from own shock. In case of agri-labour, 10.75%, 9.26% and 7.68% shocks in agri-labour is stemming from agri-output, agri-exports and agri-capital respectively. The 72.31% shocks in agri-labour are stemming from own shock. In case of agri-capital, 11.51%, 11.15% and 1.95% shocks in agri-capital are stemming from agri- output, agri-exports and agri-labour respectively. 75.39% of shocks in agri-capital are stemming from own shock.

Table 7. **Variance decomposition analysis,** *author's calculations*

Variance Decomposition of LAY					
Period	S.E.	LAY	LAX	LAL	LAK
1	0.935616	100.0000	0.000000	0.000000	0.000000
2	1.362607	59.02025	1.067056	31.02515	8.887548
3	1.439645	54.17316	1.982581	30.07331	13.77095
4	1.470925	52.57270	5.011858	28.98005	13.43539
5	1.479489	52.66607	5.034489	28.67516	13.62428
6	1.496956	53.25046	5.036870	28.28558	13.42709
7	1.520687	51.93520	4.885675	29.04954	14.12958
8	1.526674	51.77711	4.905604	28.86500	14.45228
9	1.531554	51.44768	5.411996	28.76377	14.37656
10	1.536391	51.34800	5.493445	28.72435	14.43420
Variance Decomposition of LAX					
Period	S.E.	LAY	LAX	LAL	LAK
1	0.186638	0.096731	99.90327	0.000000	0.000000
2	0.226589	3.004949	86.98804	9.997410	0.009600
3	0.282350	19.02641	65.18234	15.58864	0.202614
4	0.332806	13.80453	51.17369	32.86939	2.152383
5	0.351703	13.93766	49.47243	33.57704	3.012872
6	0.377509	12.40100	50.05940	34.90670	2.632902
7	0.401737	11.99171	48.06659	37.59501	2.346689
8	0.426849	11.75069	45.92905	40.24141	2.078848
9	0.451112	10.68090	43.85435	43.59621	1.868542
10	0.470909	10.25040	42.92141	45.09145	1.736738
Variance Decomposition of LAL					
Period	S.E.	LAY	LAX	LAL	LAK
1	0.032503	25.58331	0.823231	73.59346	0.000000
2	0.055835	22.42191	2.890564	72.16629	2.521242
3	0.067552	15.95014	2.425834	76.45924	5.164787
4	0.069183	15.53228	2.679242	76.65288	5.135597
5	0.071836	14.61079	5.771239	73.15654	6.461426
6	0.075655	13.76278	6.843304	72.51355	6.880375
7	0.079246	12.97880	6.929455	73.49091	6.600836
8	0.082239	12.06018	7.311710	74.20060	6.427505
9	0.084561	11.41376	8.215223	73.54303	6.827982
10	0.087395	10.74766	9.264707	72.30698	7.680652
Variance Decomposition of LAK					
Period	S.E.	LAY	LAX	LAL	LAK
1	0.211232	3.521431	7.235282	0.022224	89.22106
2	0.254561	8.783051	7.552824	0.620090	83.04404
3	0.293707	9.887138	8.836275	0.647182	80.62941
4	0.327192	10.20943	8.344922	0.814432	80.63122
5	0.353950	10.65101	8.695825	0.787679	79.86549
6	0.375705	10.48079	9.260954	0.912276	79.34598
7	0.395106	11.05473	9.747846	0.963821	78.23360
8	0.411924	11.21471	10.29135	1.284727	77.20921
9	0.427254	11.37630	10.64792	1.615375	76.36040
10	0.440565	11.50827	11.15016	1.950527	75.39104

Conclusions and policy implications. The study has explored the relationship between agri-exports and agri-output/growth in Egypt. For this purpose, agri-exports have been assumed a productivity parameter in the agri-output model. The DF-GLS unit root test has been applied to verify the order of integration, ARDL cointegration test has been applied to test the cointegration in the variables of the model and Granger causality test has been applied to test the direction of causality. The analysis reveals I(1) order integration in the model. The cointegration/long-run relation is proved in all models. In the long-run equation, agri-exports, agri-labour and agri-capital have positive and significant contribution in agri-output/growth. Short-run relationship in our model has also been proved and it shows a very fast speed of adjustment from a short-run deviation towards long-run equilibrium. Further, the causality test has given an evidence for the feed-back causal relationships in case of agri-exports and agri-output growth and agri-labour and agri-output growth. By the innovative accounting approach, variance decomposition has unveiled the evidence that innovative shocks in agri-output, agri-labour and agri-capital are majorly stemming from their own shocks respectively in the analysis. Only, agri-export has greatest innovative shock stemming from agri-labour.

Based on the analyses and conclusions, the present study suggests Egyptian economy to promote the agricultural export sector as it enhances economic growth of the sector and this growth is raising the overall economic growth. Economic growth is also, in turn, enhancing exports. Therefore, both have spiral effect on each other. Secondly, low exports' elasticity of economic growth shows a technology gap which can be filled through investment in agricultural mechanization to promote and facilitate further growth of the sector. Thirdly, the results show that elasticity of labour to output is greater than capital elasticity. This is a good indicator for the economy like Egypt concerning the unemployment level. Therefore, it is recommended to "open the doors" of employment in agriculture by giving conditional subsidies to the agriculture export producers hiring more workers. This will help enhancing the growth in the sector under study and will foster economic prosperity among agricultural staff.

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