The Determinants of Agricultural Exports: Empirical Validation for the Case of Tunisia

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Abstract:

In this investigation, we attempt to identify and to examined the determinants of agricultural exports in Tunisia. To achieve this aim, we used annual data for the period 1972 – 2017 and seven ad hoc specifications. Empirical results of each specification show us that gross domestic product in the agricultural sector, agricultural imports, bank loans to the agricultural sector and imports of agricultural machinery have a positive effect on agricultural exports in the long run. Conversely, domestic investment in the agricultural sector and the exploitation of agricultural land have a negative effect on agricultural exports in the long term. In the short term, only domestic investments in the agricultural sector cause agricultural exports. Findings and interpretations provide evidence that is very substantial to inspire validity planning and reforms to ameliorate agricultural investment and agricultural trade, so it can uphold economic development in Tunisia.

Keywords: Determinants, Agricultural, Exports, Tunisia.

JEL Classification: F11, F13, F14, F17, F18, F47, Q16, Q17, Q18, O55.

1. Introduction

Unlike developed countries, the agricultural sector exceeds most of the economic activity in developing countries. Thanks to their structural nature, agriculture contributes to economic development as a continuous process of improving the standard of living of the population. In fact, agriculture is the first economic activity without which life cannot subsist. It is also responsible for the provision of food and clothing for the population of other non-agricultural economies. Likewise, it's capable of supplying the supply of a large part of the production materials, such as capital, raw materials and human material for other economic sectors. Many economic indicators and criteria are used to judge the efficiency of the performance of the agricultural sector, which mainly depend on the value of GDP, the volume of production, investments and exports.

In this context, agricultural exports are defined as one of the main means of economic growth and sustainable development of the countries. They are seen as a crucial means of acquiring currency, stimulating agricultural investment, increasing the employment rate, reducing the number of unemployed and eliminating the poverty rate. It would therefore be of great importance to identify the determinants of this latter category of exports. This identification will help guide economic policies with the aim of strengthening agricultural exports. This is what we will try to do with this research.

In the determinants whose importance we will test empirically, our interest will focus on agricultural investment, gross domestic product in the agricultural sector, agricultural imports, credits to the agricultural sector, farms and agricultural imports. agricultural machinery. This article is organized as follows. The following section presents a review of the literature on the determinants of total exports and the determinants of agricultural exports. In section 3, we describe the sample, the data and the empirical strategy. Section 4 presents the empirical results of our estimation.

2. Literature Survey

Contrary to the predominance of certain crops and overall productivity, the role of agricultural diversity remains largely unexplored. Likewise, empirical studies which attempt to explain the determinants of exports, where agricultural trade and trade in other sectors are still neglected. For this reason, we draw inspiration from studies that have examined the determinants of total exports.

Elbeydi et al (2018) examined the relationship between exports and economic growth in Libya during the period 1980 - 2017. They used the Vector Error Correction Model and the Granger Causality Tests. Empirical results have shown that economic growth has a positive effect on exports in the long run. Fatemah and Qayyum (2018) studied the link between economic growth and exports to Pakistan over the period 1971 - 2016. By applying an estimation based on Vector Error Correction Model and Granger's causality tests. They found that economic growth causes exports in the short term, but in the long term, the results indicate that there is no causal relationship between the two variables. In the case of Malaysia, Chau et al (2017) studied the link between exports and economic growth for the period 1984 - 2014 using Johansen's cointegration analysis and the Vector Auto Regressive model. They found that there is a bidirectional causality link between exports and economic growth. Dritsakis and Stamatiou (2018) examined the link between exports and economic growth in the countries of the European Union during the period 1970-2015. The application of cointegration analysis, the Vector Auto Regressive (VAR) model and Granger's causality tests have shown that economic growth causes exports. It is the same result found by Guntukula (2018) for the case of India during the period 2005-2007 (monthly data), applying the same empirical methodology as Dritsakis and Stamatiou (2018). El Alaoui (2015) examined the link between exports and economic growth in Morocco during the period 1980 - 2013. As an empirical methodology, he applied an estimate based on the error correction vector model. The empirical results indicate that economic growth has no influence on economic growth in the short run and in the long run.

There are several empirical works which have tried to study the impact of imports on exports, among these works, we can start first by Bakari (2017) who studied the link between exports and imports in Tunisia during the period 1965 - 2016. He used cointegration analysis and Vector Error Correction Model as an empirical methodology. Empirical results have indicated that imports have a positive effect on exports over the long term. On the other hand, results indicate that imports have no effect on exports in the short term. Using Johansen's cointegration analysis and the Vector Auto Regressive (VAR) model, Bakari and Mabrouki (2017) examined the link between exports and imports in Panama for the period 1980 - 2015. They found that imports have no effect on exports. Likewise, Ali et al (2018) studied the relationship between imports and exports in Somalia for the period 1970 - 1991. Granger's causality tests showed that there is a bidirectional causality relationship between imports and exports. Chaudhry et al (2017) discovered that imports have a positive impact on exports in the long term for the case of Pakistan during the period 1948 - 2013. They applied for their analysis Sims's Model (1980) and cointegration analysis. For the case of Chile, Herzer and Nowak-Lehmann (2005) applied the error correction vector model on a sample of 30 observations (for the period 1975 - 2006). They found that imports have a positive impact on exports in the long run. Baek (2016) studied the link between exports and imports in 7 countries (Canada, France, Germany, Japan, the United Kingdom, Italy and the United States) during the period the period 1989 – 2013. He utilized cointegration analysis and the Auto-Regressive Distributive Lags Model . Empirical results have shown that imports have a positive impact on exports in the long term to the next 5 countries; Canada, France, Germany, Japan and the United Kingdom, Italy and the United States. On the other hand, for the other countries, the results showed that imports have a negative effect on exports in the long term.

On the other hand, domestic investment increases the productive capacity of the company by increasing the number of machines and equipment, part of the increase in production will be devoted to increasing exports. Likewise, the process innovations introduced by the modernization investment allow companies to reduce their production costs thanks to productivity gains, this improves price competitiveness and stimulates exports. Finally, since modernization investment is a vector of technical progress, it introduces product innovations which improve the quality of the products offered on the market, thereby improving the non-price competitiveness which results from this stimulating exports. Teodora and Marinela (2011) examined the relationship between investment and exports in Romania for the period 2000 - 2010. The Vector Error Correction Model and the Granger causality tests were used in their empirical analysis. They found that domestic investment has a positive effect on exports in the long run. Similarly, by using the Logit Model, Peluffo (2015) found that domestic investment had a positive effect on exports for the case of Uruguay during the period 1997-2008. In contrast, Bakari et al (2018) involved the same empirical methodology as Teadorat and Marinela (2011) in the Nigerian context during the period 1981 - 2015. The empirical results indicated the absence of a causal relationship between domestic investments and exports in the short and long terms. These are the same results shared by Bakari (2017), who studied the link between exports, imports, domestic investment and economic growth in the Sudan. He used a sample of 51 observations (for the period 1976 - 2015) and an estimate based on cointegration analyzes, the error correction vector model and the Granger causality tests. Also, Popovici and Calin (2017) examined the impact of domestic investments on exports in the case of European Union countries during the period 1999 - 2013. They applied an estimation based on the Dynamic Gravity Model. The empirical results indicate that domestic investment has no effect on economic growth.

For the link between exports and pollution, Ferdousi and Qamruzzaman (2017) studied the impact of pollution on Bangladesh's exports during the period 1972 - 2013. They applied cointegration analysis, VAR Model and Granger Causality Tests. Findings denote that pollution causes exports. Ben Jebli et al (2014) looked at the impact of pollution on exports in the case of African countries over the period 1980 - 2010. The results of Granger's causality tests marked the existence of a bidirectional causality between exports and pollution. In the same way, Ben Jebli and Youssef (2015), researched the relationship between pollution and exports over the period 1980 to 2009. Their study was done on the basis of cointegration analysis, VECM Model and Granger Causality Tests concluded that pollution has a positive influence on Tunisian exports in the short term and in the long term. For the case of 22 exporting countries which are (Australia, Belgium, Brazil, Canada, China, Germany, Spain, France, United Kingdom, Indonesia , India, Italy, Japan, Korea, Mexico, Netherlands, Poland, Russia, Sweden, Turkey, Taiwan and the United States, Sakamoto and Managi (2016) studied the impact of pollution on export performance during the period 1995 - 2009. They used the Static Gravity Model and the Generalized Method of Moments Model. Empirical results show that a 1% decrease in pollution leads to a 2.7% increase in exports. Ekaputri and Panennung (2011) examined the link between pollution and exports during the period 2001 to 2006 by taking a sample of developing and developed countries. As an empirical methodology, they used the gravity model and the quadratic model. They found that in the developing country, there is a positive relationship between exports of manufactured goods and carbon dioxide (CO_2) emissions. In contrast, in developed countries, the empirical results indicate that there is a negative relationship between exports of manufactured goods and carbon dioxide (CO_2) emissions. On the other hand, Takeda and Matsuura (2005) studied the impact of environmental pollution on merchandise trade in the case of 10 countries in Latin America. Using an estimation based on the panel data model and a sample of 15 annual observations, they found that pollution had no effect on merchandise trade during the period 1986 - 2000.

Some researches search for the link between labor and exports, among these studies, we can cite, Josheski and Apostolov (2013) whom searched for the link between population and exports for the case of the Balkan countries (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Romania, Slovenia, Turkey, Serbia and Montenegro) during period 1999 - 2013. The results of the estimation of the Gravity Model, show that the population has a positive impact on exports during this period. For the case of Syria, Mohsen and Chua (2015) looked for the nexus between exports and population during the period 1980 - 2010. They applied cointegration analysis, Vector Error Correction Model, Granger Causality Tests and the variance of decomposition. Findings show that the population causes exports in the short run and in the long run. By using a sample of monthly data for the period July 2003 to June 2015, Hanif (2018) examined the relationship between population and exports in Pakistan. Empirical results show that population is a very important factor in boosting Pakistan's exports. Also, Cohen et al (2012) studied the nexus between exports and the population in the European Union (EU) during the period 1994 - 2010. They involved the Fixed Effect Model, the Random Effect Model and the Hausman Test. Empirical results show that population affects positively on commercial activity.

A few studies have examined the nexus between debt and exports. Among these studies, we commence with Liviu et al (2011), who looked for the impact of debt on exports in Greece, Bulgaria, Romania and Hungary during the period 2001 - 2009. They used the statistical gravity model, the empirical results indicate that external debt is positively affecting exports.
Cem Karaman (2015) used the cointegration analysis and the error correction vector model to determine the relationship between exports and public debt in the case of Turkey. During the period 1998 - 2014, he found that external debt has no influence on exports in both short and long terms. Jayaraman and Choong (2008) examined the nexus between exports and debt for the case of Fiji during the period 1970 – 2005. By using cointegration analysis, ARDL Model, VECM Model and Granger Causality Tests, they found that debt affects positively exports in the long run. Lau et al (2015) examined the link between exports and debts in Malaysia during the period 1970 – 2012, in Thailand during the period 1980 – 2012 and in the Philippines during the period 1985 – 2012. As an empirical strategy, they applied cointegration analysis, VECM Model and Granger Causality tests. In the three cases, empirical results indicate that debt cause exports in the long run. Oguledo (1993) examined the effect of the foreign debt of less-developed countries (48 most indebted countries) on their exports to the United States in 1984. He used the ordinary least squares method. Empirical results show that the external debt situation of the less developed countries is an important factor influencing their exports to the United States. Ahmed et al (2000) searched the link between external debt and exports in 8 Asian Countries (Malaysia, Indonesia, Thailand, Korea, India, Sri Lanka, Pakistan and Bangladesh) during the period 1970-1997. By applying VECM Model and Granger Causality Tests, they found that external debt affects negatively exports in the long term. Saad (2005)

examined the link between public debt and exports in the case of Lebanon during the period 1970 -2010. He used cointegration analysis, the Error Correction Model and the Granger Causality tests. Findings show that public debts have no effect on exports in the long run and in the short run.

our research also leads us to find a link between the size of the land area and exports. this output is very important to inspire the link between the exploitation of agricultural land and agricultural exports. For example, Daude et al (2014) studied the impact of arable land on exports in 43 countries during the period 1976-2010. They applied the fixed effect model and the Bayesian model. Empirical results show that arable land has a negative effect on exports. Ogundipe et al (2013) examined the relationship between agricultural land and agricultural exports in 16 African countries during the period 1995 to 2010. They used the Generalized Method of Moments Model, the Fixed Effect Model and the Random Effect Model. They found that farmland has a positive and significant impact on agricultural exports. Mbogela (2018) analyzed the impact of arable land on exports in the case of African countries and BRIC countries for the period 1980 – 2012. By employing an estimation based on the Static Gravity Model. He found that arable land affects positively exports.

3. Empirical methodology

To identify the determinants of agricultural exports to Tunisia, we will involve the most appropriate process which first involves establishing the order of integration of each variable (the stationarity of each variable).

- ✓ If the variables are stationary in level, we use an estimate based on a simple linear model.
- ✓ On the other hand, if the variables are stationary in level and in first difference, we will apply an estimate based on the ARDL model. These should not however be integrated in order 2
- ✓ On the other hand, if the variables are all stationary in prime difference, our estimates will be based on the Sims model (1980). When we apply the SIMS model, the cointegration between the variables of the model is tested. In the absence of a cointegration relationship, we refer to an autoregressive vector model (VAR) and to the Granger causality tests. On the other hand, in the context of the presence of a cointegration relation, we refer to the vector error correction model (VECM).

- ✓ Finally, on the technical level, diagnostic and stability tests are carried out to check the robustness and the credibility of the model and the empirical results.

We specify 7 ad-hoc specifications to examine the determinants of long-term and short-term agricultural exports. Our first model includes agricultural exports as a variable to explain. It includes six explanatory variables, which are agricultural investments, agricultural GDP, agricultural imports, credits to the agricultural sector, exploitation of agricultural land and imports of agricultural machinery. It is written as follows:

$$\mathbf{AX = F\,(AI, YA, AM, AC, AL, IAM)\ \ (1)}$$

The function including all these variables is expressed as:

$$\mathbf{AX = A\,AI^{\alpha_1} YA^{\alpha_2} AM^{\alpha_3} AC^{\alpha_4} AL^{\alpha_5} IAM^{\alpha_6} \quad (2)}$$

In the equation (2) α_1,α_2, α_3.α_4,α_5, et α_6 represent the elasticities of agricultural export relative to its determinants. In addition, "A" indicates the level of technology (assumed to be exogenous) used in the country. The linearization of equation (2) by the logarithm function allows it to be rewritten as follows:

$$\mathbf{Log(AX_t) = Log(A) + \alpha_1 Log(AI) + \alpha_2 Log(YA_t) + \alpha_3 Log(AM_t) + \alpha_4 Log(AC_t) + \alpha_5 Log(AL_t) + \alpha_6 Log(IAM) + \varepsilon_t\ \ (3)}$$

The empirical counterpart of this equation (model 1) is:

$$\mathbf{Log(AX_t) = \alpha_0 + \alpha_1 Log(AI_t) + \alpha_2 Log(YA_t) + \alpha_3 Log(AM_t) + \alpha_4 Log(AC_t) + \alpha_5 Log(AL_t) + \alpha_6 Log(IAM_t) + \varepsilon_t\ \ (4)}$$

Because of the short period and the structure of our sample, we try to explain the determinants that influence agricultural exports, each is independent of the other in order to obtain a very favorable degree of freedom in our empirical analysis. In this case the other ad hoc specifications are as follows:

Model 2 presents the specific ad hoc which expresses the impact of gross domestic product in the agricultural sector on agricultural exports is written as follows:

$$\mathbf{Log(AX_t) = \alpha_0 + \alpha_1 Log(YA_t) + \varepsilon_t\ \ (5)}$$

Model n°3 presents the specific ad 'hoc which expresses the impact of domestic investments in the agricultural sector on agricultural exports is written as follows:

$$\mathbf{Log(AX_t) = \alpha_0 + \alpha_2 Log(AI) + \varepsilon_t \ \ (6)}$$

Model n°4 presents the specific ad 'hoc which expresses the impact of agricultural imports on agricultural exports is written as follows:

$$\mathbf{Log(AX_t) = \alpha_0 + \alpha_3 Log(AM_t) + \varepsilon_t \ \ (7)}$$

Model n°5 presents the specific ad hoc which expresses the impact of bank loans to the agricultural sectors on agricultural exports is written as follows

$$\mathbf{Log(AX_t) = \alpha_0 + \alpha_4 Log(AC_t) + \varepsilon_t \ \ (8)}$$

Model n°6 presents the specific ad 'hoc which expresses the impact of imports of agricultural machinery on agricultural exports is written as follows

$$\mathbf{Log(AX_t) = \alpha_0 + \alpha_6 Log(IAM_t) + \varepsilon_t \ \ (9)}$$

Model n°7 presents the specific ad 'hoc which expresses the impact of the exploitation of arable land on agricultural exports is written as follows

$$\mathbf{Log(AX_t) = \alpha_0 + \alpha_5 Log(AL_t) + \varepsilon_t \ \ (10)}$$

Knowing that :

- α_0 : Coefficient of constancy
- α_1 : Coefficient of the variable which designates agricultural investments (AI)
- α_2 : Coefficient of the variable which designates the gross domestic product in the agricultural sector (YA)
- α_3 : Coefficient of the variable which designates agricultural imports (AM)
- α_4 : Coefficient of the variable which designates agricultural credits (CA)
- α_5 : Coefficient of the variable which designates the exploitation of agricultural land (AL)

- α_6 : Coefficient of the variable which designates imports of agricultural machinery (AMI)
- t: The time trend.
- ε: The random error term

To examine the determinants of agricultural exports in Tunisia, we will use a chronological database covering the period 1972-2017. The brief description of the variables is given below in Table 1.

Table 1.Description of the variables

No	Variables	Description	Source
1	**AX**	Agricultural exports at constant prices (in millions of dinars)	The Central Bank of Tunisia
2	**AI**	Domestic investments in the agricultural sector: Gross fixed capital formation in the agricultural sector at constant prices (in millions of dinars)	The Central Bank of Tunisia
3	**YA**	Burt domestic product in the agricultural sector at constant prices (in millions of dinars)	The Central Bank of Tunisia
4	**AM**	Agricultural imports at constant prices (in millions of dinars)	The Central Bank of Tunisia
5	**AC**	Credits to the agricultural sector at constant prices (in millions of dinars)	The Central Bank of Tunisia
6	**AL**	Farmland use: Farmland area (square km)	The World Bank
7	**IAM**	Imports of agricultural machinery at constant prices (in millions of dinars)	The World Bank and the Central Bank of Tunisia

4. Empirical Analysis

4.1. Unit Root Tests

As pointed out before in the baring of our empirical strategy, we start with the analysis of the stationarity of the variables of the model. To do this we refer to the tests of Dickey and Fuller Augmented (ADF) and Philips Perrons (PP). The ADF and PP tests are tests which aim to detect the non-stationarity of the variables of a time series and to check the variation of the variables over time. All the variables will be tested using three different models noted: (i) model with constant and without trend, (ii) model with constant and with trend, (iii) and model without constant and without trend.

The general form of the ADF test is estimated by the following regression:

$$\Delta Y_1 = a + \beta Y_{t-1} + \sum_{i=1}^{n} \beta_1 \Delta Y_i + \varepsilon_t \qquad (11)$$

For the variables to be stationary, the following two conditions must be observed:

- ✓ ADF statistical test > Critical test at the 1%, 5% or 10% thresholds
- ✓ The probability value must be less than 5%

The general form of the PP test is estimated by the following regression:

$$\Delta Y_t = a + \beta \Delta Y_{t-1} + \varepsilon_t \qquad (12)$$

This is also the case for the PP test, for the variables to be stationary the rule states that:

- ✓ PP statistical test > Critical test at the 1%, 5% or 10% thresholds
- ✓ The probability value must be less than 5%

With:

- Δ: is the first difference operator
- Y: is a time series
- t: is a linear time trend
- α: is a constant
- n: is the optimal number of delays in the dependent variable
- ε: is the random error term.

The results of the ADF and PP stationarity tests are presented in Tables 2 and 3 respectively.

Table 2. Results of ADF Test

Variables	Level								
	Constant			***Constant and linear trend***			***No constant and no linear trend***		
	ADF statistical test	Test critique au seuil 5%	Probability	ADF statistical test	Critical test	Probability	ADF statistical test	Critical test	Probability
Log (AX)	0.538898	2.928142	0.8737	3.911358	3.513075	0.0196	1.288920	1.948313	0.9478
Log (YA)	0.489472	2.928142	0.8837	2.542277	3.513075	0.3075	2.802323	1.948313	0.9984
Log (AM)	1.687903	2.929734	0.4302	5.141184	3.513075	0.0007	0.738879	1.948495	0.8705
Log (AI)	1.799093	2.928142	0.3763	1.998152	3.513075	0.5865	2.484476	1.948313	0.9963
Log (AC)	1.969798	2.928142	0.2987	1.632225	3.513075	0.7641	2.944854	1.948313	0.9989
Log (AL)	0.543572	2.928142	0.8727	2.086902	3.513075	0.5388	1.222233	1.948313	0.9411
Log (IAM)	1.508018	2.928142	0.5205	2.722435	3.513075	0.2330	2.095443	1.948313	0.9904
Variables	**First Difference**								
	Constant			***Constant and linear trend***			***No constant and no linear trend***		
	ADF statistical test	Critical test	Probability	ADF statistical test	Critical test	Probability	ADF statistical test	Critical test	Probability
Log (AX)	9.994087	2.929734	0.0000	9.891418	3.515523	0.0000	9.255278	1.948495	0.0000
Log (YA)	7.146003	2.929734	0.0000	7.063105	3.515523	0.0000	5.950751	1.948495	0.0000
Log (AM)	10.49886	2.929734	0.0000	10.37883	3.515523	0.0000	10.40982	1.948495	0.0000
Log (AI)	6.647300	2.929734	0.0000	6.785048	3.515523	0.0000	5.730109	1.948495	0.0000
Log (AC)	6.902956	2.929734	0.0000	7.195401	3.515523	0.0000	5.726205	1.948495	0.0000
Log (AL)	6.392249	2.929734	0.0000	6.382528	3.515523	0.0000	6.283212	1.948495	0.0000
Log (IAM)	7.411768	2.929734	0.0000	7.421680	3.515523	0.0000	6.526428	1.948495	0.0000
Variables	**Second Difference**								
	Constant			***Constant and linear trend***			***No constant and no linear trend***		
	ADF statistical test	Critical test	Probability	ADF statistical test	Critical test	Probability	ADF statistical test	Critical test	Probability
Log (AX)	10.35329	2.933158	0.0000	10.22357	3.520787	0.0000	10.48030	1.948886	0.0000
Log (YA)	6.883249	2.935001	0.0000	6.795959	3.523623	0.0000	6.975790	1.949097	0.0000
Log (AM)	7.334892	2.935001	0.0000	7.234806	3.523623	0.0000	7.434062	1.949097	0.0000
Log (AI)	8.245838	2.933158	0.0000	8.138842	3.520787	0.0000	8.350833	1.948886	0.0000
Log (AC)	12.74393	2.931404	0.0000	12.58669	3.518090	0.0000	12.89821	1.948686	0.0000
Log (AL)	12.34104	2.931404	0.0000	12.18946	3.518090	0.0000	12.48981	1.948686	0.0000
Log (IAM)	8.663608	2.933158	0.0000	8.538967	3.520787	0.0000	8.784670	1.948886	0.0000

Source: Calculations made by the author on the basis of Eviews 10 software

Table 3. Results of PP Test

Variables	Level								
	Constant			***Constant and linear trend***			***No constant and no linear trend***		
	PP statistical test	Critical test	Probability	PP statistical test	Critical test	Probability	PP statistical test	Critical test	Probability
Log (AX)	0.120445	2.928142	0.9408	3.972504	3.513075	0.0168	1.978327	1.948313	0.9874
Log (YA)	0.397711	2.928142	0.9008	2.586288	3.513075	0.2881	3.324654	1.948313	0.9996
Log (AM)	2.087714	2.928142	0.2504	5.149953	3.513075	0.0007	1.264762	1.948313	0.9455
Log (AI)	1.970071	2.928142	0.2986	2.001424	3.513075	0.5847	2.473465	1.948313	0.9962
Log (AC)	1.969798	2.928142	0.2987	1.597648	3.513075	0.7783	2.775445	1.948313	0.9983
Log (AL)	0.565632	2.928142	0.8680	2.181761	3.513075	0.4878	1.339211	1.948313	0.9525
Log (IAM)	1.736493	2.928142	0.4065	2.711414	3.513075	0.2372	2.633514	1.948313	0.9975
Variables	**First Difference**								
	Constant			***Constant and linear trend***			***No constant and no linear trend***		
	PP statistical test	Critical test	Probability	PP statistical test	Critical test	Probability	PP statistical test	Critical test	Probability
Log (AX)	10.04028	2.929734	0.0000	9.942380	3.515523	0.0000	9.029706	1.948495	0.0000
Log (YA)	7.302009	2.929734	0.0000	7.213511	3.515523	0.0000	5.984427	1.948495	0.0000
Log (AM)	17.78171	2.929734	0.0000	17.72618	3.515523	0.0000	12.57923	1.948495	0.0000
Log (AI)	6.647293	2.929734	0.0000	6.823305	3.515523	0.0000	5.779540	1.948495	0.0000
Log (AC)	6.897522	2.929734	0.0000	7.192893	3.515523	0.0000	5.943282	1.948495	0.0000
Log (AL)	6.402274	2.929734	0.0000	6.465634	3.515523	0.0000	6.283707	1.948495	0.0000
Log (IAM)	8.056615	2.929734	0.0000	8.304311	3.515523	0.0000	6.526751	1.948495	0.0000
Variables	**Second Difference**								
	Constant			***Constant and linear trend***			***No constant and no linear trend***		
	PP statistical test	Critical test	Probability	PP statistical test	Critical test	Probability	PP statistical test	Critical test	Probability
Log (AX)	16.14602	2.931404	0.0000	15.89867	3.518090	0.0000	16.35127	1.948686	0.0000
Log (YA)	41.49538	2.931404	0.0001	42.77095	3.518090	0.0000	42.19271	1.948686	0.0000
Log (AM)	42.71122	2.931404	0.0001	42.17230	3.518090	0.0000	43.30705	1.948686	0.0000
Log (AI)	24.10875	2.931404	0.0001	23.62448	3.518090	0.0000	24.58706	1.948686	0.0000
Log (AC)	27.26968	2.931404	0.0001	26.97965	3.518090	0.0000	27.60203	1.948686	0.0000
Log (AL)	41.18310	2.931404	0.0001	40.60050	3.518090	0.0000	42.12442	1.948686	0.0000
Log (IAM)	36.02939	2.931404	0.0001	41.99590	3.518090	0.0000	30.87986	1.948686	0.0000

Source: Calculations made by the author on the basis of Eviews 10 software

According to these results, it can be concluded that the use of an estimate based on the simple linear regression model will be impossible since all the variables are not stationary in level (except the variable Log (AM). Similarly the application of 'an estimate based on the ARDL model will also be impossible because of the existence of the variables which are integrated of order 2. Since all the variables are integrated of order 1, the Sims model will be retained.

4.2.Cointegration Analysis

To determine the cointegration between the variables of the model, it is necessary to go through two stages. First of all, it is essential to determine the optimal number of delays. Then, we will use the test of Johansen and Juselius to indicate the number of cointegration relations between the variables.

4.2.1. Lag Order Selection Criteria

The selection of the number of lags has a very important role in the design of a VAR model. In practice, it is considered that most of the VAR models interweave the symmetrical shifts, the same shift length is applied to all the variables in all the equations of the model. This delay length is often chosen on the basis of a specific statistical criterion such as HQ, AIC or SIC. In our case, we will use, like many empirical works, the information criterion AIC and the information criterion SC which are presented as follows.

$$\mathbf{AIC = 2k - 2\ ln\ (}L\mathbf{)} \qquad \mathbf{(13)}$$

$$SIC = -2\ (L) + k.\ \ln\ (n) \qquad \mathbf{(14)}$$

Knowing that :

- ✓ L: The maximum values of the likelihood function for the model.
- ✓ K: the number of parameters estimated in the model.
- ✓ n: the number of observations.

Table 4. VAR Lag Order Selection Criteria

Model 1: AX = F (AI,YA,AM,AC,AL,IAM)						
Number of Lags	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	142.6537	NA	4.29e-12	-6.309476	-6.022769*	-6.203747*
1	193.7270	83.14253*	4.02e-12*	-6.405907*	-4.112251	-5.560078
2	235.3540	54.21195	6.80e-12	-6.062978	-1.762374	-4.477048
Model 2: AX= F(YA)						
Number of Lags	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	1.375387	NA	0.003534	0.030469	0.114058*	0.060907
1	7.912813	12.11816*	0.003124*	-0.093308*	0.157459	-0.001993*
2	10.79222	5.056514	0.003306	-0.038645	0.379300	0.113548
3	14.90809	6.826319	0.003302	-0.044297	0.540825	0.168772
4	17.38146	3.860885	0.003585	0.030172	0.782472	0.304119
Model 3: AX= F(AI)						
Number of Lags	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-4.265303	NA*	0.004558	0.284787	0.365886*	0.314862*
1	0.076500	8.091543	0.004489*	0.269250*	0.512549	0.359477
Model 4: AX= F(AM)						
Number of Lags	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-76.79195	NA	0.133855	3.664742	3.746658	3.694950
1	-68.13192	16.11167*	0.107819*	3.447997*	3.693745*	3.538621*
2	-64.90962	5.695232	0.111976	3.484168	3.893750	3.635209
Model 5: AX= F(AC)						
Number of Lags	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-2.988961	NA*	0.004301	0.226771	0.307870*	0.256847*
1	1.195334	7.798004	0.004267*	0.218394*	0.461693	0.308621
Model 6: AX= F(IAM)						
Number of Lags	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-13.26489	NA*	0.006973	0.709995	0.791911*	0.740203*
1	-8.852802	8.208534	0.006843*	0.690828*	0.936577	0.781453
2	-7.327620	2.695670	0.007691	0.805936	1.215517	0.956977
Model 7: AX=F(AL)						
Number of Lags	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	102.6322	NA*	3.18e-05	-4.680566	-4.598649*	-4.650357*
1	107.6394	9.315803	3.03e-05*	-4.727414*	-4.481665	-4.636790
2	108.7685	1.995628	3.47e-05	-4.593884	-4.184303	-4.442843

Source: Calculations made by the author on the basis of Eviews 10 software

In our case, the optimal number of lags is equal to a period (Number of lags = 1). Once the integration order is fixed for each series and the number of shifts is determined, the second step consists of an evaluation of the cointegration properties of the variables.

4.2.2. Johansen Test

Cointegration tests make it possible to see whether the variables, which are individually non-stationary, become stationary when they are combined linearly. Two time series are said to be cointegrated if they have a long-term relationship or an equilibrium relationship, although they can deviate from each other in the short term.

There are many approaches to test for cointegration, such as those of Granger (1987), Johansen (1988), Johansen and Juselius (1990), and Johansen (1991). It is the latter that we will use. It is based on the autoregressive vector (VAR) and it refers to two statistics called (i) the trace statistic (λ_Trace) and (ii) the maximum eigenvalue (λ_Max) which are used to determine the number of vectors of cointegration. In the trace statistics the following VAR is estimated:

$$\Delta \mathbf{y_t} = \mathbf{r_1} \Delta \mathbf{y_{t-1}} + \mathbf{r_2} \Delta \mathbf{y_{t-2}} + \dots \dots \dots .. \mathbf{r_P} \Delta \mathbf{y_{t-p+1}} \quad \textbf{(15)}$$

In the trace statistics the following VAR is estimated:

$$\mathbf{y_t} = \mathbf{r_1} \Delta \mathbf{y_{t-1}} + \mathbf{r_2} \Delta \mathbf{y_{t-2}} + \dots \dots \dots .. \mathbf{r_P} \Delta \mathbf{y_{t-p+1}} \quad \textbf{(16)}$$

Where y_t is the vector of the variables involved in the model and p is the order of self-regression. In Johansen's cointegration test, the null hypothesis indicates that there is no cointegration vector ($r = 0$) and the alternative hypothesis gives an indication of one or more co-integrating vectors ($r > 1$).

To determine the number of cointegration relationships, the decision rule is as follows: If the trace statistic is greater than the critical value, then we reject H_0 so there is at least one cointegration relationship. If the trace statistic is less than the critical value, then H_0 is not rejected, leading to accept that there is no cointegration relation.

Table 5. Results of Trace Test

Trace Test				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
Model 1: AX = F (AI,YA,AM,AC,AL,IAM)				
None *	0.795997	241.3519	125.6154	0.0000
At most 1 *	0.699810	172.9982	95.75366	0.0000
At most 2 *	0.650911	121.2545	69.81889	0.0000
At most 3 *	0.506319	76.00006	47.85613	0.0000
At most 4 *	0.386761	45.64783	29.79707	0.0004
At most 5 *	0.310846	24.62083	15.49471	0.0016
At most 6 *	0.181504	8.612338	3.841466	0.0033
Model 2: AX= f(YA)				
None *	0.481269	53.21788	15.49471	0.0000
At most 1 *	0.440804	24.99398	3.841466	0.0000
Model 3: AX= f(AI)				
None *	0.504711	48.74364	15.49471	0.0000
At most 1 *	0.350114	18.53124	3.841466	0.0000
Model 4: AX= f(AM)				
None *	0.590399	66.28186	15.49471	0.0000
At most 1 *	0.477362	27.90127	3.841466	0.0000
Model 5: AX= f(AC)				
None *	0.479359	39.58124	15.49471	0.0000
At most 1 *	0.234939	11.51537	3.841466	0.0007
Model 6: AX= f(IAM)				
None *	0.507527	57.00930	15.49471	0.0000
At most 1 *	0.460699	26.55173	3.841466	0.0000
Model 7: AX= f(AL)				
None *	0.468355	39.84777	15.49471	0.0000
At most 1 *	0.255404	12.68126	3.841466	0.0004
**** indicates rejection of the hypothesis at 0.05 level***				
***** MacKinnon-Haug-Michelis probability values (1999)***				

Source: Calculations made by the author on the basis of Eviews 10 software

Table 6. Results of Eigen Value Test

Eigen Value Test				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Probability
Model 1: AX = F (AI,YA,AM,AC,AL,IAM)				
None *	0.795997	68.35372	46.23142	0.0001
At most 1 *	0.699810	51.74367	40.07757	0.0016
At most 2 *	0.650911	45.25447	33.87687	0.0015
At most 3 *	0.506319	30.35223	27.58434	0.0215
At most 4	0.386761	21.02700	21.13162	0.0517
At most 5 *	0.310846	16.00849	14.26460	0.0262
At most 6 *	0.181504	8.612338	3.841466	0.0033
Model 2: AX= f(YA)				
None *	0.481269	28.22390	14.26460	0.0002
At most 1 *	0.440804	24.99398	3.841466	0.0000
Model 3: AX= f(AI)				
None *	0.504711	30.21240	14.26460	0.0001
At most 1 *	0.350114	18.53124	3.841466	0.0000
Model 4: AX= f(AM)				
None *	0.590399	38.38059	14.26460	0.0000
At most 1 *	0.477362	27.90127	3.841466	0.0000
Model 5: AX= f(AC)				
None *	0.479359	28.06586	14.26460	0.0002
At most 1 *	0.234939	11.51537	3.841466	0.0007
Model 6: AX= f(IAM)				
None *	0.507527	30.45757	14.26460	0.0001
At most 1 *	0.460699	26.55173	3.841466	0.0000
Model 7: AX= f(AL)				
None *	0.468355	27.16651	14.26460	0.0003
At most 1 *	0.255404	12.68126	3.841466	0.0004
**** indicates rejection of the hypothesis at 0.05 level***				
***** MacKinnon-Haug-Michelis probability values (1999)***				

Source: Calculations made by the author on the basis of Eviews 10 software

According to the Trace test and the Eigen Value test, there are cointegration relationships in the 7 models taken. The error-correcting vector model will therefore be chosen.

4.3.Estimation of the Vector Error Correction Model (VECM)

Based on the results of the unit root and cointegration tests above, the following error correction vector model (VECM) is used to determine the nature of the short-term and long-term relationships between the variables.

4.3.1. Long term relationships

4.3.1.1.Long-term equilibrium equations

The results of the maximum likelihood estimation indicate the relationships of the cointegration equilibrium of each model. Each equation looks like this:

Model 1: AX = F (AI,YA,AM,AC,AL,IAM)

$$\begin{aligned}\text{Log (AX)} &= 0{,}059206 + 5{,}264375 \text{ Log (YA)} - 0{,}222945 \text{ Log (AI)} \\ &\quad + 0{,}038202 \text{ Log (AM)} \\ &\quad + 2{,}326745 \text{ Log (AC)} - 6{,}004121 \text{ Log (IAM)} - 19{,}58857 \text{ Log (AL)}\end{aligned}$$

For the estimation of model 1, the equation of long-term equilibrium shows that:

- ✓ Gross domestic product in the agricultural sector {Log (YA)} has a positive effect on the dependent variable {Log (AX)}; In other words, a 1% increase in gross domestic product in the agricultural sector leads to a 5.264375% increase in agricultural exports.
- ✓ Domestic investment in the agricultural sector {Log (AI)} has a negative effect on the dependent variable {Log (AX); In other words, a 1% increase in domestic investment in the agricultural sector leads to a 0.222945% decrease in agricultural exports.
- ✓ Agricultural imports {Log (AM)} have a positive effect on the dependent variable {Log (AX); In other words, a 1% increase in agricultural imports leads to a 0.038202% increase in agricultural exports.
- ✓ Bank loans to the agricultural sector {Log (AC)} have a positive effect on the dependent variable {Log (AX)}; In other words, a 1% increase in bank loans to the agricultural sector leads to an increase of 2.326745% in agricultural exports.

- ✓ Imports of agricultural machinery {Log (IAM)} have a negative effect on the dependent variable {Log (AX)}; In other words, a 1% increase in imports of agricultural machinery leads to a 6.004121% decrease in agricultural exports.
- ✓ The exploitation of agricultural land {Log (AL)} has a negative effect on the dependent variable {Log (AX); In other words, a 1% increase in the exploitation of agricultural land leads to a 19.58 857% decrease in agricultural exports.

Model 2: AX= f(YA)

$$\text{Log (AX)} = 0.009905 + 0.966004 \text{ Log (YA)}$$

For the estimation of model 2, the equation of long-term equilibrium shows that gross domestic product in the agricultural sector {Log (YA)} has a positive effect on the dependent variable {Log (AX)}; In other words, a 1% increase in gross domestic product in the agricultural sector leads to an increase of 0.966004% in agricultural exports.

Model 3: AX= f(AI)

$$\text{Log (AX)} = 0.113129 - 0.248007 \text{ Log (AI)}$$

For the estimation of model 3, the long-term equilibrium equation shows that domestic investment in the agricultural sector {Log (AI)} has a negative effect on the dependent variable {Log (AX); In other words, a 1% increase in domestic investment in the agricultural sector leads to a 0.248007% decrease in agricultural exports.

Model 4: AX= f(AM)

$$\text{Log (AX)} = -0.070163 + 1.659902 \text{ Log (AM)}$$

For the estimation of model 4, the long-term equilibrium equation shows that agricultural imports {Log (AM)} have a positive effect on the dependent variable {Log (AX); In other words, a 1% increase in agricultural imports leads to a 1.659902% increase in agricultural exports.

Model 5: AX= f(AC)

$$\text{Log (AX)} = 0.090774 + 0.022737 \text{ Log (AC)}$$

For the estimation of model 5, the long-term equilibrium equation shows that bank loans to the agricultural sector {Log (AC)} have a positive effect on the dependent variable {Log (AX)}; In other words, a 1% increase in bank loans to the agricultural sector leads to an increase of 0.022737% in agricultural exports.

Model 6: AX= f(IAM)

$$\text{Log}\,(AX) \;=\; -0.022294 \;+\; 1.221641\,\text{Log}\,(IAM)$$

For the estimation of model 6, the long-term equilibrium equation shows that imports of agricultural machinery {Log (IAM)} have a positive effect on the dependent variable {Log (AX)}; In other words, a 1% increase in imports of agricultural machinery leads to a 1.221641% increase in agricultural exports.

Model 7: AX= f(AL)

$$\text{Log}\,(AX) \;=\; 0.101957 \;-\; 3.532425\,\text{Log}\,(AL)$$

For the estimation of model 7, the long-term equilibrium equation shows that the exploitation of agricultural land {Log (AL)} has a negative effect on the dependent variable {Log (AX); In other words, a 1% increase in the exploitation of agricultural land leads to a 3.532425% decrease in agricultural exports.

To justify the robustness of the results and prove and affirm that these long-term relationships are correct or not, it is necessary to test the significance of each equation.

4.3.1.2.Estimation of long-term equilibrium equations

In the analysis of an estimate based on the error-correcting vector model, the Gauss-Newton method is used to verify the significance of the long-term equilibrium equations. The decision rule is as follows: the error correction term (ECT) must be negative and significant.

In this case the long-term equilibrium equation is significant (that is, all the coefficients included in the long-term equilibrium equation are significant). Without this condition, the long-term equilibrium equation will not be meaningful.

Table.7: Estimation of the long-term equation

Model.1: AX = F (AI,YA,AM,AC,AL,IAM)				
Variables	Coefficient	Std. Error	t-Statistic	Probability
ECT	-0.132512	0.091665	-1.445612	0.1574
Model.2: AX= f(YA)				
Variables	Coefficient	Std. Error	t-Statistic	Probability
ECT	-1.608249	0.356784	-4.507625	0.0001
Model.3: AX= f(AI)				
Variables	Coefficient	Std. Error	t-Statistic	Probability
ECT	-1.439215	0.228426	-6.300565	0.0000
Model.4: AX= f(AM)				
Variables	Coefficient	Std. Error	t-Statistic	Probability
ECT	-0.156114	0.086589	-1.802930	0.0791
Model.5: AX= f(AC)				
Variables	Coefficient	Std. Error	t-Statistic	Probability
ECT	-1.532789	0.257923	-5.942808	0.0000
Model.6: AX= f(IAM)				
Variables	Coefficient	Std. Error	t-Statistic	Probability
ECT	-0.823764	0.345646	-2.383259	0.0221
Model.7: AX= f(AL)				
Variables	Coefficient	Std. Error	t-Statistic	Probability
ECT	-1.532908	0.261924	-5.852487	0.0000
***** ; ** and * denote significances at 1% , 5% and 10% levels respectively***				
ECT: Error Correction Term				

Source: Calculations made by the author on the basis of Eviews 10 software

For model 1 {AX = F (AI, YA, AM, AC, AL, IAM)}, the error correction term is not significant because it has a probability greater than 5% (equal = 0.1574). This shows that the cointegration between agricultural exports, gross domestic product in the agricultural sector, domestic investments in the agricultural sector, bank loans to the agricultural sectors, agricultural imports, imports of agricultural machinery and land use arable is not significant in the long run.

For model 2 {: AX = f (YA)}, the error correction term is significant because it has a negative coefficient (-1.608249) and a significant probability (0.0001). Therefore, we confirm the existence of a long-term relationship between agricultural exports and gross domestic product to the agricultural sector. This means that gross domestic product in the agricultural sector has a positive effect on agricultural exports.

For model 3 {AX = f (AI)}, the error correction term is significant because it has a negative coefficient (-1.439215) and a significant probability (0.0000). Therefore, we confirm the existence of a long-term relationship between agricultural exports and domestic investment in the agricultural sector. This means that domestic investment in the agricultural sector has a negative effect on agricultural exports.

For model 4 {AX = f (AM)}, the error correction term is significant because it has a negative coefficient (-0.156114) and a significant probability (0.0791). Therefore, we confirm the existence of a long-term relationship between agricultural exports and agricultural imports. This means that agricultural imports have a positive effect on agricultural exports.

For model 5 {AX = f (AC)}, the error correction term is significant because it has a negative coefficient (-1.532789) and a significant probability (0.0000). Therefore, we confirm the existence of a long-term relationship between agricultural exports and bank loans to the agricultural sectors. This means that bank loans to the agricultural sector have a positive effect on agricultural exports.

For model 6 {AX = f (IAM)}, the error correction term is significant because it has a negative coefficient (-0.823764) and a significant probability (0.0221). Therefore, we confirm the existence of a long-term relationship between agricultural exports and imports of agricultural machinery. This means that imports of agricultural machinery has a positive effect on agricultural exports

For model 7 {AX = f (AL)}, the error correction term is significant because it has a negative coefficient (-1.532908) and a significant probability (0.0000). Therefore, we confirm the existence of a long-term relationship between agricultural exports and the exploitation of arable land. This means that the exploitation of arable land has a negative effect on agricultural exports.

4.3.2. Short term relationships

Granger causality tests applied in the error correction vector model will be conducted to examine the short-term effects.

For the existence of a short-term causal relationship, the following assumption is applied: If there is a probability of less than 5%, then the independent variable causes the dependent variable. On the other hand, if there is a probability greater than 5% in this case, the absence of a short-term causal relationship can be noted.

In the short term, Table 7 shows that domestic investments in the agricultural sector cause agricultural exports to Tunisia. In contrast, gross domestic product in the agricultural sector, bank loans to the agricultural sectors, agricultural imports, imports of agricultural machinery and the exploitation of arable land do not cause agricultural exports.

Table 8. Results of WALD Test

Model.1: AX = F (AI,YA,AM,AC,AL,IAM)	
Dependent variable: Log (AX)	
Independent variable	Probability
Log (YA)	0.3314
Log (AI)	0.7123
Log (AM)	0.2643
Log (AC)	0.8385
Log (IAM)	0.3848
Log (AL)	0.2158
Model.2: AX= f(YA)	
Dependent variable: Log (AX)	
Independent variable	Probability
Log (YA)	0.7214
Model.3: AX= f(AI)	
Dependent variable: Log (AX)	
Independent variable	Probability
Log (AI)	0.0059
Model.4: AX= f(AM)	
Dependent variable: Log (AX)	
Independent variable	Probability
Log (AM)	0.2710
Model.5: AX= f(AC)	
Dependent variable: Log (AX)	
Independent variable	Probability
Log (AC)	0.2064
Model.6: AX= f(IAM)	
Dependent variable: Log (AX)	
Independent variable	Probability
Log (IAM)	0.2039
Model.7: AX= f(AL)	
Dependent variable: Log (AX)	
Independent variable	Probability
Log (AL)	0.7472
* ** ; ** and * denote significances at 1% , 5% and 10% levels respectively	
Values in parentheses are P-values of the Granger causality test / Wald test for short-term relationships	

Source: Calculations made by the author on the basis of Eviews 10 software

4.4. Checking the quality of the model

To ensure the relevance of our empirical results, we must apply a set of tests to verify the robustness and credibility of our model and the results of our estimation. These are diagnostic tests and model stability test.

4.4.1. Diagnostic tests

In the approach adopted, it is necessary to carry out diagnostic tests. The latter show that the approach respects the assumptions related to normality (Jarque Bera test), homoscedasticity (Breusch-Pagan-Godfrey, Harvey, Glejser and ARCH heteroscedasticity test), absence of correlation (LM correlation test) and adjustment (Coefficient of determination and the Fisher test).

Table 9. Diagnostic Tests

R²	0.607602	**R² adjusted**	0.515273
F-statistic	6.580844	**Probability (F-statistic)**	0.000035
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.749829	Probability (F-statistic)	0.7424
Heteroskedasticity Test: Harvey			
F-statistic	1.159157	Probabilité (F-statistic)	0.3691
Heteroskedasticity Test: Glejser			
F-statistic	1.042040	Probability (F-statistic)	0.4629
Heteroskedasticity Test: ARCH			
F-statistic	1.475711	Probability (F-statistic)	0.2316
Breusch-Godfrey Serial Correlation LM Test			
F-statistic	9.648086	Probability (F-statistic)	0.0039
Test of Normality			
Jarque-Bera	3.203567	Probability	0.201537

Source: Calculations made by the author on the basis of Eviews 10 software

Diagnostic tests show that the estimation results are acceptable and that the model meets the conditions for applying OLS. In fact, the probabilities of heteroskedasticity tests are greater than 5%, and those of the Fisher test are generally less than 5%, the adjusted coefficients of determination R^2 are close to or greater than 50%, and the Normality test (Jarque - Bera test) shows that the residuals follow the normal law.

4.4.2. The stability of the VECM model

To check the stability of our model, we apply the stability tests which are the "CUSUM" and the "CUSUM square". The two graphs below show that our model is stable and indicate that our model is stable.

Figure 1: CUSUM Test

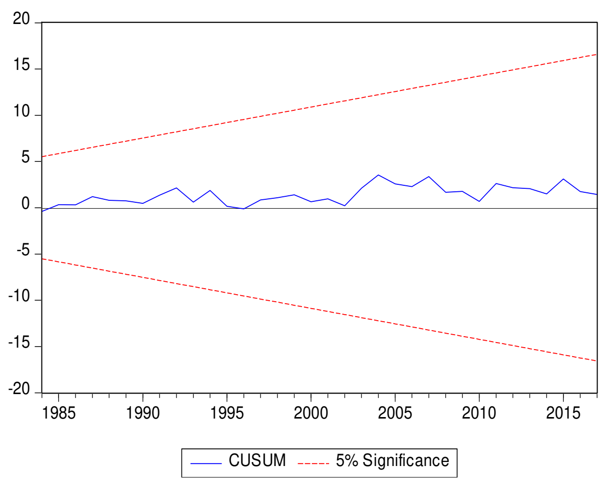
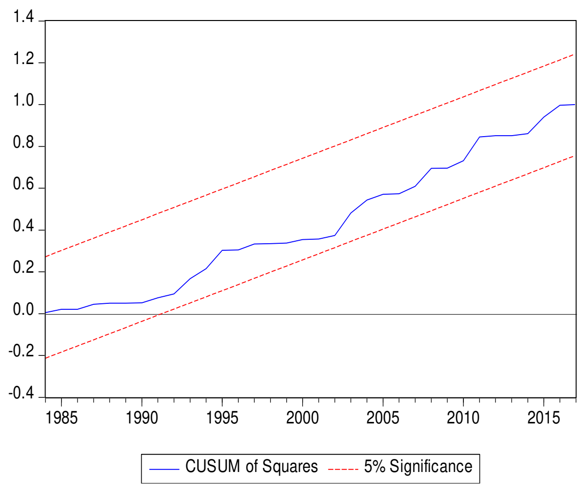


Figure 2: CUSUMQ Test



5. Conclusion

The objective of this article has been to identify the determining exports to Tunisia. To achieve this goal, we used annual data relating to the period 1972-2017. Our estimates were based on an error-correcting vector model to determine long-term and short-term relationships.

In our model, we sought to explain agricultural exports by gross domestic product, domestic investment in the agricultural sector, agricultural imports, bank loans to the agricultural sectors, imports of agricultural machinery and the exploitation of arable land. We used 7 ad hoc specifications to examine the determinants of long-term and short-term agricultural exports. The empirical results show that the cointegration between agricultural exports, gross domestic product in the agricultural sector, domestic investments in the agricultural sector, bank credits to the agricultural sectors, agricultural imports, imports of agricultural machinery and the exploitation of arable land is not significant in the long run. However, when we try to explain the determinants that influence agricultural exports, each is independent of the other in order to obtain a very favorable degree of freedom in our empirical analysis. The empirical results of estimating each equation show us that gross domestic product in the agricultural sector, agricultural imports, bank loans to the agricultural sector and imports of agricultural machinery have a positive effect on agricultural exports in the long run. Conversely, domestic investment in the agricultural sector and the exploitation of agricultural land have a negative effect on agricultural exports in the long term. In the short term, only domestic investments in the agricultural sector cause agricultural exports.

These results are explained by the development model chosen. The latter is based on a strong mobilization of natural resources and a gradual disengagement of the State from the agricultural sector which has reached its limits. It is no longer able to cope with the new context characterized by greater instability in international markets. The development of Tunisian agricultural exports today faces a number of structural constraints. Among these challenges we can note:

(1) The strong pressure on natural resources leads to the degradation of certain ecosystems. another challenge is the strong growth in imports of certain basic products, which has led to a deterioration in food security conditions and a decrease in the value of exports.
(2) The absence of the state’s oversight role in order to control the market and prevent brokers and intruders in raising prices without objective reasons, as well as combating the smuggling of agricultural products to neighboring countries
(3) The low valuation of exported products and the difficult control of export markets (whose price volatility is high) jeopardizes producers' strategies.
(4) The institutional framework of agrarian structures is ineffective and greatly limits the development effort.
(5) Price war
(6) Increased trade incentives
(7) The lack of skilled manpower for the agriculture department
(8) Lack of marketing information, which causes difficulty in exporting.

(9) The weakness of the policy of promotion and advertisement as a result of the weakness or lack of advertisement through modern means of communication, such as websites
(10) The control of large producers and exporters, and their greater benefit from the price difference, at the expense of small producers
(11) Lack of distinguished relations between exporters and importers
(12) Bureaucratic legislation prevails, which impedes the easy access of exports to importers and in a timely manner
(13) The lack of cash flow and the low possibility of using insurance systems are two factors which severely limit private agricultural investment.
(14) Lack of labor in the agricultural sector and a preference for work in other sectors, such as the services sector or the industrial sector due to weak wages and the lack of social insurance for workers in the agricultural sector.
(15) Lack of water resources due to the scarcity and scarcity of water resources and the failure to build and maintain enough dams.
(16) The lack of agricultural support services by the state, such as equipment, fertilizers and agricultural guidance.
(17) High costs of transportation and freight.
(18) Extensive agricultural and technical conditions in some countries, especially the European Union.
(19) Weak banking services and the weight of procedures related to the settlement of export operations, and the existence of significant restrictions for obtaining financial receivables in hard currency.
(20) The poor organization of the sectors leads to the stagnation of agricultural exports.

The various problems and challenges mentioned above call for an update of the agricultural trade policy within the framework of the global economic policy and especially the agricultural export policies. This update aims to renew the methods of implementing agricultural policy in order to achieve effective responsiveness of the institutional framework in the face of changes in the national and international context. These methods aim to:

(1) Dependence on modern agricultural methods, especially in the field of production, irrigation, fertilization and agricultural extension support

(2) Urging rational exploitation of agricultural resources such as land and water by building dams to exploit rain water
(3) Extending unused land reclamation and preventing urban sprawl on fertile agricultural lands
(4) Attention to international marketing research and the establishment of a marketing information system in order to know: the nature of the consumer and its tastes, the volume of demand, laws and standards that must be respected to enter the international market.
(5) Carrying out an effective promotion policy to introduce the national product to the international market by advertising and selecting the most influential and widespread means of communication in the global market.
(6) Facilitating customs procedures and standardizing national products.
(7) Conducting research to assess export potential, study export incentives, and organize trade and promotional missions.
(8) Benefiting from the experiences of the leading export countries
(9) Expanding the exploitation of more agricultural lands and reclaiming new lands in order to double the production
(10) Which leads to an excess of domestic consumption directed to export
(11) Given the rapid deterioration of agricultural products, we recommend the importance of providing cold stores either in production areas or when marketing in order to preserve it and deliver to the consumer in good conditions.
(12) Improve the efficiency and coordination of State interventions;
(13) Improve the organization of supply chains
(14) strengthening the participation of rural populations;
(15) Guide the behavior of stakeholders towards sustainable management of natural resources.
(16) Improve access to suitable credit and insurance instruments;
(17) Improve the competitiveness of the national offer;
(18) Stabilize the national supply of agricultural products;
(19) Adopt a trade policy consistent with the objectives of the agricultural policy;
(20) Promote access to sufficient food, of guaranteed and balanced quality.
(21) The protection of irrigation water against pollution.

(22) Maintaining the demand for irrigation water at a level compatible with long-term available water resources.
(23) Develop the risk management system such as drought protection mechanisms and credit rationing

At the end of this article, we are aware that the relevance of our results and recommendations remains limited, both by the methodology adopted and by the availability of data. Indeed, our methodology does not take into account several determinants of agricultural exports. Also, it is on the basis of intuitions leading to estimate seven ad-hoc specifications. The development of a theoretical model dealing with the determinants of agricultural exports or the adoption of a microeconomic approach based on a field survey are possible avenues that can lead to more relevant results.

It is important to note that the outcome of one of the research avenues envisaged would be largely dependent on the availability of data. The latter constituted for us a very constraining factor in the conduct of our research, because we had to consult, for several variables, different data sources to build the time series necessary for the estimates.

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