

WHAT ROLE FOR THE AGRICULTURAL SECTOR IN THE PROCESS OF ECONOMIC GROWTH OF TUNISIA? EVIDENCE FROM MULTIVARIATE COINTEGRATION

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Abstract

For the past two decades, Tunisia has been undertaken important structural reforms, which call in most cases for market and trade liberalization (agricultural structural adjustment program, GATT reforms, free trade area with the European Union). The private-led type of growth strategy with less government intervention has culminated these last years into a more rapid economic growth and openness.

Within this context, this paper examines the agricultural sector role into the economic development process and its interactions with the other sectors using time-series cointegration techniques. We use annual data from 1961 to 2005 to estimate a VAR model that includes GDP indices of five sectors in Tunisian economy.

Empirical results from this study indicate that in the long-run all economic sectors tend to move together (cointegrate). But, in the short-run, the agricultural sector seems to have a limited role as a driving force for the growth of the other sectors of the economy. In addition, growth of the agricultural output may not be conducive directly to non-agricultural economic sector in the short-run. This may be the results of previous economic policies that were biased against agriculture.

Key words: cointegration, economic growth, agricultural sector, Tunisia.

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1. Introduction

The ongoing globalization process in the world economy is a big challenge for Tunisia, a country which has “suffered” a large process of structural economic reforms. For the past two decades, Tunisia has been undergoing major structural reforms, which call in most cases for market and trade liberalization (Adjustment Structural Program, GATT reforms, Free Trade Area with the European Union). The private-led type of growth strategy with less government intervention has culminated these last years into a more rapid growth and openness. Major sectors of economy started to recover and Tunisian exports considerably increased.

Despite the changes observed in the Tunisian economy (industrialization, growth of service sector and the development of tourism), the agricultural sector remains economically and socially important for its contribution to the achievement of national objectives as regards to food security, employment, regional equilibrium and social cohesion. It generates around 15% of total Gross Domestic Product (GDP), employs 20% of total labor force and agro-food exports represent around 15% of total exports.

Agriculture role in economic development has been debated from two points of view. The first view argues that agriculture only plays a passive role as major source of resources for the development of industry and other non-agricultural sectors. It suggests that agriculture provides materials, capital and labor for the rest of economy in order to raise the total national output since the industrial sector is more productive than agriculture (forward linkage effects). The second view maintains the forward linkage effects of agriculture but also underlines its backward linkage to other sectors of the economy. Agriculture not only provides resources to, but also an important market for, the non-agricultural sectors¹.

Within this context, the aim of this empirical paper is to understand the linkages between agriculture and other economic sectors in the Tunisian economy and to examine the agricultural sector role into the economic development process. In fact, in estimating the relation between the relation between agricultural and non-agriculture sectors, the former should not be assumed to be exogenous, rather, this should first be established. The

¹ See Kanwar (2000) and Yao (2000) for a literature review of the agricultural non-agricultural linkages.

contribution of agricultural growth to economic development varies markedly from country to country and from one time period to another within the same economy.

In addition, given the presence of non-stationarity, traditional regression techniques may yield spurious regressions. To circumvent these limitations, we use time-series techniques to study the cointegration of the different sectors of the Tunisian economy in a multivariate vector autoregression structure. Special attention is paid to the distinction between long-run structural relationships and short-run dynamics.

2. Methodological approach: a cointegration analysis

2.1. Variables selection

Availability of long series of data is one of the major problems for economic modeling in Tunisia. In this study time-series data of GDP indices in constant price of five sectors have been considered. Table 1 describes the database used. The sample period covers annual data from 1961 to 2005. All variables are in logarithms.

Table 1: Description of database

Variable	Symbol	Source
Gross Domestic Product (GDP) index of agricultural sector in constant price (Basis 100 = 1990)	AGRP	Institut National de la Statistique (INS). Ministère du Développement et Coopération Internationale. Tunisia.
Gross Domestic Product (GDP) index of manufacturing industry in constant price (Basis 100 = 1990)	IM	
Gross Domestic Product (GDP) index of non-manufacturing industry in constant price (Basis 100 = 1990)	INM	
Gross Domestic Product (GDP) index of transportation, tourism and telecommunication sector in constant price (Basis 100 = 1990)	TTT	
Gross Domestic Product (GDP) index of commerce and services sector in constant price (Basis 100 = 1990)	CDS	

Taking into account the methodological approach followed in this paper, the first step in our analysis has been to explore univariate properties and test the order of integration of each series. When the number of observations is low, unit root tests have little power. For this reason we have examined the results from two different tests: the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979, 1981), which tests the null of unit root, and KPSS (Kwiatkowski et al., 1992), which tests the null of stationarity. Both tests indicated that the five variables were $I(1)^2$.

² Results are not shown due to space limitations. They are available upon request.

2.2. Long-run relationships study

The cointegration analysis has been conducted using the Johansen approach. Johansen's (1988) procedure starts with the following reformulation of a VAR(k) model into a Vector Error Correction Model (VECM):

$$\Delta Z_t = \Pi Z_{t-1} + \delta D_t + \sum_{i=1}^{k-1} \Psi_i \Delta Z_{t-i} + \varepsilon_t \quad (1)$$

where Z_t is a $p \times 1$ vector of endogenous variables; Ψ_i , $i = 1, 2, \dots$ are $(p \times p)$ matrices of short-run parameters; Π is a $(p \times p)$ matrix of long-run parameters; D_t is a vector of deterministic terms (a constant, a linear trend, seasonal dummies, intervention dummies, etc.); and ε_t is a vector of errors that are assumed to be independently and identically Gaussian distributed, such that $E(\varepsilon_t \varepsilon_t') = \Sigma$ for all t , where $\Sigma = \{\sigma_{ij}, i, j = 1, 2, \dots, p\}$ is an $(p \times p)$ positive definite matrix.

In the $I(1)$ system Z_t is said to be cointegrated if the following rank conditions are satisfied: $H_r : \Pi = \alpha\beta'$ of rank $0 < r < p$, where α and β are matrices of dimension $p \times r$. β is a matrix representing the cointegrating vectors which are commonly interpreted as long-run equilibrium relations between the Z_t variables, while α gives the weights of the cointegration relationships in the VECM equations. The cointegration rank is usually tested by using the maximum eigenvalue (λ -max) and the trace test statistics proposed by Johansen (1988).

The estimation of a VECM (1) subject to rank restrictions on the long-run matrix Π does not generally lead to a unique determination of cointegrating relationships and is not meaningful from an economic point of view. In fact, the structural estimation of the two cointegrating vectors obtained in the previous section requires the imposition of at least r^2 restrictions³. In recent years, considerable attention has been paid to the problem of identifying the long-run relationships in a linear cointegrating model. Johansen and Juselius (1994), Johansen (1995a), and Boswijk (1995), among others, have developed a testing procedure to identify cointegrating vectors by imposing linear restrictions in order to determine long-run behavioral parameters such as supply and demand elasticities.

However, sometimes it is more interesting to test joint restrictions on both the cointegration vectors and the adjustment coefficients. Johansen and Juselius (1990, 1992)

³ When we impose $(r-1)$ restrictions and one- normalization on each cointegration relation we say that β is just identified. In this case, no tests are involved because just-identifying restrictions do not change the likelihood function.

developed a procedure to carry out individual tests on parameters from both matrices⁴. Mosconi (1998), extended the previous procedure to jointly consider general linear restrictions on both the long-run parameters, α and β .

A general formulation of the null hypothesis can be expressed as:

$$H_0: \begin{cases} \beta = [\beta_1; \dots; \beta_r] = [H_1\phi_1; \dots; H_r\phi_r] \\ \alpha = [\alpha_1; \dots; \alpha_r] = [A_1a_1; \dots; A_ra_r] \end{cases} \quad (2)$$

where: H_j is a $(k \times s_j)$ matrix defining linear restrictions that reduce the k -dimensional vector β_j to the s_j -dimensional vector ϕ_j , with s_j representing the number of unrestricted parameters in β_j ; k_j is the number of restricted parameters in β_j , such that $k_j + s_j = k$; similarly, A_i are $(k \times f_i)$ restriction matrices α_i 's, where f_i is the number of unrestricted parameters in α_i .

Note that in the case where α is not restricted ($A_i = I$), (2) can be used to test the identification restrictions on β . In this case, the hypothesis is formulated as $\beta = (H_1\phi_1, \dots, H_r\phi_r)$. As shown in Johansen (1995b), inference on the coefficients of cointegrated VAR systems is asymptotically based on mixed Gaussian distributions, so the Likelihood Ratio (LR) statistic for testing the hypothesis (2) is asymptotically $\chi^2(v)$. The degrees of freedom (v) can be calculated using the following expression:

$$v = \sum_i^r [k_i - (r - 1)] + \sum_i^r (k - f_i)$$

The procedure outlined above has been applied to the system including the five variables described above (AGRP; IM; INM; TTT and CDS). System (1) has been initially estimated including two lags with a constant term restricted in the cointegration space, implying that some equilibrium means are different from zero. In the present work, although the underlying variables are trended, they move together, and it seems unlikely that there will be a trend in cointegrating relation between variables⁵.

Table 2 shows the results of Johansen's likelihood ratio tests for cointegration rank. As can be observed, at the 5% of significance level, both the maximum eigenvalue and trace

⁴ The general procedure is to test restrictions on the β parameters and afterwards on the α coefficients with the restrictions on β being imposed.

⁵ The lag length has been determined by both the Akaike and Schwarz Information criteria. With respect to the deterministic components, and following Harris (1995), several tests have been conducted to empirically select such components. Results indicated that a model with a restricted constant was statistically preferred. Also, in the case of Tunisia, in 1986 a Structural Adjustment Program was implemented which substantially changed the objectives and instruments of both the economic and agricultural policies. To account for this event on the level of the variables, an earlier model was estimated including a restricted step dummy variable, but there is no statistical evidence to including this dummy variable.

statistics do not reject the null hypothesis that there are two cointegrating relation between the variables ($r = 2$).

Table 2: Tests of the cointegration rank

Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix					Cointegration LR Test Based on Trace of the Stochastic Matrix				
$H_0 :$	$H_a :$	$\lambda - \max$	Critical Value (95%)	Critical Value (90%)	$H_0 :$	$H_a :$	Trace	Critical Value (95%)	Critical Value (90%)
$r = 0$	$r = 1$	60.132	34.400	31.730	$r = 0$	$r = 1$	122.732	75.980	71.810
$r = 1$	$r = 2$	33.932	28.270	25.800	$r = 1$	$r = 2$	62.600	53.480	49.950
$r = 2$	$r = 3$	12.605	22.040	19.860	$r = 2$	$r = 3$	28.668	34.870	31.930
$r = 3$	$r = 4$	8.414	15.870	13.810	$r = 3$	$r = 4$	16.063	20.180	17.880
$r = 4$	$r = 5$	7.649	9.160	7.530	$r = 4$	$r = 5$	7.649	9.160	7.530

Note: The critical values are taken from Pesaran et al. (2000).

In all the following analysis we assume the presence of two stationary or cointegrating relations and three common stochastic trends in the system. The presence of two cointegrating vectors in our system suggests an inherent movement in the system to revert towards long-run equilibrium path of the Tunisian economy subsequent to a short-run shock. Their estimates are presented in Table 3 along with the corresponding adjustment matrix α .

Table 3: Estimated β and α parameters with two cointegration vectors

$\beta'Y_t = \begin{bmatrix} 0.468 & 1.000 & -5.075 & 6.273 & -6.094 & 17.892 \\ -10.423 & -21.093 & -7.884 & 1.000 & -14.814 & 52.521 \end{bmatrix} \times \begin{pmatrix} \text{AGRP} \\ \text{IM} \\ \text{INM} \\ \text{TTT} \\ \text{CDS} \\ \text{Cte.} \end{pmatrix}$					
$\alpha = \begin{bmatrix} \alpha_{\text{AGRP1}} & \alpha_{\text{AGRP2}} \\ \alpha_{\text{IM1}} & \alpha_{\text{IM2}} \\ \alpha_{\text{INM1}} & \alpha_{\text{INM2}} \\ \alpha_{\text{TTT1}} & \alpha_{\text{TTT2}} \\ \alpha_{\text{CDS1}} & \alpha_{\text{CDS2}} \end{bmatrix} = \begin{bmatrix} 0,044 & 0,019 \\ (2,407) & (1,957) \\ 0,040 & -0,003 \\ (5,141) & (-0,702) \\ 0,032 & -0,010 \\ (6,036) & (-3,392) \\ 0,060 & 0,004 \\ (7,886) & (0,908) \\ 0,045 & 0,012 \\ (7,215) & (3,779) \end{bmatrix}$					

Note: Values in parentheses correspond to t-ratios in the case of the α parameters.

To facilitate the analysis of the cointegration space as summarized by the estimates, we also compute certain tests to investigate the relative importance of the individual α values. The test of the null hypothesis for α , $H_0 : \alpha_{i1} = \alpha_{i2} = 0$, check for the weak exogeneity. Individual elements of these joint tests are reported in Table 4.

Table 4: Tests for weak exogeneity

	AGRP	IM	INM	TTT	CDS
$\chi^2(2)$	7.100	18.570	27.875	34.790	32.102
Critical Value (95%)			5.991		

Weak exogeneity is rejected for all the variables in the system. For the five variables, the corresponding statistics are larger than the critical value. The rejection of weak exogeneity in agriculture means that agricultural growth can cause the growth of the non-agricultural sector in Tunisia. Also the rejection of weak exogeneity in the non-agriculture sectors means that the growth of these four sectors (IM; INM; TTT and CDS) can cause agricultural to grow.

The next problem is that of identity. As the tow cointegration vectors include a whole range of the variables, each equation is not uniquely defined. Following the Johansen's approach, we impose a number of restrictions on the β coefficients to see whether some of these coefficients may be equal to zero so that unique relationship can be found.

Without knowing which restrictions may be statistically acceptable and have empirical support, many alternative restrictions on β are conducted. The most acceptable restriction is that the coefficient of TTT in the first vector and the coefficients of AGRP and CDS in the second vector are set to zero. The final cointegrating vectors are presented in Table 5.

Table 5: Estimated β and α matrices under long-run identification

$\beta'Y_t = \begin{bmatrix} -0.285 & 1.000 & -0.332 & 0.000 & -0.783 & 1.878 \\ 0.000 & -0.823 & -0.494 & 1.000 & 0.000 & 1.824 \end{bmatrix} \times \begin{pmatrix} \text{AGRP} \\ \text{IM} \\ \text{INM} \\ \text{TTT} \\ \text{CDS} \\ \text{Cte.} \end{pmatrix}$					
$\alpha = \begin{bmatrix} \alpha_{\text{AGRP1}} & \alpha_{\text{AGRP2}} \\ \alpha_{\text{IM1}} & \alpha_{\text{IM2}} \\ \alpha_{\text{INM1}} & \alpha_{\text{INM2}} \\ \alpha_{\text{TTT1}} & \alpha_{\text{TTT2}} \\ \alpha_{\text{CDS1}} & \alpha_{\text{CDS2}} \end{bmatrix} = \begin{bmatrix} 0.591 & 0.309 \\ 0.095 & 0.194 \\ -0.096 & 0.130 \\ 0.344 & 0.318 \\ 0.497 & 0.265 \end{bmatrix}$					
$\chi^2(1)=3.25$			p-value = 0.07		

Note: Values in parentheses correspond to standard deviations, in the case of the β parameters, and to t-ratios, in the case of the α parameters.

The first vector taken to pertain to the sector of the manufacturing industry, interpreted as a long-run relation, indicates that an increase in the AGRP, INM and CDS induce an increase in the INM. For example, the first cointegration vector, indicates, that a 10% rise in agricultural GDP would raise industry GDP by 2.85%.

The second vector may be taken to relate to the TTT sector. This long-run relation indicates that an increase in the manufacturing industry GDP and non-manufacturing industry GDP originate an increase in the transportation, tourism and telecommunication GDP.

2.3. Short-run relationships study

Once the VECM has been estimated, short-run dynamics can be examined by considering the impulse response functions (IRF). These functions show the response of each variable in the system to a shock in any of the other variables. The IRF should be calculated from the Moving Average Representation of the VECM (see Lütkepohl, 1993 and Pesaran and Shin, 1998):

$$Z_t = \sum_{i=0}^{\infty} B_i \varepsilon_t$$

where matrices B_i ($i=2, \dots, n$) are recursively calculated using the following expression: $B_n = \Phi_1 B_{n-1} + \Phi_2 B_{n-2} + \dots + \Phi_k B_{n-p}$; $B_0 = I_p$; $B_n = 0$ for $n < 0$; $\Phi_1 = I + \Pi + \Psi_1$; and $\Phi_i = \Psi_i - \Psi_{i-1}$ ($i=2, \dots, k$).

Following Pesaran and Shin (1998) the scaled Generalized Impulse Response Functions (GIRF) of variable Z_i with respect to a standard error shock in the j^{th} equation can be defined as:

$$\text{GIRF}(Z_{it}, Z_{jt}, h) = \frac{e_i' B_h \Sigma e_j}{\sqrt{\sigma_{jj}}}; \quad h = 0, \dots, n$$

where e_m ($m=i, j$) is the m^{th} column of the identity matrix (I_p).

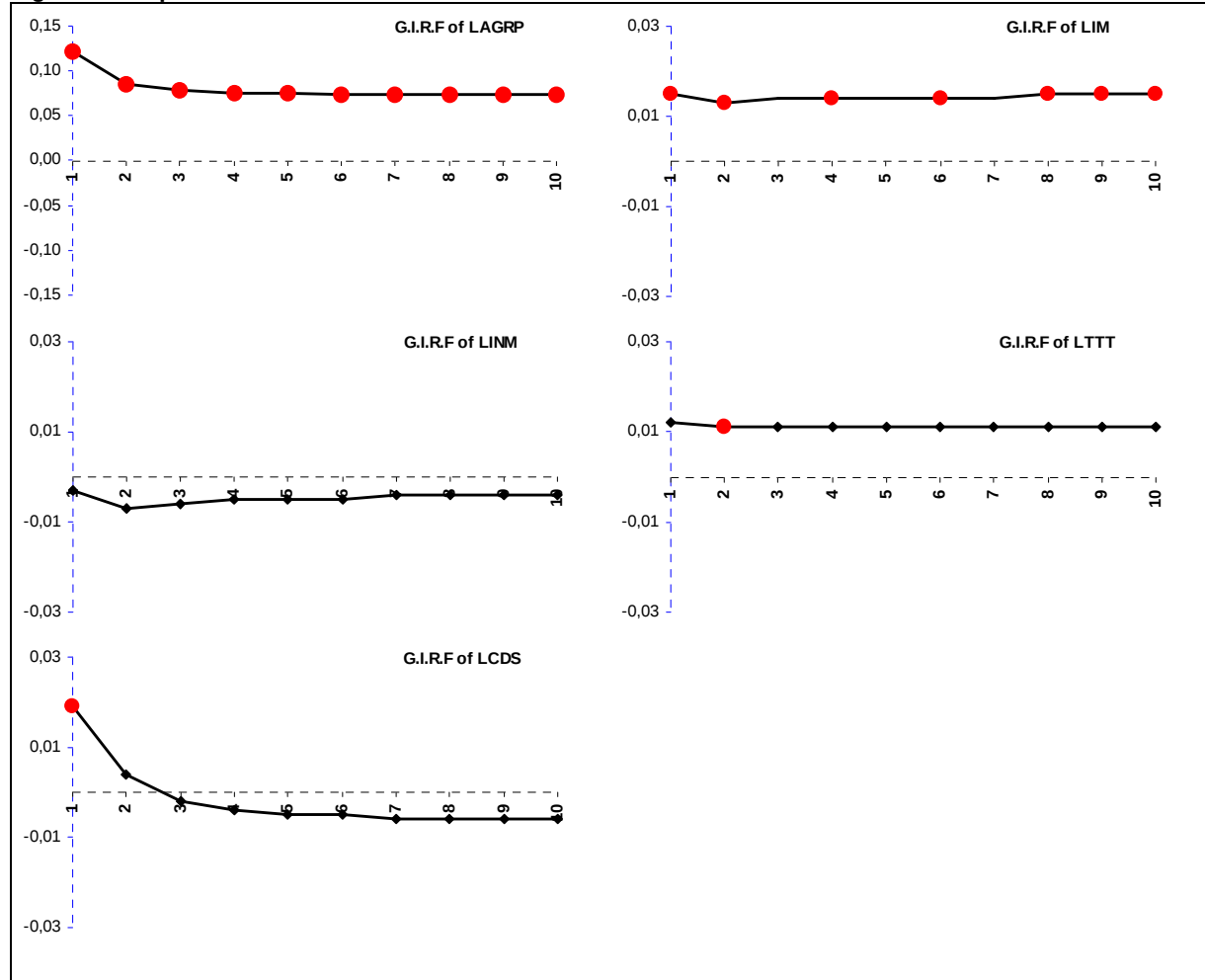
The GIRF are unique and do not require the prior orthogonalisation of the shocks (reordering of the variables in the system). On the other hand, the GIRF and the orthogonalised IRF (Cholesky) coincide if the covariance matrix, Σ , is diagonal and $j=1$.

In order to investigate the role of agricultural sector and his interactions with others non-agricultural sectors in the short-run, the IRF are calculated using the VECM estimated in

the last section (with restrictions imposed on the β and α matrices). For all GIRF, the standard deviations are computed following Pesaran and Shin (1998)⁶.

Figure 1 shows the magnitude and time path of the impulse response functions of the five GDP sectors to a one standard deviation shock on the agricultural sector. Significant responses are marked with a circle.

Figure 1. Responses to a shock in the LAGRP



Note: Significant responses at the 10% level of significance are marked with a circle.

The main results from short-run dynamics can be summarized in the following points:

⁶ We have to note, however that in Pesaran and Shin (1998: pp. 27) expression (A.6) should be

replaced by:

$$\begin{pmatrix} I_k & -I_k & 0 & \dots & 0 \\ 0 & I_k & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & \ddots & 0 \\ 0 & \dots & \ddots & I_k & -I_k \\ I_k & 0 & \dots & \dots & 0 \end{pmatrix}$$

1. Most of the responses were non significant although showed the expected signs. We have to take into account that we are using annual data and then we do not expect responses longer than one or two years in general.
2. In the short-run, shock in AGRP does not generate any significant effects on INM sector. The construction, electricity, gas and water supply subsectors tended to depend on budgetary allocations rather than directly on impulses emanating from the growth of agricultural sector.
3. The effect of one positive shock in the output of agricultural sector on TTT sector is transitory and the reaction is one period later (the response is only significant for the second year). It is difficult to understand this result without further reflection. In the short-run, this result may reflect the development of the subsector of transportation driven by the extension of agricultural activities.
4. The CDS sector is affected only positively during the first year by any increase in agricultural output. This is probably reflective of widespread administrative controls over activities comprising the services subsectors (such as financial and insurance services) for the bulk of the sample period.
5. A positive shock in the agricultural sector generates a significant and sizeable effect on agricultural output and a persistent reaction in IM sector. It seems that the development of Tunisian manufacturing industry is driven especially by the growth in agro-food industry.

3. Concluding remarks

Empirical finding from the analysis of the long-run relations confirm that the different sectors of the Tunisian economy moved together over the sample period and, for this reason, their growth was interdependent. This means that it is not to 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 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 (Kanwar, 2000). The presence of two cointegrating relations provides evidence that there are two processes that separate the long-run from the short-run responses of the Tunisian economy.

The short-run dynamics indicate that agricultural sector seems to have a limited role as a driving force for the growth of the other non-agricultural sectors of the economy. Further, growth of the agricultural output may not be conducive directly to non-agricultural economic

sector in the short-run. This may be the results of previous economic policies that were biased against agriculture.

To conclude, it has to be said that results presented in this empirical work depend on the definition on variables and the sample period chosen. Further analysis, including other subsectors and an extended sample period, could be conducted in the future.

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