Agriculture Sector and Economic Growth in Palestine: Evidence from Co-integration and Error Correction Mechanism

Haroon Mohammed Alatawneh (Correspondence Author)
Ph.D. candidate.
Department of Agricultural Economics
School of Agriculture
Aristotle University of Thessaloniki
Thessaloniki, Greece
Mobile: 00306992909768
E-mail: haroon_atd@yahoo.com

And
Dr. Anastasios V. Semos
Professor.
Department of Agricultural Economics.
School of Agriculture
Aristotle University of Thessaloniki
Thessaloniki, Greece.
Tel: +30 2310 998817
E-mail: semos@agro.auth.gr
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Haroon Mohammed Alatawneh¹ and Anastasios V. Semos²

Abstract

This study examines the agricultural sector role into economic growth and its interactions with the other sectors using time-series co-integration techniques. We use annual data from 1994-2009 to estimate a Vector Auto regression (VAR) model that includes GDP indices of five sectors in Palestinian Economy. The results of improved quality of services and restructuring the banking indicate that the agricultural sector fully benefit from the development of the commerce and services sector and the presence of credit market constraints could not hamper growth of agricultural output in Palestine.

Keywords: Co-integration, Economic Growth, Agriculture Sector, Palestine

1. Introduction

The agriculture sector is one of the main economic activities in Palestine. Historically, Palestine has traditionally been renowned for trading and agriculture, and even the traditional industries in Palestine are strongly related to Agriculture. Although agriculture still plays an important role in the Palestinian economy, this role, however, has been declining.

Over the past four decades the Palestinian economy including agriculture sector experienced the impacts of different difficulties and shocks along phases of conflicts in the area. Until the late 1980s, the agricultural sector's contribution to Palestinian GDP was more than 30%. This share has experienced a dramatic fall during the past decade. In 1990 agriculture represented 35% of GDP, but declined steadily and fell to an historic low of 7% by 2000 (UNCTAD, 2001) and (PARC, 2005).

¹ Ph.D candidate, Department of Agricultural Economics, School of Agriculture, Aristotle University of Thessaloniki, Greece
² Professor, Department of Agricultural Economics, School of Agriculture, Aristotle University of Thessaloniki, Greece
Over the past decade, evidence suggests that Palestine’s economic performance has been one of the modest in the region, reflecting gradual structural reforms, well macroeconomic policies and well-targeted social policies. Real growth averaged 4.1% in the 1990s, and inflation is slowing at 4%. Despite of; the change and diversification observed in the Palestine economy, the agricultural sector remains economically, politically and socially important for its contribution to the achievement of national objectives as regards to food security, employment, regional equilibrium and social cohesion.

As a government policy objective, Palestine needs its agriculture, to maintain employment and export earnings. In fact, agricultural sector generates around 8.2% of total GDP, employs 14.2% of total labour force and agro-food exports represent around 23% of total exports. Although the high importance placed on the agricultural sector, in context of Palestine economy, the issue of the agricultural contribution to the national economic growth has often been evoked by policy makers but rarely examined empirically till now. Traditional quantitative study of sectoral linkages depends either on an input–output model or a computable general equilibrium model (CGE) or a mix of the two. Both the models require a large amount of data and suffer from many other disadvantages, such as the lack of dynamism and an inability to delineate the effects of policy and technical change over time. On the other hand, an econometric model requires less data and is able to capture the short-run as well as long-run effects of agricultural production on the rest of the economy.

However, conventional econometric models using the ordinary least squares method (OLS) may yield spurious regression results if the time-series data are not co-integrated. To ensure that OLS regression does not generate undesirable results, one has to test whether the different sets of time-series data are co-integrated. A vector auto regression (VAR) model developed in Johansen and Juselius is particularly useful for this purpose (Johansen
and Juselius, 1992).

The remainder of the paper is organized as follows. Section 2 provides a brief review of literature on the role of agriculture sector and economic growth. Section 3 describes the methodology of the study. Section 4 discusses the Estimation and results. The conclusions are given in section 5.

2. Brief review of literature

Several studies have outlined the theoretical and empirical relationships between agriculture and economic growth, disagreements still presents and the causal dynamics between agriculture and economic growth is an empirical debate, as described by Awokuse (2009).

Tsakok and Gardner (2007) showed empirical analyses on the role of agriculture in economic growth and argue that early works based on econometric study of cross-sectional data for a panel of countries, or possibly regions within a country, have significant limitations and have not provided definitive results. In particular, given the presence of non-stationarity, conventional regression techniques may yield spurious regressions and significance tests. Also, the results are limited to showing only that agriculture and GDP growth are correlated, but could not provide information on the direction of causality. Awokuse (2009) notes that the issue of causality is dynamic in nature and is best examined using a dynamic time series-modeling framework.

Gardner (2003) studied in a cross-sectional panel of 52 developing countries and discovered no significant evidence of agriculture leading overall economic growth. However, Tiffin and Irz (2006), using cointegration framework and Granger-causality tests on data for 85 countries, find statistical evidence that supports the conclusion that agricultural value added is the causal variable in developing countries, while the direction of causality in developed countries is unclear.
Yao (2000) demonstrated how agriculture has contributed to China’s economic development using both empirical data and a co-integration analysis. He drew two important conclusions: firstly, although agriculture’s share in GDP declined sharply over time, it is still an important force for the growth of other sectors. Second, the growth of non-agricultural sectors had little effect on agricultural growth. This was largely due to government policies biased against agriculture and restriction on rural-urban migration.

In addition, it is important to note that with advances in time series econometric techniques, Kanwar (2000) and Chaudhuri and Rao (2004) recommend that in estimating the relationship between agricultural and non-agricultural sectors the former should not be assumed to be exogenous, rather, this should first be established. Kanwar (2000) investigated the co-integration of the different sectors of the Indian economy (namely, agriculture, manufacturing industry, construction, infrastructure, and services) in a vector autoregressive (VAR) framework to circumvent problems of spurious regressions given the presence of non-stationarity data.

Katircioglu (2006) analyzed the relationship between agricultural output and economic growth in North Cyprus using co-integration. He used annual data covering the 1975-2002 period, to find the direction of causality in Granger sense between agricultural growth and economic growth. His empirical results suggest that agricultural output growth and economic growth as measured by real GDP growth are in long-run equilibrium relationship and there is feedback relationship between these variables that indicates bidirectional causality among them in the long-run period. The author concludes that agriculture still has an impact on the economy although North Cyprus suffers from political problems and drought.

Chebbi (2010), in his country specific study, investigated co-integration among the sectors by using data from 1961 to 2007 and showed that all Tunisian economic sectors co-
integrated and tend to move together. Furthermore, weak exogeneity for the agricultural sector is rejected. However, in the short run, agriculture in Tunisia seems to have a partial role as a driving force in the growth of other non-agricultural sectors and agricultural growth may be conducive only to the agro-food industry sub-sector.

All these above studies have made useful contributions to understanding the links between different sectors in the economy and economic growth. These studies further imply that the contribution of agricultural growth to economic development varies markedly from country to country as well as from one time period to another within the same economy. However, there is a significant gap in the growth literature because most of the inter-sectoral linkage studies were conducted for the developed countries. Furthermore, no research was conducted for Arab Countries. In an attempt to fill the gap in the literature, this study focuses on how the agricultural sector has been inter-related to rest of the economy in Palestine.

3. Methodology

The time-series data of national income indices in constant prices of the five sectors over 1994–2009 (Palestinian Central Bureau of Statistics, 2011) are used in setting up the model. Although the number of observations (16) is small for a VAR model, the data provides the longest possible time-series for the Palestinian economy. All variables are in constant prices US$ (1994) and transformed in logarithms so that they can be interpreted in growth terms after taking first difference. Let $x_t$ denote a $(5 \times 1)$ column vector of the logs of national income indices for agriculture and fishing (AGR), manufacturing industry (MAN), Non-manufacturing industry (NMI), transport, storage and communication (TSC), and services (SER). The VAR model as in Johansen and Juselius (1992) is replicated by Equation 1:

$$\Delta X_t = \sum_{i=1}^{n} \Pi_i \Delta X_{t-i} + \Pi X_{t-1} + \Psi Z_t + \epsilon_t$$

(1)
where $\Pi_i$’s ($i = 1, \ldots, p$) are $(5 \times 5)$ matrixes for the short-run variables $\Delta X_{t-i}$; $\Delta X_t$ are a $(5 \times 1)$ column vector of the first differences of $X_t$; $\Pi$ is a $(5 \times 5)$ matrix for the long-run variables $X_{t-1}$ which is a $(5 \times 1)$ column vector of the lagged dependent variables; $Z_t$ is a $(5 \times s)$ matrix containing $s$ deterministic variables (such as a time trend, a constant, and any other exogenous variables with $I(0)$ property) for each dependent variable; $\varepsilon_t$ is a $(5 \times 1)$ column vector of disturbance terms normally distributed with zero means and constant variances.

The first term in Equation 1 will capture the short-run effects of $\Delta X_t$. The lagged length (i.e. the value of $p$) is taken arbitrarily simply to insure that the residuals have the desired properties. In this model, it is found that $p = 1$ will be sufficient.

The second term in Equation 1 will capture the long-run effects on $\Delta X_t$. As the long-run effects are our main concerns of this study, it is necessary to understand the meaning of the coefficient matrix $\Pi$. usually, $\Pi$ can be factored into $\alpha \beta'$ where both $\alpha$ and $\beta$ are $(5 \times r)$ matrices of rank $r$ ($5 \geq r \geq 0$). The value of $r$ indicates the number of co-integration vectors among $X_t$. The co-integration vectors can be written as $\beta'X_t$. All these vectors will be integrated of degree zero, or $I(0)$, although all the elements in $X_t$ are integrated of degree one, or $I(1)$. The loading matrix $a$ gives the weights attached to each co-integration vector for all the equations.

The number of distinct co-integrating vectors can be obtained by checking the significance of the characteristic roots of $\Pi$. This means that the rank of matrix is equal to the number of its characteristic roots that differ from zero. The test for the number of characteristics roots that are insignificantly different from unity can be conducted using the following test statistics:

$$\hat{\lambda}_{\text{trace}}(r) = -T \sum_{i=r+1}^{n} \ln (1 - \hat{\lambda}_i)$$

(2)
\[ \lambda_{\text{max}}(r,r+1) = -T \sum_{r=r+1}^{n} \ln (1 - \hat{\lambda}_{r+1}) \]  

(3)

where \( \hat{\lambda} \) is the estimated values of the characteristics roots (called eigenvalues) obtained from the estimated matrix \( \Pi \) and \( T \) is the number of usable observations. The first, called the trace test, tests the hypothesis that there are at most \( r \) co-integrating vectors. In this test, \( \lambda_{\text{trace}} \) equals zero when all \( \lambda_i \) are zero. The further the estimated characteristic roots are from zero, the more negative is \( \ln(1 - \hat{\lambda}_i) \) and the larger the \( \lambda_{\text{trace}} \) statistic. The second, called the maximum eigenvalue test, tests the hypothesis that there are \( r \) co-integrating vectors versus the hypothesis that there are \( r+1 \) co-integrating vectors. This means if the value of characteristic root is close to zero, then the \( \lambda_{\text{max}} \) will be small.

4. Estimation and Results

Figure 1 and 2 shows that the five selected variables in the Palestine economy tend to move together over time and long run or co-integrating relationships are likely to be present in this case.
Figure 1. Trends of the index series

Figure 2. Plots of (the logs of) variables AGR, MAN, NMI, TSC and SER against time in levels.
Unit-root and order of integration analysis

The first step in this analysis is to explore the univariate properties and to test the order of integration of each time series. The Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979, 1981) is used to perform unit root tests. The analysis shows that all the five variables failed to reject the unit root hypothesis at levels and rejected at the first-differences (Table 1). The results show that the series are integrated at the first order, $I(1)$ which also be indicated by the figure 3. Since all the series are at the same order, the dataset is appropriate for cointegration and further analysis.

Table 1. Augmented Dickey-Fuller (ADF) test for unit roots ($\tau$-ADF values)

| Variables                                                      | Sectoral national income indices in logs and levels | First differences of sectoral national income indices in logs |
|                                                               |                                                       |                                                        |
| AGR: Real GDP of agricultural sector                          | -1.793                                                 | -3.364                                                 |
| MAN: Real GDP of manufacturing industry                       | -2.642                                                 | -3.971                                                 |
| NMI: Real GDP of non-manufacturing industry (Mining and quarrying, electricity and water and construction) | -2.153                                                 | -3.473                                                 |
| TSC: Real GDP of transport, storage and communication sector  | -2.361                                                 | -3.541                                                 |
| SER: Real GDP of service sector                               | -1.434                                                 | -3.466                                                 |

Notes: The critical values of $\tau$-ADF: 10% = -3.322, 5% = -3.761, 1% = -4.731. * *, ** and *** denote rejection (of non-Stationarity) at the 10%, 5% and 1% significant levels respectively.

The summary statistics of the sectoral GDP indices in logarithms and their first differences are presented in Table 2. It is interesting to note that agriculture has a modest correlation with the rest of the economy in level terms and in the first difference terms. As the GDP indices are found to be $I(1)$, it is the relationship between the first differences that is of importance and relevance. Without doing any co-integration analysis, the correlation matrix at the lower panel of Table 2 provides some interesting information. First, all the sectors appear to be relatively higher and positive relation. Second, agriculture seems to go
its own way, with a weak and positive relationship with, transport storage and telecommunication, commerce and services but a modest and positive relationship with manufacturing and non-manufacturing sectors.

Figure 3. GDP at constant prices (2004=100) of variables AGR, MAN, NMI, TSC and SER against time in first difference.
Table 2. Summary statistics of sectoral national income indices (1994–2009)

<table>
<thead>
<tr>
<th>Levels</th>
<th>AGR</th>
<th>MAN</th>
<th>NMI</th>
<th>TSC</th>
<th>SER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.743</td>
<td>6.272</td>
<td>5.941</td>
<td>5.543</td>
<td>6.800</td>
</tr>
<tr>
<td>Standard deviations</td>
<td>0.236</td>
<td>0.097</td>
<td>0.299</td>
<td>0.303</td>
<td>0.122</td>
</tr>
</tbody>
</table>

Correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>AGR</th>
<th>MAN</th>
<th>NMI</th>
<th>TSC</th>
<th>SER</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGR</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAN</td>
<td>0.423</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NMI</td>
<td>-0.106</td>
<td>0.324</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSC</td>
<td>-0.385</td>
<td>-0.174</td>
<td>0.767</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>SER</td>
<td>-0.322</td>
<td>0.121</td>
<td>0.812</td>
<td>0.863</td>
<td>1.000</td>
</tr>
</tbody>
</table>

First differences

<table>
<thead>
<tr>
<th>ΔAGR</th>
<th>ΔMAN</th>
<th>ΔNMI</th>
<th>ΔTSC</th>
<th>ΔSER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviations</td>
<td>0.162</td>
<td>0.113</td>
<td>0.245</td>
<td>0.134</td>
</tr>
</tbody>
</table>

Correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>ΔAGR</th>
<th>ΔMAN</th>
<th>ΔNMI</th>
<th>ΔTSC</th>
<th>ΔSER</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔAGR</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔMAN</td>
<td>0.421</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔNMI</td>
<td>0.530</td>
<td>0.609</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔTSC</td>
<td>0.199</td>
<td>0.344</td>
<td>0.405</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>ΔSER</td>
<td>0.219</td>
<td>0.622</td>
<td>0.467</td>
<td>0.517</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Examination on the companion matrix, different residual tests (mean, standard deviations, autocorrelation and normality) the L-max and L-trace test statistics indicates that there are one co-integrating vectors (r = 1). With one lagged differences all the residuals have the desired properties. Some major statistics from the residual analysis are presented in Table 3. Figure 4 for residuals, also suggests that there are no major problems in the data set.

Table 3. Statistics from the residual analysis

<table>
<thead>
<tr>
<th>Equation</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Normality</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGR</td>
<td>0.000</td>
<td>0.089</td>
<td>1.239</td>
<td>0.538</td>
</tr>
<tr>
<td>MAN</td>
<td>0.000</td>
<td>0.032</td>
<td>0.316</td>
<td>0.853</td>
</tr>
<tr>
<td>NMI</td>
<td>0.000</td>
<td>0.022</td>
<td>0.235</td>
<td>0.888</td>
</tr>
<tr>
<td>TSC</td>
<td>0.000</td>
<td>0.038</td>
<td>0.369</td>
<td>0.831</td>
</tr>
<tr>
<td>SER</td>
<td>0.000</td>
<td>0.036</td>
<td>1.032</td>
<td>0.597</td>
</tr>
</tbody>
</table>

3 It is the value of Jarque Bera normality test values.
Figure 4. Residual plots

It is observed from Table 4, the max and trace tests fail to reject the null of one co-integrating vector \((r = 1)\) among the five variables at the 5% significance level. This is because of the number of co-integration vectors \((r)\) is equal to the number of equations
(n=5) minus the number of roots (p = 1) in the companion matrix. In all the following analyses, we assume that there is present of one stationary or co-integrating relation and four common stochastic trends in the system. The presence of one co-integrating vector provides evidence that there is one process that separates the long run from the short-run responses of the Palestinian economy. As Kanwar (2000) notes that this does not imply that some of the sectors did not outpace the others, but only that the economic forces at work functioned in such a way as to tie together these sectors in a long-run structural equilibrium, and while short-run shocks may have led deviations from this long-run path, forces existed whereby the system reverted back to it. Their estimates are presented in Table 4a and 4b along with the corresponding adjustment matrix a, where b is presented in normalized form. The one co-integrating vectors have been normalized by TSC.

The co-integration vector reveals a positive and long-run relationship between transport, storage and communication sector output and agricultural and non manufacturing industry output and a negative linkage between transport, storage, and communication sector and manufacturing industry sector output and services sector output in Palestine. A closer examination of the negative sign between TSC and MAN; TSC and SER may indicate that the development of the transport, storage and communication sector in Palestine was achieved at the expense of the industrial and service sectors.

Table 4a. Evidence of cointegration using maximal eigenvalue and trace statistical tests for all five sectors in Palestine

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Eigen value</th>
<th>Maximum eigenvalue test</th>
<th>Trace statistical test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\lambda_{\text{max}}$</td>
<td>10% critical value</td>
</tr>
<tr>
<td>$r = 0$</td>
<td>$r = 1$</td>
<td>$r \leq 1$</td>
<td>0.930</td>
</tr>
<tr>
<td>$r = 1$</td>
<td>$r = 2$</td>
<td>$r \leq 2$</td>
<td>0.820</td>
</tr>
<tr>
<td>$r = 2$</td>
<td>$r = 3$</td>
<td>$r \leq 3$</td>
<td>0.739</td>
</tr>
<tr>
<td>$r = 3$</td>
<td>$r = 4$</td>
<td>$r \leq 4$</td>
<td>0.678</td>
</tr>
<tr>
<td>$r = 4$</td>
<td>$r = 5$</td>
<td>$r \leq 5$</td>
<td>0.469</td>
</tr>
</tbody>
</table>

* denotes reject the null hypothesis at 5% level of significance. $^1$ $^2$ denote alternative
hypothesis for maximum eigenvalue and trace statistical tests, respectively.

Table 4b. Normalized co-integration relations ($\beta$) and loading coefficients ($\alpha$)

$$\begin{pmatrix}
0.026 \\
(0.090) \\
0.334 \\
(1.138) \\
-0.008 \\
(-1.927) \\
0.194 \\
(0.820) \\
-0.031 \\
(-0.056)
\end{pmatrix}$$

$$\beta = \begin{pmatrix}
1.00 & -2.166 & 3.178 & -0.802 & 2.747
\end{pmatrix}
\begin{pmatrix}
LTSC_{t-1} \\
LAGR_{t-1} \\
LMAN_{t-1} \\
LNON_{t-1} \\
LSER_{t-1}
\end{pmatrix}
+ \begin{pmatrix}
0.015 \\
0.014
\end{pmatrix}
TREND_{t-1}$$

Granger non-causality study

Since co-integration relationships were found between the variables, we next drive to investigate the direction of causality by estimating a VECM derived from the long-run co-integrating relationship (Engle and Granger, 1987; Granger, 1988). The vector error correction model contains the cointegration relation built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their co-integrating relationships while allowing for short-run adjustment dynamics.

The short run Granger causality test indicates that there are no causal relationships between AGR and MAN, and AGR and NMI sectors (Table 5). The causal linkage between agricultural growth and service sector growth in the short run, the results provide
support for causality running from SER to AGR. Support for reverse causality is not found in the short run and growth of AGR does not generate any significant effects on SER sector.

This unidirectional causality running from SER to growth in the agricultural sector may indicate that agriculture in Palestine is a service dependent sector. In addition, when examining the linkage between AGR output and TSC output the results provide support for unidirectional causal relationship in the short-run running from TSC to AGR. This result may reflect the development of the sub-sector of transportation driven by the extension of agricultural activities.

Table 5. Results of non causality tests between agriculture and non agricultures sectors

<table>
<thead>
<tr>
<th>Hypothesis of non-causality</th>
<th>Short run Granger non-causality</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₀: LOGAGR does not Granger Cause LOGMAN</td>
<td>1.882</td>
</tr>
<tr>
<td>H₀: LOGMAN does not Granger Cause LOGAGR</td>
<td>0.023</td>
</tr>
<tr>
<td>H₀: LOGAGR does not Granger Cause LOGNMI</td>
<td>1.562</td>
</tr>
<tr>
<td>H₀: LOGNMI does not Granger Cause LOGAGR</td>
<td>0.628</td>
</tr>
<tr>
<td>H₀: LOGAGR does not Granger Cause LOGSER</td>
<td>1.661</td>
</tr>
<tr>
<td>H₀: LOGSER does not Granger Cause LOGAGR</td>
<td>4.362*</td>
</tr>
<tr>
<td>H₀: LOGAGR does not Granger Cause LOGTSC</td>
<td>0.806</td>
</tr>
<tr>
<td>H₀: LOGTSC does not Granger Cause LOGAGR</td>
<td>3.559**</td>
</tr>
</tbody>
</table>

* and ** Rejection of hypotheses H₀ at 5% and 10% levels of significance.

5. Conclusions

The aim of this study is to understand the agricultural contribution to the economic growth and the linkages between agriculture and other economic sectors in Palestine.

Although in the past, high importance is placed on the agricultural sector in Palestine, the matter of agricultural contribution to economic growth has often been raised by policymakers but rarely examined empirically. In this paper, annual data covering from 1994-2009 period were used to explore cointegration relationships and the direction of causality between growth in the agricultural sector and growth in the other sectors, namely,
the manufacturing industry; the non-manufacturing industry; the transportation, storage telecommunication sector and the services sector.

Findings from the analysis of the long-run relationships confirm that the different sectors of the Palestinian economy moved together over the sample period and, for this reason, their growth was interdependent. The analysis also shows that there is one long-run co-integrating relationship for Palestine economy.

The findings from non-causality tests indicate that the agricultural sector seems to have a partial role in the short run as a driving force in the growth of other non-agricultural sectors of the Palestine economy. This may be the result of the relative decrease of the role that the agricultural sector plays as provider of inputs for the Palestinian industry and other sectors and the consequence of the traditional Palestinian export strategy with low value-added products.

In addition, the Palestine government also started improving the quality of services and restructuring the banking sector, that also supported our statistical results which indicate that the agricultural sector fully benefit from the development of the commerce and services sector and the presence of credit market constraints could not hamper growth of agricultural output and productivity in Palestine.

**Reference**


