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Abstract

In spite of the rapid diversification of Tunisia's production bundle, the agricultural sector remains socially and economically important. Self-sufficiency in some basic food products is also an important national objective that partly guides Tunisia's agricultural policies. However, Tunisia's structural reforms have been accompanied by a stabilization of its real exchange rate, which prior to the reforms and in the initial phases of the reforms depreciated quite rapidly. The impact of this change in real exchange rate policies on the net external position of the agricultural sector is ambiguous, partly because it is not clear that the Marshall-Lerner conditions are satisfied, and partly because at the sector level general equilibrium effects may lead to a deterioration of a sector's net external position following a real exchange rate depreciation. The objective of this paper is to empirically examine the impact of the early depreciation of Tunisia's dinar (and its stabilization more recently) on the net external agricultural balance. Results suggest that the depreciation of Tunisia's exchange rate led in the long-run to a decline in the external net agricultural position of Tunisia, potentially jeopardizing other government objectives for the agricultural sector. Thus, the recent stabilization of the real exchange rate has helped, not hurt, the government achieve its non-economic objectives for the agricultural sector.

ملخص

على الرغم من التنويع السريع لحزمة الانتاج في تونس ،الا ان القطاع الزراعي لا يزال اجتماعيا واقتصاديا هاما .الاكتفاء الذاتي في بعض المنتجات الغذائية الأساسية هو أيضا هدفا هاما الوطنية والذى يوجه جزئيا السياسات الزراعية في تونس .ومع ذلك ، فقد رافق الإصلاحات الهيكلية في تونس من استقرار سعر الصرف الحقيقي، والذي استهلك بسرعة كبيرة في المراحل الأولية من الإصلاحات . أثر هذا التغيير في سياسات سعر الصرف الحقيقي على صافي الموقف الخارجي للقطاع الزراعي لا يزال غامضا ، ويرجع ذلك جزئيا لامكانية عدم استيفاء شروط مارشال ليرنر، ويرجع ذلك جزئيا ايضا لأنه آثار التوازن العام على مستوى القطاع يمكن أن تؤدي إلى تدهور الموقف على صافي القطاع الخارجي بعد انخفاض سعر الصرف الحقيقي .الهدف من هذه الورقة هو اجراء دراسة تجريبية لأثر انخفاض قيمة الدينار في وقت مبكر من تونس (واستقراره في الآونة الأخيرة) على صافى الرصيد الخارجي للزراعة . تشير النتائج إلى أن انخفاض سعر الصرف في تونس في المدى الطويل قد يؤدى الى تراجع في صافى الموقف الخارجي للمنتجات الزراعية في تونس، مما يهدد أهداف حكومية أخرى محتملة للقطاع الزراعي .وهكذا، فقد ساعد الاستقرار الأخير في سعر الصرف الحقيقي ، الحكومة لتحقيق أهدافها غير الاقتصادية للقطاع الزراعي.

1. Introduction

In 1986 Tunisia engaged in a series of broad economic reforms aimed at converting a highly regulated, inward-looking economy into a significant more open, export-oriented one.[1] Trade liberalization and exchange rate policies have been a prominent component of these reforms that have allowed the Tunisian economy to diversify becoming less vulnerable to external shocks. In spite of the diversification of Tunisia's production bundle, the agricultural sector remains socially and economically important. Agriculture contributes around 13% to Tunisia's GDP and employs about 16% of its labour force. More importantly perhaps it contributed to 25% of new jobs during the 9th Plan period (1997-2001), and about half of the average Tunisian household's expenditure is related to food products (World Bank, 2006). Food security and regional and social cohesion are important national objectives that guide Tunisia's agricultural policies, which aim at reaching self-sufficiency, and encouraging the production of food products in which Tunisia traditionally had a competitive advantage (olive oil; fruits; vegetables).

The reforms were accompanied by a stabilization of the real exchange rate, with the real exchange in 2006 at about the same level as 20 years earlier when reforms started (see Figure 1). This was a major change with respect to exchange rate policies prior to the reforms, when the real exchange rate was let to depreciate significantly between the late 1960s and the late 1980s.

Some may argue that the pre-reform depreciation of the real exchange rate was used to contribute to the net external agricultural position of Tunisia as it made its producers relatively more competitive than rest of the world producers. And by improving the net agricultural trade balance of Tunisia, it had helped achieved some of the non-economic objectives of the government in the agricultural sector. However, one cannot assume that real exchange rate depreciations will necessarily lead to an improvement of the agricultural trade balance for at least two reasons. First, it is well-known that at the aggregate level this will only be the case if the Marshall-Lerner condition is satisfied, i.e., the sum of the absolute values of the price elasticity of import demand and export supply are larger than one.[2] Second, at the sectoral level, in addition to the Marshall-Lerner condition, one needs to consider the general equilibrium effects that may reallocate resources across sectors depending on production and consumption substitutability. In a study of the reaction of sectoral trade balances for the United States, Ardalani and Bahmani-Oskooee (2007) found that of 66 industries only 22 experienced a positive and statistically significant reaction of the trade balance to the depreciation of the exchange rate, and six experienced a negative and statistically significant impact. Thus, whether the depreciation of the exchange rate contributes to improve the net external position of a given sector is inherently an empirical question.[3]

The objective of this paper is to answer this empirical question. Has the depreciation of Tunisia's exchange rate in the 1970s and 1980s contributed to its net external agricultural position? Have Tunisia's more stable exchange rate policies since the reforms hurt its net external agricultural position? In other words, are the exchange rate policies followed by

[1] See for example the works of Boughzala and Sellaouti (2003) and Chebbi et al. (2010), for a review of the trade policy in Tunisia.

[2] See Rose and Yellen (1989) for a derivation in the general case when supply elasticities are not assumed to be perfectly elastic.

[3] See also Bahmani-Oskooee and Wang (2007) who in a study of the reaction of trade balance at the sectoral level in Australia bilateral trade with the United States to bilateral real exchange rate changes found that only around a third of the industries considered had a long-run positive and statistically significant coefficient, suggesting that depreciation led to an increase of the net sectoral trade balance.

Tunisia's today consistent with its objectives for the agricultural sector, or are they jeopardizing those objectives?

Note that the answers to this question may not necessarily imply that exchange rate policies need to be modified to be consistent with the objective set for the agricultural sector. Indeed, the well-known Tinbergen principle suggests that governments should have as many policy instruments as objectives. To use exchange rate policies to achieve agricultural objectives can only be a second-best approach. However, it is important to know whether exchange rate policies have been contributing or jeopardizing the national objectives set for the agricultural sector, to assess the extent to which the agricultural sector may need to be compensated for the presence of exchange rate policies that are inconsistent with agricultural sector objectives.[4]

Although a large body of literature has been devoted to investigate the linkages between macroeconomic variables and agricultural sector (especially for the United States and the developed economies), relatively little attention has been paid to the direct effects of exchange rates on the agricultural trade balance.[5] There are a few exceptions. Carter and Pick (1989) provide the first test of the J-curve hypothesis for the US agricultural trade balance. The J-curve theory suggests that following a currency depreciation, there will be an initial deterioration of the trade balance, because the short-run elasticities of the Marshall-Lerner condition are too small. In the long run however the trade balance will improve, as long-run elasticities tend to be larger. Carter and Pick (1989) found that in the short run there is an initial deterioration of the agricultural trade balance, but did not examine the long-run reaction.

Doorodian, Jung and Boyd (1999) did examine the long-run impact and report a J-curve effect for agriculture in the US using a Shiller large model. Kim et al. (2004) use a vector error-correction model (VECM) to examine the effects of changes in the exchange rate, income, and price on the U.S.-Canada agricultural trade both in the short and long run. They conclude that the exchange rate has a significant impact on the agricultural bilateral trade in both the short and long run. Yazici (2006) investigates the response of the agricultural trade balance to devaluation and whether or not the J-curve hypothesis holds in Turkish agricultural sector. His results indicate that devaluation worsens the trade balance of the sector in the long run and following devaluation, agricultural trade balance initially improves, then worsens, and then improves again. This pattern shows that J-curve effect does not exist in Turkish agricultural sector. Baek and Koo (2008) explore the short-run and long-run relationships between the U.S. agricultural bilateral trade balances and domestic macroeconomic aggregates and agricultural variables using the Johansen cointegration analysis for 1981-2003. Their results show that, in the long run, the exchange rate, agricultural price, and disposable income are weakly exogenous in the U.S. agricultural sector and have significant effects on the trade balance. The combined short-run dynamic effects of the exchange rate, agricultural price and production, and the disposable income jointly explain changes in the trade balance. But they found little evidence of a J-curve effect for U.S. agricultural trade balances because of lack of statistical significance in the short run. This result is consistent with the survey of the literature on the J-curve by Bahmani-Oskooee

[4] Note that we do not question the desirability of Tunisia's agricultural policies and their objectives from a normative point of view. Our exercise is purely descriptive.

[5] However, the relationship between exchange rate depreciation and changes in the current account balance has been studied widely: Himarios, (1985); Bahmani-Oskooee, (1985); Rose, (1990); Bahmani-Oskooee and Malixi, (1992); Bahmani-Oskooee and Alse, (1994); Backus et al., (1994); Boyd et al. (2001); Bahmani-Oskooee and Ratha, (2004a) and (2004b).

and Ratha (2004b) who argue that in the short-run aggregate trade balances do not follow any specific pattern.[6]

This brief review of empirical studies illustrates the point made earlier that whether changes in the real exchange rate lead to an improvement or a deterioration of the agricultural trade balance is an empirical question. Tunisia appears to be an interesting case study given that it is one of the highest growth economies in the Middle East and North Africa (MENA) region and agricultural supply in this country (and region) is under pressure to meet the increasing national demand and the demand for export. It is also a country, where exchange rate policies played an important role before and during the structural reforms that started in the 1980s. The lessons that we could draw for Tunisia could be helpful for other countries in the region, or in similar conditions. Although it should be clear by now that one has to be extremely careful when drawing generalizations in this area.

In order to disentangle the long and short-run impact of changes in the exchange rate on the net agricultural trade balance, we first use cointegration techniques to capture the long-run relationship between these two variables, as well as other important macroeconomic determinants, such as agricultural production, agricultural prices and personal disposable income. We then explore the extent of short-run and long-run Granger causality between these variables. Finally, we introduce a generalized variance error decomposition to explore the relative importance of shocks to each of these variables in explaining the convergence from short-run linkages to the long-run equilibrium.

Results suggest that a depreciation of Tunisia's exchange rate leads in the long run to a decline in the external net agricultural position of Tunisia. This implies that if anything, and contrary to conventional wisdom, the continuous depreciation of the Tunisian dinar before the reforms hurt the net agricultural position of Tunisia, potentially jeopardizing the government's objectives of agricultural self-sufficiency, and higher production of agricultural products where the country had a competitive advantage. In the short run there is no causality between the exchange rate and the net external agricultural position, as in most of the literature (see Bahmani-Oskooee and Ratha, 2004b). Interestingly, the generalized variance error decomposition shows that the relative importance of shocks to the exchange rate in explaining changes in the net external position systematically increases through time, accounting for more than 20 percent of the variation in the net agricultural position of Tunisia after 20 years.

We also checked for the impact of real exchange rate depreciations in the net manufacturing external position of Tunisia, to see whether our results for agriculture are consistent with an overall improvement of the aggregate trade balance in the long run. So we perform a similar exercise for the manufacturing sector. We found that, indeed, the depreciation of the exchange rate led to improvements in the net manufacturing position of Tunisia both in the short and in the long run (which again questions the J-curve hypothesis). This may have been expected as the results obtained for agriculture suggested that exchange rate changes led to a reallocation of resources away from the agriculture tradeable sector.

The remainder of the empirical study is organized as follows. Section 2 reviews Tunisia's exchange rate policies over the last four decades. Section 3 presents a simple theoretical model with intra-industry trade that shows how the depreciation of the exchange rate can lead to either an improvement or deterioration of the net external position of a sector. Section 4

[6] Although, they conclude in their survey that in the long-run, generally, a depreciation of the domestic currency will lead to an improvement of the aggregate trade balance. But this tells us little about what happens at the sectoral level, and as the results by Yazici (2006), Ardalani and Bahmani-Oskooee (2007), and Bahmani-Oskooee and Wang (2007, 2008) suggest depreciations can well have a negative impact on sectoral trade balances in the long run.

presents the empirical approach followed, as well as the results obtained. Section 5 concludes.

2. Exchange rate policy in Tunisia

Tunisia has had different exchange rate systems over the last four decades. In the early 1970s, the Central Bank of Tunisia (BCT) chose to informally peg the dinar to the French Franc (FF), partly because France was Tunisia's largest trading partner. By the mid-1970s, to reduce the volatility of the exchange rate with respect to other currencies, the BCT decided to peg the dinar to a basket of two currencies: the French Franc and the German Mark (DM). Later, in 1978, the U.S. Dollar was included in the basket of currencies to which the dinar was pegged. In order to promote the competitiveness of Tunisia's exports, the basket was further widened in 1981 to include the Italian Lira, the Belgian Franc, and later the Dutch Florin and the Spanish Peseta. The different reforms had significant consequences on the Tunisian dinar, which depreciated quite significantly during this period. Indeed, the real exchange rate (RER) increased by 73 percent between 1975 and 1984 (Domaç and Shabsigh, 1999 and Sfia, 2006).

The recession of the mid-1980s exerted significant pressures on the dinar and forced the BCT in 1986 to start more aggressively depreciating the dinar until early 1989. The BCT let the dinar depreciate by nearly 40% over this period. In 1992, the authorities decided to introduce a more flexible exchange rate regime by targeting the Real Effective Exchange Rate (REER) through regular adjustments in the value of the nominal exchange rate and allowing the liberalization of the exchange rate for current account purposes. This exchange rate policy, combined with prudent and sound monetary and fiscal policies as part of the structural reforms, helped reduce inflation and establish a credible commitment to macroeconomic stability (Fanizza and al. 2002).

Since the early 2000, in the context of its strategy of increase regional and global integration, there has been a gradual move away from the crawling peg regime toward a more flexible arrangement - a managed float with no predetermined path or official fluctuation band. In 2004, a new Tunisian fiscal law provides for further capital account liberalization and exchange rate policy flexibility (World Bank, 2010). More recently, the central bank's interventions in the foreign exchange market have declined, though exchange rate flexibility still remains somehow limited. However, through these exchange rate reforms, the level of the real exchange rate at the end of the last decade was similar to the level existing at the beginning of the structural reforms in the mid 1980s. This contrasts with the important depreciation of the dinar from the late 1960s to the late 1980s.

3. A simple model

Assume a two-sector economy: agriculture (A) and manufacturing (N). Domestic production of A and N use some common factors, so that there are general equilibrium effects between these two sectors on the supply side. Domestically produced and foreign produced varieties are imperfect substitutes in consumption (Armington assumption). The degree of substitutability between domestic and foreign varieties varies for A and N. The rest-of-the-world is sufficiently large so that the supply of the foreign variety is perfectly elastic, and fixes the price of the foreign variety. We choose units so that the price of foreign varieties of A and N in foreign currency equals 1.

Let us also define the GDP deflator, P as a function f of the price of the domestically produced varieties of A and N, i.e., $P = f\left(p^A; p^N\right)$. The real exchange rate, q is given by the relative price of imported goods (which we have normalized to unity) in domestic currency with respect to the price of domestic varieties, i.e., $q = e/P$, where e is the nominal exchange rate given by the price of foreign currency in terms of domestic currency. Note that an increase in q implies a depreciation of the domestic currency, as foreign goods become relatively more expensive.

In the setup described above, it is easy to show that whether a depreciation of the real exchange rate leads to an improvement in the agricultural trade balance does not only depend on the price elasticity of import demand, and export supply of agricultural goods, but also on whether the depreciation of the exchange rate leads to a reallocation of expenditure away from domestically produced agricultural goods relative to domestically produced manufactured goods, and of factors of production from the agricultural to the manufacturing sector. Thus, the only way to answer the question of the impact of a real exchange rate depreciation on agricultural trade balance is through an empirical exercise.

In order to see the ambiguity of the effect of a depreciation on sectoral trade balances, let us define the agricultural trade balance as:

$$TB^A = p^A x^A - e\,m^A = p^A\left(y^A - c^A\right) - e\,m^A \tag{1}$$

where x^A are agricultural exports, m^A are agricultural imports, y^A is agricultural domestic production, and c^A is agricultural domestic consumption. Divide everywhere by the GDP deflator, P, to obtain:

$$\frac{TB^A}{P} = \frac{p^A}{P}\left(y^A - c^A\right) - q\,m^A \tag{2}$$

Take the derivative of (2) with respect to q to obtain:

$$\frac{\partial\left(TB^A/P\right)}{\partial q} = \frac{\partial\left(p^A/P\right)}{\partial q}\left(y^A - c^A\right) + \frac{p^A}{p}\left(\frac{\partial y^A}{\partial q} - \frac{\partial c^A}{\partial q}\right) - m^A - q\frac{\partial m^A}{\partial q} \tag{3}$$

The last three terms in (3) are very similar to the classic Marshall-Lerner condition that requires the sum of the absolute value of the price elasticity of import demand and export supply to be larger than 1.[7] But the first term is new and the second term is not necessarily positive as in the one tradeable good model used to derive the Marshall-Lerner condition.

In order to see this, note that the first term captures how the price of domestically produced agricultural goods relative to all goods produced in the economy varies as the real exchange rate increases. Depending on the consumption substitutability between domestically produced and imported varieties of both agricultural and manufacturing goods, as well as between domestically produced agricultural and manufacturing varieties, the demand for domestic varieties of agricultural goods relative to domestically produced manufacturing goods can move in either direction. This implies that $\partial\left(p^A/P\right)/\partial q$ can be either positive or negative. When it is negative, it makes more likely that a depreciation would lead to a decline in the agricultural trade balance.

The second term captures the impact of changes in the real exchange rate on quantities produced and consumed of the domestic agricultural variety. The sign of $\partial y^A/\partial q$ depends clearly on whether p^A/P increases or decreases after the depreciation. If we assume that it decreases, then $\partial y^A/\partial q < 0$ contrary to what we obtain in the one tradeable sector model,

[7] To see this simply note that in the presence of a one tradeable good, $p^A = P$, by definition. Then divide everywhere by the imported quantity, m, and note that if initially the trade balance is zero, then $x = x/q$. The last three terms become then the Marshall-Lerner condition.

where quantities exported (and therefore produced) increase after a depreciation. In the case of domestic consumption, the sign of $\partial c^A / \partial q$ is also ambiguous. Substitution away from imported varieties after depreciation suggests that there will be more domestic consumption of the domestically produced good, but one also needs to consider the potential substitution between domestic agricultural and manufacturing varieties in consumption. If we assume that p^A / P decreases, as before, then there will be more consumption of the domestically produced variety, which will further contribute to the deterioration of the agricultural trade balance.

This simple model has illustrated that the sign of sectoral trade balances is ambiguous for reasons that go beyond the constraints imposed on trade elasticities by the Marshall-Lerner condition. Indeed, at the sectoral level, substitution on the production and consumption side of the economy increases the ambiguity regarding the expected sign of the derivative of the sectoral trade balance with respect to the real exchange rate.

4. Methodological issues and empirical analysis

Developments in time series analysis have modified the econometric framework for analyzing the linkages between macroeconomic variables. The concepts of non-stationarity and cointegration now need to be explicitly tested. In this paper, we proceed in four steps to explore the link between the real exchange rate and sectoral trade balances. We first explore the univariate properties and test the order of integration of the selected variables. Second, if the variables are non-stationary we test whether the variables are cointegrated. Third, we test for short and long-run causality among these variables. Finally, we estimate the generalized forecast error variance decompositions.

4.1. Data set and stationary properties

To understand the linkages between the real exchange rate and sectoral trade balances (agricultural and manufacturing) in Tunisia we collected annual data for agricultural production (AGDP); manufacturing industrial production (MGDP); agricultural price (AP); manufacturing price (MP); agricultural trade balance (ATB); manufacturing trade balance (MTB); personal disposable income (PDI); and the real exchange rate (RERB) for the period 1965-2007.[8] All variables are transformed in logs (LAGDP; LMGDP; LAP; LMP; LATB; LMTB; LPDI and LEREB) so that first differences can be interpreted as percentage changes. We then extend the recent work of Baek and Koo (2008) and consider two systems of variables.[9] The first system, namely the "AGRI-TRADE" system, is defined by including LATB; LRERB; LAGDP; LAP and LPDI. The second one, namely the "MANUF-TRADE" system, includes the following variables LMTB; LRERB; LMGDP; LMP and LPDI. Figures 1 and 2 plot the selected variables for each system over the 1965-2007 period. As can be observed, all the variables tend to move together over time and a long-run or cointegrating relationship is likely to be present in each system.[10]

The first step in our analysis is to explore the univariate properties of the series. When the number of observations is low, unit root tests have little power. For this reason and as a preliminary step in this paper, we have examined the order of integration of each variable using two conventional tests: the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979 and 1981) which tests the null of unit root, and the KPSS (Kwiatkowski et al., 1992), which tests the null of stationarity. Table 1 shows the results of the unit root tests and suggest that

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[8] See Appendix 1 for a detailed description of the selected variables.

[9] These authors modify the original agricultural trade model developed by Chambers (1981) to take into account the interaction between agricultural exports, imports and domestic macroeconomic factors.

[10] The variables in levels were indexed in order to present the data series in the same scale.

all variables in levels are non-stationary and are integrated of order one (i.e., I(1)) at conventional levels of statistical significance.

As pointed out by Perron (1989), the conventional unit root tests are inappropriate for variables that have undergone structural changes (i.e., the power to reject the unit root null declines if the data contains a structural break that is ignored). In this case, the application of the unit root test allowing for the presence of structural breaks allow us to check the possible impact of some Tunisian reforms (i.e., the first off-shore companies law of 1972[11], the implementation of the 1986 Structural Adjustment Program, Tunisia's trade policy,) on the evolution of the selected variables in this study.

To account for possible structural breaks, we used the LLS unit root test with an unknown break date developed by Lanne et al. (2003).[12] Results from unit root tests with structural breaks are shown in Table 2 and indicate that the null of unit root cannot be rejected. In addition, it is important to note that the endogenously determined structural breaks for each variable are different, and it seems that the implementation of the pre and post 1990s reforms in the Tunisian economy has not generated an abrupt change in the evolution of the analyzed series.

Therefore, the combination of the unit root tests results (see Tables 1 and 2) suggests that the series involved in our estimation procedure are integrated of order one (i.e., I(1)) and this implies the possibility of cointegrating relationships.

4.2. Long-run relationship study

In this section we investigate whether the series in each system (i.e., the "AGRI-TRADE" and the "MANUF-TRADE" systems) are cointegrated since the variables in levels were non-stationary and integrated of order one. The concept of cointegration is identical to the existence of a long-run equilibrium to which an economic system converges over time (Harris and Sollis 2003). The cointegration analysis (i.e., the second step of our empirical analysis) is conducted using the Johansen approach.[13]

The base-line econometric specification for multivariate cointegration is a vector autoregressive (VAR) representation of a k-dimensional time series vector Y_t reparameterized as a vector error correction model (VECM):

$$\Delta Y_t = \mu D_t + \Gamma_1 \Delta Y_{t-1} + \cdots + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi\, Y_{t-1} + e_t \qquad (4)$$

where Y_t is a $(k \times 1)$ column vector of the endogenous variables; D_t is a vector of deterministic variables (intercepts, trend...); μ is the matrix of parameters associated with D_t; Γ_i are $(k \times k)$ matrices of short–run parameters $(i = 1, \cdots, p-1)$ where p is the number of lags; $\Pi = -(I - \Pi_1 \cdots - \Pi_P)$ is a $(k \times k)$ matrix of long–run parameters; and e_t is the vector of disturbances assumed to be normal, independent, and identically distributed.

In the I (I (1) system, Y_t is said to be cointegrated if the following rank conditions are satisfied: $H_r : \Pi = \alpha\beta'$ of rank $0 < r < k$, where r is the number of cointegrating vectors; and α and β are matrices of dimension ($k \times r$). β is a matrix representing the cointegrating

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[11] In April 1972, an offshore regime for exports was created in order to encourage the emergence of industrial exports. The first offshore companies law of 1972 marked the transition of Tunisia to economic liberalization after cooperativism.

[12] Lanne et al. (2003) extended Lanne et al. (2002) non-linear break tests to the case of an unknown break date.

[13] Johansen (1988 and 1995) and Johansen and Juselius (1990; 1992 and 1994).

vectors which are interpreted as long-run equilibrium relations between the Y_t variables, while α gives the weights of the cointegration relationships in the ECM equations.

This procedure has been applied to the "AGRI-TRADE" system including the five variables (LAGDP, LAP, LATB, LPDI and LRERB) and the "MANUF-TRADE" system including the five variables (LMGDP, LMP, LMTB, LPDI and LRERB).

In the present work, the two systems were estimated including two lags and a linear trend restricted to the cointegration space and an unrestricted constant. In this case, the underlying VAR model contains both intercepts and deterministic linear trends, with the intercept and the trend coefficients being unrestricted.[14]

Table 3 shows the results of Johansen's likelihood ratio tests for cointegration rank. As can be observed, the trace does not reject the hypothesis that there is one cointegrating relation between the variables (r=1).[15] From now on we assume the presence of one cointegrating or stationary relationship and four common stochastic trends in the system.

The estimated β and α parameters are displayed in Table 4, where β is presented normalizing the coefficient of agricultural trade balance (LATB) for the "AGRI-TRADE" system and manufacturing trade balance (LMTB) for the "MANUF-TRADE" system. For each system (i.e., "AGRI-TRADE" and "MANUF-TRADE"), this long-run equilibrium relationship among the variables can be considered as a long-run trade balance.

The result for the "AGRI-TRADE" system shows that the Tunisian agricultural trade balance (LATB) has a negative long-run relationship with real exchange rate (LRERB). This indicates that a continuous depreciation of the Tunisian dinar is associated with deterioration of the agricultural trade balance in the long-run. In addition, a positive long-run relationship between the agricultural trade balance and agricultural output suggests that an increase in the national agricultural production may lead to an increase in exportable national products and import substitutes and may help to improve the agricultural trade balance in the long-run.

A negative long-run relationship between the trade balance (LATB) and the Tunisian agricultural price (LAP) implies that the increase in the Tunisian price is accompanied with deterioration in the agricultural trade balance. Finally, the trade balance has a negative long-run relationship with disposable income (LPDI), indicating that an increase in disposable income leads to a rise in the Tunisian agricultural imports through the increased purchasing power of the Tunisian consumers, thereby decreasing the trade surplus.

The result for the "MANUF-TRADE" system shows that the Tunisian manufacturing trade balance (LMTB) has a positive long-run relationship with real exchange rate (LRERB) and a negative relationship with manufacturing price (LMP). This indicates that a depreciation of the of the Tunisian exchange rate leads to an improvement in the manufacturing trade balance in the long-run. Exchange rate plays a central role in Tunisia's manufacturing trade competitiveness (i.e., since the 70's) and still is a functioning policy for the intervention in manufacturing trade competitiveness. The Tunisian dinar depreciation improves manufacturing trade competitiveness, as the domestic prices of exported goods become cheaper in foreign currency, thus lowering the price of the country's exports.

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[14] Multivariate tests for autocorrelation (Godfrey, 1988) and normality (Doornik and Hansen, 1994) have been carried out to check for model statistical adequacy before applying the reduced rank tests. Results support the VAR model with two lags as a sufficient description of the data set.

[15] Johansen cointegration methods may produce unreliable results for small sample. Therefore, for robustness check, we present also the trace statistic tests computed using the Bartlett small sample correction. For a discussion of the properties of both tests in small samples, see Lütkepohl, H, P. Saikkonen and C. Trenkler (2001).

In addition, a positive long-run relationship between the manufacturing trade balance (LMTB) and industrial output (LMGDP) suggests that an increase in the industrial production may lead to an increase in exportable products and may help to improve the Tunisian manufacturing trade balance in the long-run.

In order to better understand these long-run linkages, is useful to consider the results of non-causality tests.

4.3. Non-causality study

The presence of one cointegration relationship between the variables in the "AGRI-TRADE" system and the "MANUF-TRADE" system, implies the presence of Granger-causality but it does not necessarily identify the direction of causality. [16] Thus, the next step is to investigate the direction of causality by estimating a VECM derived from the long-run cointegrating relationship (Engle and Granger, 1987 and Granger, 1988).

The VECM contains the cointegration relation built into the specification so that it restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relationships while it allows for short-run adjustment dynamics.

Empirically, three different non-causality tests can be performed. The short-run Granger non-causality test is related with the statistical significance of the lagged dynamic terms. The long-run weak exogeneity test is related with the statistical significance of the coefficients associated with the lagged error-correction term derived from the long-run cointegrating vectors. So, the variable is called weakly exogenous if it is not influenced by deviations from the long-run relationships (Johansen, 1992). Finally, the joint test of overall strong exogeneity implies satisfying both short-run Granger non-causality and weak exogeneity and indicates the overall non-causality within the variables.

Table 5 shows the main findings of non-causality tests in our multivariate framework related with the agricultural trade balance (LATB) for the "AGRI-TRADE" system and manufacturing trade balance (LMTB) for the "MANUF-TRADE" system.

For the "AGRI-TRADE" system, statistical results of long-run weak exogeneity presented in Table 5 show that only three coefficients (LATB; LPDI and LAGDP) are significant and adjust in the long run. This suggests that joint deviation by these variables from the long-run equilibrium position in this system due to a specific shock gradually disappears, and they eventually return to a long-run equilibrium position. On the other hand, the parameters of the two variables (LAP and LRERB) are not significant, indicating that are not influenced by deviations from the long-run relationship. Following the idea of Baek and Koo (2008), these two variables are considered as the determining parts of the long-run relationship and play key roles in determining the long-run movement of Tunisian agricultural trade balance but they are not affected by the other variables. In fact, in line with national agricultural policies, agricultural and food prices are "not allowed" to increase over "expected inflation" in order to secure access to basic agricultural products.

When examining the causal linkage between agricultural trade balance and exchange rate, statistical results provide support for only unidirectional causality in the short run, running from lagged LATB to LRERB. The non- causality results provide also some support that LRERB do not have a significant effect on LATB in the short run. Although the traditional policy used by the Tunisian Government to promote exports has been via the depreciation of exchange rate, our empirical finding indicates that exchange rate may not generate significant improvement in the case of agricultural trade balance. In addition, this pattern may indicate that J-curve phenomenon does not exist in Tunisian agricultural sector.

[16] Granger-causality implies causality in the prediction (forecast) sense rather than in a structural sense.

In regards to causality between agricultural trade balance and agricultural production, the results provide support for lack of mutual causal and feedback relationship in the short run. Our findings corroborate the idea of dissociation between agricultural trade balance and agricultural supply and may indicate that there does not seem to be a significant relationship between agricultural supply and Tunisian exports in the short run. These results substantiate the findings of Gil et al. (2009). These authors conclude that agricultural exports depend more on other factors than on the Tunisian agricultural output performance, for example, commercial agreements (i.e., most of the exported agro-food products are sent to the European Union and are subject to quantity restrictions) or decisions made by existing exporter lobbies in the most important export goods (olive oil, dates, citrus fruit, etc.).

When examining the linkage between agricultural trade balance and agricultural prices, results show evidence for lack of causal and feedback relationship in the short and the long run. This result supports the view that ATB and AP are neutral with respect to each other in the Tunisian agricultural sector. This is a consequence of the traditional Tunisian export strategy with low value added products. In addition, this may confirm the idea that agricultural prices are not the main source of competitiveness for Tunisian agricultural exports as they are mainly subject to quantity restrictions through tariff-quotas.

Finally, when considering the causal flow between agricultural trade balance and disposable income, the findings provide support for only unidirectional causality running from LATB to LPDI. This result indicates that improvement of the agricultural trade balance may have a positive effect on personal disposable income and consequently on farmers' income in Tunisia. In addition, results from reverse causality indicate that an increase in personal disposable income and thereby the increased purchasing power of Tunisian consumers may not lead to a significant rise in agricultural imports in the very short run. This is probably reflective of widespread administrative controls over activities comprising the import of food and agricultural products in Tunisia.

For the "MANUF-TRADE" system, statistical results of long-run weak exogeneity presented in Table 5 show that only three coefficients (LMTB, LMP and LPDI) are significant and adjust in the long run. On the other hand, the parameters of the two variables (LMGDP and LRERB) are not significant, indicating that are not influenced by deviations from the long-run relationship (i.e., they are not affected by the other variables in the "MANUF-TRADE" system). These two variables are considered as the determining parts of the long-run movement of Tunisian manufacturing trade balance.

When examining the causal linkage between manufacturing trade balance (LMTB) and exchange rate (LRERB), statistical results provide support for unidirectional causality in the short and the long run, running from LRERB to LMTB. This result may indicate that the J-curve phenomenon exist on the manufacturing trade balance in Tunisia.

In regards to causality between manufacturing trade balance and industrial output, the results provide support for only unidirectional causal relationship running from lagged LMGDP to LMTB in the short and the long run.

Finally, when considering the causality between manufacturing trade balance and disposable income, the findings provide support for only unidirectional causality running from LPDI to LMTB in the short-run.

4.4. Generalized forecast error variance decompositions

The main purpose of this section is to complete the investigation of the short-run linkages and convergence to the long-run equilibrium of the variables. Once the VECM has been estimated, short-run dynamics can be examined by considering Generalized forecast error variance decompositions.

This technique measures the share of the forecast error variance for any variable in the "AGRI-TRADE" system and the "MANUF-TRADE" system that is explained by innovations in each of the explanatory variable over different time horizons. The generalized forecast error variance decompositions are given in Table 6.

The main findings for the "AGRI-TRADE" system may be summarized as follows:

- The agricultural output seems to be more important than the exchange rate, agricultural prices, and per capita disposable income in explaining the variation in agricultural trade balance. Innovations in LAGDP explained 38% of the variance forecast errors of LATB at the first horizon (1 year). However, innovations in RERB explained only 2% of LATB variance at the first horizon but the impacts of shocks in LRERB on LATB seem to rise over time and account for more than 21% of variation in LATB by the 20-year horizon.
- Shocks to LATB seem to have a reduced impact on variation in LRERB from around 6% to 9% after 20 years.

The results of generalized forecast error variance decompositions for the "MANUF-TRADE" system are quite different and may be summarized as follows:

- Personal disposable income innovations seem to account for important percentages (from 40% to 21%) of the variance forecast errors of LMTB. interestingly, the impacts of shocks in LRERB on LMTB rise from 1% in the first year to 27% after 20 years.
- Shocks to LMTB seem to have only a reduced impact on variation in LRERB from around 1% to 2% after 20 years.

5. Concluding remarks

Tunisia's agricultural sector is important for socio-economic reasons. Partly for this reason the government has pursued non-economic objectives in the agricultural sector, such as self-sufficiency for some sub-sectors, as well as increase competitiveness in other sub-sectors where the country has a comparative advantage. Nevertheless, an important element of the structural reforms introduced in Tunisia in the late 1980s has been a stabilization of a previously depreciating real exchange rate. This could have jeopardized the country's external position in agriculture, hurting some of the government's objectives for this sector. In this paper we first showed that theoretically, the impact that an exchange rate depreciating has on the net external position of a given sector is ambiguous for reasons that go beyond the constraints imposed on trade elasticities by the Marshall-Lerner condition. Indeed, substitutability on the production and consumption side among domestically produced and between domestically produced goods and imported varieties make the prediction more ambiguous. Thus, the answer to the question of whether a depreciation of the real exchange rate helps the agricultural trade balance is inherently empirical. In this paper we empirically address this question, and found that, contrary to conventional wisdom, exchange rate depreciations have led to a deterioration of the net external position of Tunisia's agricultural sector. Thus, the recent stabilization of the real exchange rate that was part of the structural reforms has if anything helped the government achieve its economic and non-economic objectives for the agricultural sector.

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Figure 1: Trends in the "AGRI-TRADE" System

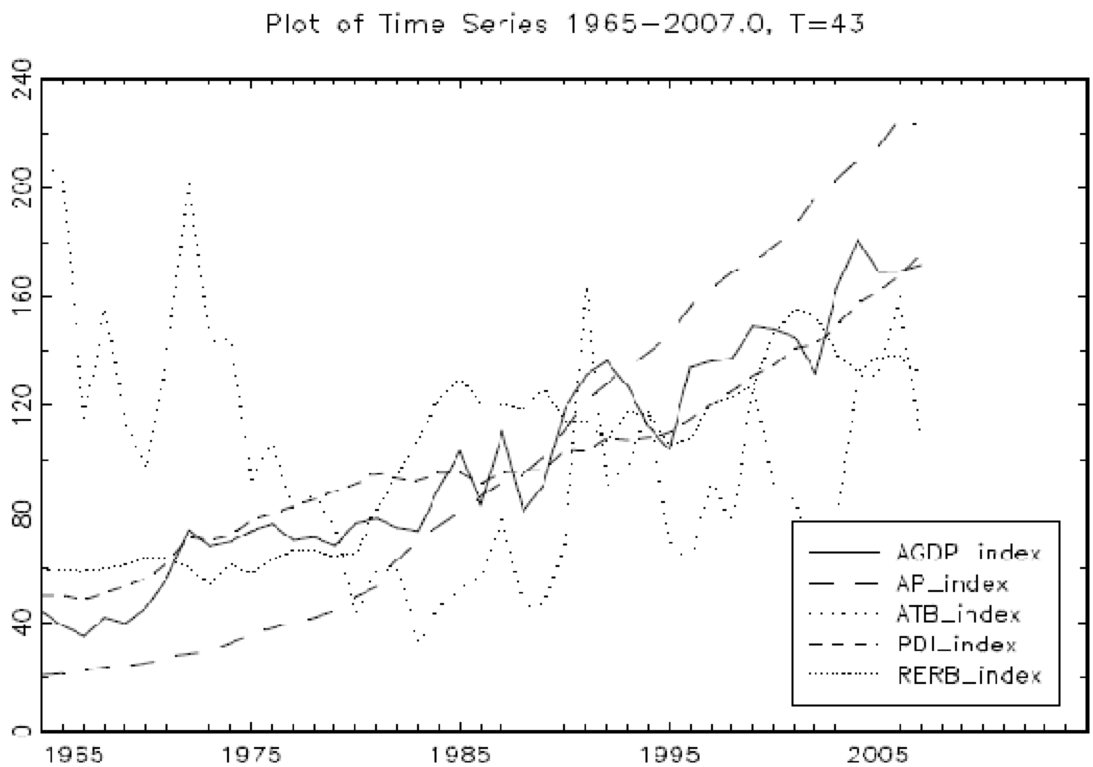

Figure 2: Trends in the "MANUF-TRADE" System

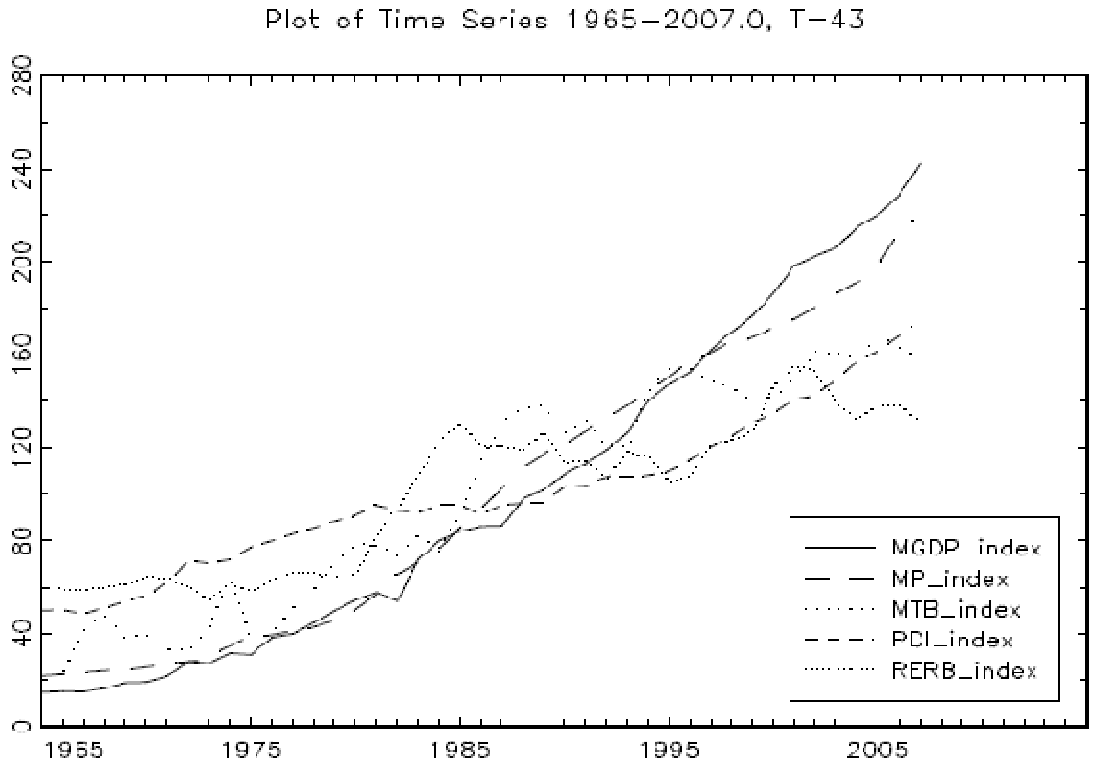

Table 1. Results from unit root tests without structural breaks[a]

		ADF test	KPSS test	
			l=1	l=3
		Level form		
Intercept and trend	LATB	-2.9912 (0)	0.3643^{c}	0.2316^{c}
	LMTB	-2.8090 (0)	0.3372^{a}	0.2340^{a}
	LRERB	-1.8383 (1)	0.2129^{b}	0.1258^{c}
	LAGDP	3.6125^{b} (0)	0.1249^{c}	0.0982
	LMGDP	-0.1842 (3)	0.4376^{a}	0.2359^{a}
	LAP	0.5125 (0)	0.4137^{a}	0.2286^{a}
	LMP	-1.1622 (3)	0.4376^{a}	0.2359^{a}
	LPDI	-3.0555 (3)	0.2689^{a}	0.1503^{b}
Intercept	LATB	-3.1447 (0)	0.4574^{c}	0.2880
	LMTB	-1.7390 (0)	2.0710^{a}	1.1204^{a}
	LRERB	-0.9913 (0)	1.9403^{a}	1.0233^{a}
	LAGDP	-1.1315 (0)	2.0529^{a}	1.1132^{a}
	LMGDP	-4.1735^{a} (3)	2.1870^{a}	1.1534^{a}
	LAP	-1.6306 (0)	2.2217^{a}	1.1640^{a}
	LMP	-1.3164 (1)	2.2015^{a}	1.1528^{a}
	LPDI	-0.4788 (0)	2.0674^{a}	1.1118^{a}
		First difference form		
Intercept and trend	ΔLATB	-6.1983^{a} (1)	0.0312	0.0496
	ΔLMTB	-5.1811^{a} (4)	0.0248	0.0448
	ΔLRERB	-5.0543^{a} (0)	0.0916	0.0829
	ΔLAGDP	-7.6946^{a} (0)	0.0277	0.0397
	ΔLMGDP	-5.1060^{a} (3)	0.0509	0.0865
	ΔLAP	-5.0614^{a} (0)	0.2578^{a}	0.1974^{b}
	ΔLMP	-3.9652^{b} (0)	0.2135^{b}	0.1649^{b}
	ΔLPDI	-5.0715^{a} (0)	0.1349^{c}	0.1195^{c}
Intercept	ΔLATB	-6.1405^{a} (1)	0.1191	0.1741
	ΔLMTB	-4.7871^{a} (4)	0.1094	0.1845
	ΔLRERB	-5.0839^{a} (0)	0.1119	0.1006
	ΔLAGDP	-7.7518^{a} (0)	0.0341	0.0483
	ΔLMGDP	-8.3852^{a} (0)	0.4172^{c}	0.4893^{b}
	ΔLAP	-2.6063^{c} (1)	0.4963^{b}	0.3613^{c}
	ΔLMP	-3.7759^{a} (0)	0.4079^{c}	0.2987
	ΔLPDI	-5.7290^{a} (0)	0.1395	0.1230

[a]Superscripts a, b and c indicate the rejection of the null hypothesis at the 1, 5 and 10 percent level of statistical significance, respectively. The lag length in the ADF tests (in parentheses) has been chosen based on the Akaike's Information Criterion. The maximum number of lags is set to be four. For the KPSS tests, lag-truncation parameters one and three (l=1 and l=3) were performed since it is unknown how many lagged residuals has been used to construct a consistent estimator of the residual variance.

Table 2. Results from unit root tests with structural breaks[a]

	LLS test			
	With trend	Suggested break date	Without trend	Suggested break date
LATB	-2.5721	1991	-2.1474	1991
LMTB	-2.6871	1974	-2.3364	1974
LRERB	-1.4761	1973	-1.1224	1973
LAGDP	-3.2686	1987	-1.4595	1987
LMGDP	-1.4825	1982	-2.4266	1982
LAP	-0.9308	1981	-2.2279	1981
LMP	0.8025	1973	1.5870	1973
LPDI	-1.1704	1972	-0.7229	1972

[a]The null hypothesis of unit root cannot be rejected at the 5 and 10 percent level of statistical significance. Critical values are from Lanne et al. (2002).

Table 3. Results of cointegration tests for the two systems (trend and intercept included)[a]

		"AGRI-TRADE" System		"MANUF-TRADE" system		Critical values		
H_0:	H_1:	LR-Trace	LR-Trace*	LR-Trace	LR-Trace*	(90%)	(95%)	(99%)
$r = 0$	$p-r = 5$	108.749[a]	87.796[c]	118.070[a]	95.307[b]	84.27	88.55	96.97
$r \leq 1$	$p-r = 4$	62.208[c]	49.517	61.753[c]	44.700	60.00	63.66	70.91
$r \leq 2$	$p-r = 3$	39.323	32.852	34.065	25.422	39.73	42.77	48.87
$r \leq 3$	$p-r = 2$	19.282	14.273	16.707	10.233	23.32	25.73	30.67
$r \leq 4$	$p-r = 1$	5.771	4.916	5.236	4.732	12.45	12.45	16.22

[a] (r) is the number of cointegrating vectors and $(p-r)$ is the number of common stochastic trends. Critical values are based on Doornik (1998). The LR-Trace* is computed using the Bartlett small sample correction. Superscripts a, b and c indicate the rejection of the null hypothesis at the 1, 5 and 10 percent level of statistical significance, respectively.

Table 4. Normalized cointegration relations (β') and loading coefficients (α) for the two systems[a]

"AGRI-TRADE" system

$$\alpha = \begin{pmatrix} -0.608^{a} \\ (-2.749) \\ -0.013 \\ (-0.254) \\ -0.195^{b} \\ (-2.226) \\ -0.002^{a} \\ (-0.094) \\ 0.107^{a} \\ (-5.535) \end{pmatrix} \text{ and } \quad \beta' = \begin{pmatrix} 1.000 & 0.909^{a} & -2.566^{a} & 4.384^{a} & 6.626^{a} & -0.384^{a} \\ & (3.609) & (-8.651) & (10.398) & (13.044) & (-13.704) \end{pmatrix} \times \begin{pmatrix} \text{LATB} \\ \text{LRERB} \\ \text{LAGDP} \\ \text{LAP} \\ \text{LPDI} \\ \text{TREND} \end{pmatrix}$$

"MANUF-TRADE" system

$$\alpha = \begin{pmatrix} -0.690^{a} \\ (-9.685) \\ -0.011 \\ (-0.180) \\ -0.052 \\ (-0.977) \\ -0.096^{a} \\ (-2.632) \\ 0.059^{b} \\ (2.253) \end{pmatrix} \text{ and } \quad \beta' = \begin{pmatrix} 1.000 & -0.354^{b} & -1.104^{a} & 0.128 & -0.292 & 0.051^{a} \\ & (-2.118) & (-2.876) & (0.328) & (-0.558) & (3.096) \end{pmatrix} \times \begin{pmatrix} \text{LMTB} \\ \text{LRERB} \\ \text{LMGDP} \\ \text{LMP} \\ \text{LPDI} \\ \text{TREND} \end{pmatrix}$$

[a] Figures in parenthesis are $t-$value of model coefficients. Superscripts a, b and c indicate the rejection of the null hypothesis at the 1, 5 and 10 percent level of statistical significance, respectively.

Table 5. Results of non-causality tests[a]

Hypothesis of non-causality	Short-run Granger non-causality	Long-run non-causality	Overall strong exogeneity
"AGRI-TRADE" system			
$H_0: LATB \nrightarrow LRERB$	3.7396[c]	0.0646	7.1205[b]
$H_0: LRERB \nrightarrow LATB$	0.1607	6.9351[a]	7.5738[b]
$H_0: LATB \nrightarrow LAGDP$	0.1363	4.6786[c]	6.2969[b]
$H_0: LAGDP \nrightarrow LATB$	0.8600	6.9351[a]	12.8873[a]
$H_0: LATB \nrightarrow LAP$	0.3947	0.0088	0.8007
$H_0: LAP \nrightarrow LATB$	0.4068	6.9351[a]	7.1558[b]
$H_0: LATB \nrightarrow LPDI$	6.4424[b]	22.8793[a]	23.6259[a]
$H_0: LPDI \nrightarrow LATB$	1.2413	6.9351[a]	7.8672[b]
"MANUF-TRADE" system			
$H_0: LMTB \nrightarrow LRERB$	1.9255	0.0324	2.3417
$H_0: LRERB \nrightarrow LMTB$	7.4310[a]	48.8007[a]	50.1936[a]
$H_0: LMTB \nrightarrow LMGDP$	0.7820	0.9431	2.4801
$H_0: LMGDP \nrightarrow LMTB$	12.2651[a]	48.8007[a]	48.8027[a]
$H_0: LMTB \nrightarrow LMP$	5.7022[b]	6.3998[b]	8.8678[b]
$H_0: LMP \nrightarrow LMTB$	18.8826[a]	48.8007[a]	53.1494[a]
$H_0: LMTB \nrightarrow LPDI$	0.0268	4.7852[b]	5.5486[c]
$H_0: LPDI \nrightarrow LMTB$	11.3726[a]	48.8007[a]	53.1496[a]

[a]Superscripts a, b and c indicate the rejection of the null hypothesis at the 1, 5 and 10 percent level of statistical significance, respectively

Table 6. Generalized forecast error variance decompositions

Horizon	LATB	LRERB	LAGDP	LAP	LPDI
"AGRI-TRADE" system					
	Variance decomposition for LATB				
1	84,86%	2,43%	37,83%	1,67%	0,81%
2	79,35%	7,38%	39,76%	1,34%	1,63%
3	76,56%	9,92%	41,04%	1,37%	2,52%
4	73,17%	12,37%	42,43%	1,37%	3,25%
5	70,76%	14,38%	42,85%	1,51%	3,80%
10	64,01%	19,06%	43,70%	1,99%	5,19%
15	62,85%	20,81%	43,94%	2,19%	5,71%
20	61,75%	21,71%	44,06%	2,30%	5,97%
	Variance decomposition for LRERB				
1	5,84%	91,46%	6,14%	5,16%	11,32%
2	6,94%	88,97%	8,31%	7,00%	12,40%
3	7,14%	87,90%	8,51%	8,25%	12,63%
4	7,65%	86,69%	8,81%	9,14%	12,84%
5	7,91%	86,02%	9,04%	9,65%	12,97%
10	8,46%	84,53%	9,41%	10,81%	13,22%
15	8,65%	84,03%	9,54%	11,18%	13,31%
20	8,74%	83,79%	9,60%	11,36%	13,35%
	Variance decomposition for LAGDP				
1	12,24%	9,24%	88,46%	7,58%	31,86%
2	9,24%	12,07%	86,85%	6,32%	33,75%
3	7,67%	14,18%	86,04%	5,47%	34,65%
4	6,55%	15,90%	85,14%	4,78%	35,34%
5	5,82%	17,31%	84,48%	4,24%	35,96%
10	4,21%	20,98%	82,93%	2,84%	37,55%
15	3,62%	22,46%	82,31%	2,29%	38,17%
20	3,32%	23,23%	81,99%	2,01%	38,50%
	Variance decomposition for LAP				
1	0,46%	5,42%	0,70%	96,62%	15,69%
2	0,51%	8,96%	0,53%	93,83%	16,92%
3	0,53%	11,19%	0,52%	91,91%	17,67%
4	0,60%	12,68%	0,53%	90,55%	18,07%
5	0,67%	13,72%	0,57%	89,54%	18,33%
10	0,84%	16,08%	0,68%	87,26%	18,88%
15	0,91%	16,88%	0,72%	86,47%	19,05%
20	0,94%	17,27%	0,74%	86,08%	19,14%
	Variance decomposition for LPDI				
1	7,87%	16,10%	36,34%	7,25%	83,82%
2	17,07%	20,08%	25,61%	10,65%	70,99%
3	18,02%	24,18%	21,32%	14,87%	67,30%
4	17,35%	26,97%	19,71%	17,63%	65,27%
5	16,85%	29,18%	18,53%	19,49%	63,64%
10	14,67%	34,30%	16,63%	23,91%	60,69%
15	13,85%	35,98%	16,13%	25,29%	59,79%
20	13,46%	36,78%	15,90%	25,94%	59,37%

Table 6. (Continued)

Horizon	LMTB	LREBB	LMGDP	LMP	LPDI
"MANUF-TRADE" system					
	Variance decomposition for LMTB				
1	61,58%	10,96%	5,31%	15,93%	39,11%
2	48,22%	8,55%	16,78%	25,82%	31,93%
3	41,05%	9,59%	28,44%	23,08%	30,50%
4	36,18%	12,03%	34,63%	20,32%	28,42%
5	32,94%	13,58%	38,79%	18,51%	26,67%
10	19,98%	20,53%	55,74%	10,86%	22,95%
15	14,38%	24,54%	61,57%	7,87%	21,79%
20	11,68%	26,64%	64,03%	6,55%	21,31%
	Variance decomposition for LREBB				
1	1,23%	98,89%	0,87%	21,29%	2,62%
2	1,33%	98,41%	0,67%	24,72%	2,86%
3	1,76%	97,62%	0,47%	27,37%	3,68%
4	2,01%	97,17%	0,36%	28,70%	4,21%
5	2,05%	96,99%	0,30%	29,38%	4,38%
10	1,94%	96,61%	0,23%	31,32%	4,29%
15	1,84%	96,45%	0,22%	32,16%	4,14%
20	1,78%	96,36%	0,22%	32,61%	4,04%
	Variance decomposition for LMGDP				
1	4,79%	1,59%	98,26%	4,74%	22,68%
2	4,88%	3,01%	96,06%	3,06%	23,94%
3	5,00%	3,12%	94,76%	2,37%	23,94%
4	5,29%	3,36%	93,70%	1,88%	24,36%
5	5,70%	4,29%	92,61%	1,56%	24,86%
10	6,74%	6,35%	88,43%	1,17%	26,11%
15	7,24%	6,94%	86,27%	1,20%	26,62%
20	7,50%	7,44%	85,07%	1,25%	26,88%
	Variance decomposition for LMP				
1	6,22%	18,09%	5,26%	99,76%	7,03%
2	4,18%	18,89%	3,47%	98,48%	5,04%
3	2,77%	21,46%	2,56%	92,72%	3,32%
4	2,24%	23,75%	2,60%	86,94%	2,80%
5	1,98%	25,23%	2,76%	83,22%	2,62%
10	2,19%	27,88%	4,07%	74,10%	3,29%
15	2,54%	28,65%	4,87%	70,57%	3,92%
20	2,75%	29,00%	5,29%	68,88%	4,27%
	Variance decomposition for LPDI				
1	31,67%	1,76%	21,45%	6,68%	98,91%
2	26,24%	4,35%	18,29%	9,01%	95,75%
3	25,70%	8,26%	16,05%	12,76%	91,88%
4	23,96%	11,05%	14,38%	16,39%	88,43%
5	22,52%	13,19%	13,10%	19,25%	85,55%
10	17,33%	21,02%	8,77%	28,87%	73,59%
15	14,62%	25,25%	6,66%	34,04%	66,54%
20	13,07%	27,70%	5,48%	37,01%	62,36%

Appendix 1: Construction of the Dataset

Variables	Symbols	Description and source of variables
Agricultural production	AGDP	The agricultural gross domestic product is used as a proxy for aggregate Tunisian agricultural production and is taken from the World Development Indicators (WDI). The GDP deflator (2000=100) obtained from the International Financial Statistics (IFS) is used to derive agricultural GDP.
Manufacturing production	MGDP	Manufacturing Output (as a percent of GDP) is taken from the WDI. Manufacturing refers to industries belonging to ISIC divisions 15-37. The GDP deflator (2000=100) obtained from the IFS is used to derive agricultural GDP.
Agricultural price	AP	The wholesale price index (2000=100) of food products and the price index (2000=100) of agro food industrial are obtained from the *Institut National de la Statistique* (INS) and used as a proxy for Tunisian agricultural price
Manufacturing price	MP	The wholesale price index (2000=100) are obtained from the INS.
Agricultural trade balance	ATB	The Tunisian agricultural trade balance is obtained from the Food and Agriculture Organization of the United Nations statistical database (FAOSTAT). Trade balance is measured as the ratio of the export value to the import value.
Manufacturing trade balance	MTB	The manufacturing trade balance is calculated from the WDI. Trade balance is measured as the ratio of the export value to the import value.
Personal disposable income	PDI	The Tunisian Personal Disposable Income is obtained from the IFS and the INS. The GDP deflator (2000=100) obtained from the IFS is used to derive real disposable Income.
Exchange rate	RERR	In the formulation of the real exchange rate, we use both the European Union and Tunisian consumer price indices. The formula used for estimation of the RERR is given by: $RERR = \frac{CPI_{EU}}{CPI_{TN}} \times TCN$ where : CPI_{EU} is the consumer price index of the Euro area, CPI_{TN} is the Tunisian consumer price index (2000=100) and TCN is the official exchange rate (Dinar per US Dollar, period average), from the IFS. In addition, since the exchange rate represents the national currency value per dollar, an increase in the exchange rate indicates a depreciation of the Tunisian dinar.