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Testing the causal relationship between Exports and Imports using a Toda-Yamamoto approach: Evidence from Tunisia

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***Abstract*—The aim of this paper is to investigate the direction of causality between imports and exports in Tunisia using monthly data covering the period from January 2005 to August 2013 within a vector autoregressive (VAR) framework. The order of integration of the variables is initially determined using unit root tests. The tests reveal that the variables are non-stationary at their levels but stationary at their first differences, being integrated of order one, I(1). Applying a modified version of the Granger causality test due to Toda and Yamamoto [20], we found a bi-directional causality between imports and exports. This result reveals that Tunisia is still relying on the imports of items, good and services to promote the development of its exports sector. It would, thus, beneficial for Tunisia to enhance the country’s international trade competitiveness in order to reduce the current account deficits. The most convenient method for this is to put emphasis on research development and to produce export products which have high value added and which rely on science and technology.**

***Keywords*—Exports, Imports, Tunisia, VAR models, Granger causality, Toda-Yamamoto approach.**

I. Introduction

THE relationship between exports and imports is one of major interest. They together play an integral role in determining the trade balance of a country. In this respect the dynamics of relationship between these variables hold significant importance and attract the researchers for testing the nature of relationships between exports and imports. For this reason, the main objective of this paper is to investigate the direction of causality between imports and exports in Tunisia using monthly data covering the period from January 2005 to August 2013. This study has too main objectives. The first is to examine whether there exists any relationship between exports and imports for Tunisia. The second is to analyze the pattern of causality between exports and imports. Testing causality among variables is one of the most important and, yet, one of the most difficult issues in economics.

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We have chosen Tunisia as a case study for several reasons. First, because it is a small and open developing country and an export-oriented country, in the process of liberalizing its economy. Over the last three decades, Tunisia has experienced extensive and rapid trade liberalization, undertaken both in the context of multilateral trade negotiations and as part of the conditionality linked to structural adjustment and stabilization programmes agreed with the International Monetary Fund and the World Bank. For industrial imports, Tunisia is committed to a gradual elimination of tariffs and to the abolition of any quantitative restrictions that have the same effects as tariffs. Accordingly, the promotion of exports has been a decisive factor for improving economic growth and external payments, as part of the trade reform started in 1987. Concerning export policies, the Tunisian government implemented and heavily promoted tax incentives for export-oriented firms in the early 1970s. The most significant measure was the ”1972 law”, which encouraged exports and foreign direct investment through fiscal incentives to foreign and local exporters. In addition to these measures, the Tunisian state created supporting institutions such as the Fonds de Promotions des Exportations (FOPRODEX) and the Fonds d’Accs aux Marchs d’Exportations” (FAMEX), which provides market information, loan guarantees, and technical support around trade logistical issues to facilitate export market penetration.

Secondly, despite the change and diversification observed in the Tunisia’s export economy, with significant exports in the oil and petrochemicals sectors, garments, electrical appliances and equipment, and agricultural products, trade balance remains the vast majority component of the current account balance. As in many developing countries, the resilience of exports and the drop in demand for imports averted an even stronger deterioration. Evidently, in 2011, the Tunisian current account deficit widened substantially to $7,3$ percent of GDP. Thirdly, the choice of this country is also motivated by the fact that no known substantial study has been conducted to examine the relationship between imports and exports in Tunisia. One of the purposes of this paper is therefore to examine whether there is a long-run or a casual relationship between Tunisia’s imports and exports. From a policy perspective, knowledge of the direction of causality between imports and exports is essential for the design and evaluation of current and future macropolicies aimed at achieving the trade balance.

Indeed, the link between imports and exports is not a new concern. Several empirical studies have been conducted to examine the relationship between the two variables over the past few decades. Yet there seems to be no consensus regarding the direction of causality between imports and exports. For some countries there is a bi-directional causality while for others there is no causality at all. Still for some countries there is a unidirectional causality running from imports to exports while for others there is the opposite causality running from exports to imports. As this paper examines the causality relationship in Tunisia, we tried to focus on recent studies especially about countries with developing economies such as Tunisia. Thus, we had an opportunity to compare the results from Tunisia and similar countries.

[10] analysed the cointegration and causality between exchange rate, imports and exports for Turky. Their results supported a long-run relationship and bidirectional causality between the two variables. In another recent study, [8] explored the relationship between imports and exports for Turky over the period 1982-2005. By using the cointegration and error-correction analysis, they showed that imports and exports are cointegrated, and long-run relationship between them exists. The more recent study conducted by [23] for Turkey shown that there is long run relationship between export and import. [1] investigated the presence of equilibrium relationship between exports and imports in 50 countries over the quarterly period 1973M02 to 1998M01. The author reported different results from the use of different methodologies. By using the Johansen cointegration method, [1] found that the variables are cointegrated in 35 of the 50 countries. However, using the Stock and Watson test revealed that imports and exports are cointegrated, not just in low-income countries but in middle-income and high-income countries as well (except Mexico).

[6] examined the causality between imports and exports for Chile over the sample period of 1960-2000. Cointegration and Granger causality tests indicated a unidirectional causality running from exports to imports. [27] applied the cointegration theory to examine the causal relationship between exports and imports of Indonesia and Malaysia. Their estimates indicated that exports and imports for Malaysia were cointegrated, but were not found in the case of Indonesia.

[28] applied the autoregressive distributed lag (ARDL) bounds testing approach to investigate the long-run relationship between manufacturing exports and imports of capital good for Thailand. By using monthly data from January 2000 to July 2011, cointegration was established between manufacturing exports and imports of capital good. To compliment the above results the author also carried out causality tests and found evidence of a unidirectional causality running from imports to growth rate of manufacturing output. This result imply that Thailand cannot reduce imports of capital goods for its effect on reducing manufacturing output and exports will decrease.

[29] examined the long-run relationship between between exports and imports in India using annual data for the period from 1949/50 - 2004/05. Johansen cointegration method was used, and variables were found to be no cointegrated.. The paper concluded that Indian exports and imports do not exhibit a cointegration relationship and therefore, India is in violation of its international budget constraint. Recently, [31] tested the causal relationship exports and imports in Qatar's economy over the period 1980-2011. By using a vector error correction model (VECM), they showed that imports are causal to exports.

A literature review suggests that there is a lack of empirical study concerning the relationship between imports and exports in Tunisia. To the best knowledge of the authors, only two studies have considered it. First, [18] applied the autoregressive distributed lag (ARDL) bounds testing approach on 1960-2008 data for Tunisia to explore the existence of long-run equilibrium among exports, imports and GDP. Their estimates indicate that there is bidirectional causality between exports and imports. In another recent study, [16] examined export-led growth (ELG) hypothesis in Tunisia and Morocco for the period 1961-2011. Toda-Yamamoto's (1995) version of the Granger causality test was used for testing the direction of causality between exports, imports and economic growth and they discovered evidence of the existence of a unidirectional causal relationship between imports and exports and another unidirectional relationship between exports and economic growth.

To summarise the literature review, there has been an explosion of research on the relationship between imports and exports, but the existing research efforts failed to provide clear evidence on the direction of causality between these two variables. The diversity of the empirical findings, together with the important role of imports and exports play in determining the trade balance of a country, not only necessitates further research but also new methodologies for testing the relationship between imports and exports. Therefore keeping in view all this, the current study investigates the causal relationship between imports and exports in Tunisia by employing a modified version of the Granger causality test due to Toda and Yamamoto [20]. This procedure has been found to be superior to ordinary Granger- causality tests since it eliminates the need for pre-testing for cointegration and therefore avoids pre-test bias and is applicable for any arbitrary level of integration for the series used. Also, the Toda-Yamamoto approach is useful because it fits a standard vector autoregressive model in the levels of the variables (rather than the first differences, as the case with Granger causality tests) thereby minimising the risks associated with the possibility of wrongly identifying the order of integration of the series ([12]). The remainder of the paper is organized as follows. Sections 2 discuss the data and econometric techniques employed by this study. Section 3 presents our empirical results and section 4 concludes.

II. Data and empirical methodology

A. Data

We employ monthly data for Tunisia exports and imports for the period 2005M01-2013M08. Two data set have been taken from the National Institute of Statistics of Tunisia (INS). The series were transformed into log form. A basic advantage of transformation into logarithms is the reduction of heteroscedasticity problem.

According to data released by the National Institute of Statistics (INS), the Tunisia's trade deficit has steadily increased considerably from $3497,9$ (MTD) in 2005 to $11630,3$ in 2012. More specifically, during the first 11 months of 2012, following the 14 January 2011 revolution, this deficit has widened considerably ranging from $10703,800$ (MTD) to $7828,3$ against the same period of 2011. This deficit is due, to a large increase in imports of $14,1\%$ while exports evolved only $6,3\%$. The coverage of imports by exports has therefore lost $5,1$ percentage points to $69,3\%$ in 2012 against $74,4\%$ compared to the same period of 2011, despite years of the revolution. Hence, the worsening of the Tunisia's trade deficit must have an impact on its foreign currency reserves and balance of payments deficit which must widen to $7,5\%$ this year according to international rating agencies. As shown in the figure (fig.1), there is dependence between exports and imports during the period 2005-2013.

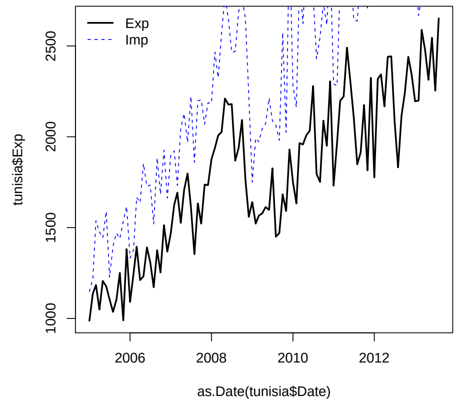

Fig. 1. Export and Import in Tunisia (2005M01-2013M08)

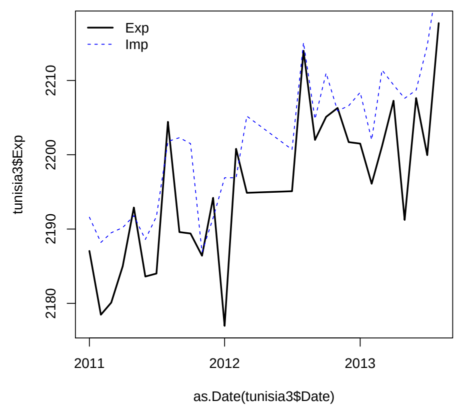

Fig. 2. Export and Import in Tunisia (2011M01-2013M08)

The figure (fig.2) shows that imports and exports exhibits strong upward trends for the period 2011M01-2013M08, the period after the revolution. This provides anecdotal evidence that the two series tend to move together. As it can also be seen in the graphic, import has always increased at a higher pace than the export. The main cause of this is the dependency of export to the import in Tunisia. According to the above graphic, it is observed that, in the first half of year 2012, export reached the low level in the period, but afterwards it again increased quickly. Thus the foreign trade deficit is also maximum. On the other hand, in the second half of year 2012, import and export reached the highest level in the period. Although, the foreign trade deficit is also minimum in this year. But the foreign trade deficit is maximum in the first half of year 2013. For most years, imports have exceeded exports, leading to balance of trade deficit.

B. Granger causality based on Toda-Yamamoto methodology

As regards the causality test method, several tests have been developed later in the literature. Granger causality [4] is one of the earliest methods developed to quantify the causal effect from time series observations. Causality testing in Granger sense is conventionally conducted by estimating VAR models. But this model still suffers of the non stationary problem. The most difficult parts of testing multivariable Granger causality are how to confirm the cointegrating relationship and how to estimate the VAR accurately when its system is integrated. [3] and [21] have shown that the Wald test for non-causality in an integrated or cointegrated unrestricted VAR system will have nonstandard limit distributions. [33] stated also that if the Granger causality test is conducted at first difference VAR framework then it will be misleading in the presence of cointegration. Therefore, the inclusion of an additional variable, such as the error- correction term, would help us to capture the long-run causal relationship. Taken these limitations cautiously, new developments in econometrics offer the ECM model (due to [33]) and the VECM Model (due to [32]) as alternatives for the testing of non-causality between economic time series. It has been noted that the validity of the causality test is conditional on avoiding biases in testing for unit root and cointegration among the variables. Unfortunately, these tests are sensitive to the values of trend and constant terms in finite samples and thus not very reliable for typical time-series sample sizes. Moreover, as demonstrated by [20], the conventional F-statistic used to test for Granger causality may not be valid as the test does not have a standard distribution when the time series data are integrated or cointegrated.

To obviate some of these problems, [20] propose an interesting yet simple procedure requiring the estimation of an augmented VAR irrespective of whether the time series is integrated or cointegrated. The underline objective of the Toda-Yamamoto causality test is to overcome the problem of invalid asymptotic critical values when causality tests are performed in the presence of nonstationary series or even cointegrated. One advantage of [20] procedure is that it makes Granger Causality test easier. Researchers do not have to test cointegration or transform VAR into VECM. Before making a description of this study's empirical model, this section simply illustrates the rationale of Toda and Yamamoto procedure.

[20] procedure uses a Modified Wald (MWALD) test for restrictions on the parameters of the VAR(p) model. This test has an asymptotic chi-squared distribution with p degrees of freedom in the limit when a VAR $[p + d_{max}]$ is estimated (where d_{max} is the maximal order of integration for the series in the system). Three stages are involved with implementing the procedure. The first stage, test each of the time-series to determine the maximum order of integration d_{max} of the variables in the system. Ideally, this should involve using a test, such as the Augmented Dickey-Fuller (ADF) ([5]) and Phillips-Perron (PP) ([30]) tests, for which the null hypothesis is non-stationarity; as well as a test, such as the Kwiatkowski, Phillips, Schmidt and Shin test (KPSS) ([7]), for which the null is stationarity.

The second stage includes the determination of the optimal lag length (p). The lag length (p) is always unknown and therefore has to be obtained in the process of the VAR in levels among the variables in the system by using different lag length criterion such as the Aikaike's information criterion (AIC) ([14]), Schwarz information criterion (SC) ([13]), final prediction error (FPE) ([15]) and Hannan Quinn (HQ) ([9]) Information Criterion. The third stage uses the modified Wald procedure to test the VAR (k) model for causality. The optimal lag length is equal to $k = (p + d_{max})$.

In order to test for [20] based Granger causality between two variables the study estimates the following bivariate VAR (k) Model:

$$X_t = \alpha_1 + \sum_{i=1}^{h+d} \beta_{1i} X_{t-i} + \sum_{j=1}^{l+d} \gamma_{1j} Y_{t-j} + \epsilon_{1t}, \tag{1}$$

$$Y_t = \alpha_2 + \sum_{i=1}^{h+d} \beta_{2i} Y_{t-i} + \sum_{j=1}^{l+d} \gamma_{2j} X_{t-j} + \epsilon_{2t}. \tag{2}$$

Where d is the maximal order of integration order of the variables in the system, h and l are the optimal lag length of X_t and Y_t, are error terms ϵ_{1t} and ϵ_{2t} and that are assumed to be white noise with zero mean, constant variance and no autocorrelation.

We can obtain two tests from this analysis. For the first equation, the null hypothesis can be drawn as,
$H_0 : Y_t$ does not Granger-cause X_t, if $\sum_{j=1}^{l} \gamma_{1j} = 0$,
against the alternate hypothesis
$H_1 : Y_t$ does Granger-cause X_t, if $\sum_{j=1}^{l} \gamma_{1j} \neq 0$.
For the second equation, the null hypothesis is
$H_0 : \sum_{j=1}^{l} \gamma_{2j} = 0$ or X_t does not Granger-cause Y_t,
against the alternative hypothesis,
$H_1 : \sum_{j=1}^{l} \gamma_{2j} \neq 0$ or X_t does Granger-cause Y_t.

If we fail to reject the former null hypothesis and reject the latter, then we conclude that X_t changes are Granger caused by a change in Y_t. Unidirectional causality will occur between two variables if either null hypothesis of equation (1) or (2) is rejected. Bidirectional causality exists if both null hypotheses are rejected and no causality exists if neither null hypothesis of equation (1) nor (2) is rejected.

III. Empirical findings

The main goal of the study is to investigate the nature of the relationship between exports and imports and to identify any possible direction of causality between them. To do so, we use a modified version of the Granger causality test, which requires information about the lag length (p) and the maximum order of integration (d_{max}) of the two variables.

Before conducting any causality testing it is important to determine the order of integration of the series (d_{max}) and the optimal lag length k, in order to avoid spurious causality or spurious absence of causality ([24]). Using several unit root tests (ADF, PP and KPSS), we found that the variables are non-stationary at their levels but stationary at their first differences, being integrated of order one, I(1). Therefore, the maximum order of integration for the variables in the system is one $d_{max} = 1$. Results of unit root tests are presented in table (I).

The second step in testing for causality is to investigate the optimum lag length (p) chosen by AIC, FPE, SC and HQ. Ganger causality test is very sensitive to the selection of lag length. If the chosen lag length is less than the true lag length, the omission of relevant lags can cause bias. If the chosen lag length is more, the irrelevant lags in the equation cause the estimates to be inefficient ([11]). The table (II) reports the optimal lag length of two $(p = 2)$ out of a maximum of 5 lag lengths as selected by AIC and HQ is found to be 2.

TABLE I. ADF, PP and KPSS unit root tests

	ADF		PP		KPSS	
	Exp	Imp	Exp	Imp	Exp	Imp
Level	0.611	0.876	2.813	4.130	2.848	3.147
Δ	-9.30^{**}	-10.18^{**}	-6.50^{**}	-9.05^{**}	0.04^{*}	0.03^{*}

** and * denote rejection of the null hypothesis at the 1% and 5% respectively.

TABLE II. LAG LENGTH SELECTION

Lag	AIC	HQ	SC	FPE
1	2.10878e+01	2.12727e+01	2.12975e+01*	1.44007e+09
2	2.09136e+01*	2.11409e+01*	2.14282e+01	1.47802e+09
3	2.10810e+01	2.12507e+01	2.15004e+01	1.43116e+09*
4	2.11459e+01	2.13580e+01	2.16701e+01	1.52811e+09
5	2.11119e+01	2.13664e+01	2.17410e+01	1.47855e+09

$*$ indicates lag order selected by the criterion

The final step in this study is to verify the direction of causality between exports (Exp) and imports (Imp) using the Toda and Yamamoto causality test. The empirical results of Granger Causality test based on [20] methodology is estimated through MWALD test and reported in Table (III). The estimates of MWALD test show that the test result follows the chi-square distribution with 3 degrees of freedom in accordance with the appropriate lag length along with their associated probability.

To undertake the Toda and Yamamoto version of the Granger non-causality test, for VAR (3), ($d_{max} = 1$ and $p = 2$), we estimate the following system equations:

$$\begin{bmatrix} Exp_t \\ Imp_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \sum_{i=1}^{3} \begin{bmatrix} Exp_{t-i} \\ Imp_{t-i} \end{bmatrix} \begin{bmatrix} \beta_{1i} & \gamma_{1i} \\ \beta_{2i} & \gamma_{2i} \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix} \quad (3)$$

where: $E(\varepsilon_t) = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} = 0$ and $E(\varepsilon_t, \varepsilon_t^{'}) = \Sigma$.

To test that imports does not Granger cause exports, we estimate the VAR (3) model and test that Imp_{t-1} and Imp_{t-2} does not appear in exports equation. Thus the null hypothesis is $H_0 : \gamma_{11} = \gamma_{12} = 0$. Similarly, the second null hypothesis that Exp_{t-1} and Exp_{t-2} does not appear in imports equation. Thus the null hypothesis is $H_0 : \beta_{21} = \beta_{22} = 0$.

The existence of causality between exports and imports can be established through rejecting the above null hypothesis which requires finding the significance of the MWALD statistic for the group of the lagged independent variables identified above.

However, causality will be tested in four possible ways. Firstly, for the existence of Wagner's law with the possibility of unidirectional causality from exports to imports. Secondly, unidirectional relationship for the existence from imports to exports. Thirdly, for the existence of bidirectional causality, that is the feedback of both variables and finally, lack of any causal relationship among variables. Table (III) provides the results of the causal relationships between variables.

The results reveal causality between exports and imports. The results show that we can reject the null hypothesis that exports does not cause imports at 5% level of significance. Also, we can reject the null hypothesis that imports does not cause exports at 1% level of significance. Thus, we can conclude that there is a bi-directional direction of causality between exports and imports.

TABLE III. TODA-YAMAMOTO TESTS OF GRANGER CAUSALITY

Null Hypothesis	MWald	p-values	Decision
H_0 : Exp does not Granger cause Imp	22.5	0.0399	Reject H_0
H_0 : Imp does not Granger cause Exp	19.8	0.009	Reject H_0

IV. CONCLUSIONS

The study has investigated the nature and the direction of causality between exports and imports of Tunisia by using monthly data for the period 2005M01-2013M08. A modified version of the Granger causality test proposed by Toda and Yamamoto ([20]) is applied for testing the bilateral causality between the two variables.

The empirical results point out that there is evidence of bi-directional causality between exports and imports in Tunisia for the mentioned time period. This result joints the same finding of [18] and differs from the recent study of [16]. The important implication of this finding is that in, Tunisia, there is a simultaneous cause and effect between imports and exports. This simultaneity arises from the fact that export depends on import and export increase occurs along with the import increase.

This result reveals that Tunisia is still relying on the imports of items, good and services to promote the development of its exports sector. The major policy implication derived from this analysis is that Tunisia cannot reduce imports of capital goods for its effect on reducing manufacturing output and exports will decrease. Hence, Tunisian policymakers should take into consideration of this conclusion and should adopt more structural reforms to enhance export capacity and productivity of manufacturing and industrial sector. This can be done by increasing vocational training, seeking partnerships with science and technology companies and producing export products which have high value added. Ties between universities and local industry are also important for industrial cluster development.

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