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Trade balance and exchange rate depreciation in Tunisia: The agriculture sector puzzle [*]

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Abstract

In spite of the diversification of Tunisia's production bundle, the agricultural sector remains socially and economically important. 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). However, since the beginning of the structural reforms Tunisia's exchange rate has been depreciating, which provided a competitive edge to Tunisian producers over foreign competitors. However, the impact on the net external position at the sectoral level is theoretically ambiguous. The objective of this paper is assess the impact that the continuous depreciation of Tunisia's currency since the beginning of the reforms has had on the net external agricultural balance. In other words, are the exchange rate policies followed by Tunisia helping or hurting Tunisia's objectives for the agricultural sector?. Results suggest that the continuous depreciation of Tunisia's exchange rate led in the long-run to a decline in the external net agricultural position of Tunisia, potentially jeopardizing the objectives of self-sufficiency, food security and higher production of agricultural products where the country had a competitive advantage.

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1 Introduction

Prudent macroeconomic management and a series of structural economic reforms have led to an improvement of Tunisia's major macroeconomic indicators. 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.[1]

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 labor 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 consumption 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).

Throughout the process of reforms the exchange rate has been depreciating, helping Tunisia's producers become more competitive in world markets. In 2006 the exchange rate was 50 percent higher than its level 20 years earlier when reforms started (see Figure 1). This has been an important component of the reform package. It also had the desired overall effect on Tunisia's current account, which has been improving.

However, it is not clear that the continuous depreciation of the exchnage rate has had necessarily positively contributed to the net external agricultural position, which is part of of Tunisia's national objectives as discussed above. Indeed, while a depreciation of the exchange rate is likely to have a positive impact on net exports, as it makes domestic goods relatively cheaper than foreign goods, it also creates a wedge between tradeable and non-tradeable goods. Depending on the relative tradeability of each sector, the depreciation of the exchange rate will lead in the long-run to a reallocation of resources from sectors that are relatively less tradeable to sectors with a higher share of tradeable goods. Thus, whether the depreciation of the exchange rate contributes to improve the net external position of a given sector is inherently an empirical question.

The objective of this paper is to answer this empirical question. How has the depreciation of Tunisia's exchange rate throughout the reform period contributed to its net external agricultural

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

position? In other words, are the exchange rate policies followed by Tunisia consistent with its objectives for the agricultural sector, or are they jeopardizing those objectives?. The answer to this question may not necessarily imply that exchange rate policies need to be modified to be consistent with 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. 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.

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.[2]

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. 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 trade balance 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.

[2]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).

This very brief review of empirical studies linking mainly macroeconomics to agricultural trade balance underlines the idea that whether macroeconomic policies 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 during the structural reforms. The lessons that we could draw for Tunisia could be helpful for other countries in the region, or in similar conditions.

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 the continuous depreciation of Tunisia's exchange rate led in the long-run to a decline in the external net agricultural position of Tunisia, potentially jeopardizing the objectives of self-sufficiency, food security and higher production of agricultural products where the country had a competitive advantage. In the short-run there is no causality going from exchange rate to the net external agricultural position. 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.

In order to see whether a consistent impact was observed in the net manufacturing external position of Tunisia, 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. 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 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 depending on the degree of tradeability of different sectors. Section 4 present 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 peg informally their currency to the French Franc (FF), partly because France was its 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 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 helped the country not only to ovoid currency and financial crises, but it also contributed to reduce inflation and to establish a credible commitment to macroeconomic stability (Fanizza and al. 2002).

Since the early 2000, in the context of its strategy of increased 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). More recently, the central bank's interventions in the foreign exchange market have declined, though exchange rate flexibility still remains limited. In 2004, a new Tunisian fiscal law provides for further capital account liberalization and exchange rate policy flexibility (World Bank, 2010).

3 A simple model

Assume a two sector Ricardian economy: agriculture (A) and manufacturing (M). Within each sector there is a continuum of goods as in Dornbusch, Fischer and Samuelson (1977). Each sector has a different degree of tradeability. In particular trade costs in the agricultural sector are much higher than in the manufacturing sector. Thus, the non-tradeable agricultural sector is much larger than the non-tradeable manufacturing sector. For simplicity and to understand the basic mechanics of the model, assume that the agricultural sector is initially entirely non-tradeable, i.e., there is self-sufficiency. A depreciation of the domestic currency will then make the tradeable sector relatively more profitable relatively to the non-tradeable sector in both agricultural and manufacturing. This will attract ressource towards the tradeable sector and out of the non-tradeable sector. Given that the agricultural sector is exclusively non-tradeable initially this will lead to a reduction of the size of the agricultural sector, which will then have to replace domestic production by imports from the rest of the world deteriorating the agricultural trade balance.

4 Methodological issues and empirical analysis

Developments in time series analysis have modified the econometric framework for analyzing the linkages between macroeconomic indicators and trade balance. The concepts of non-stationarity and cointegration have become very popular and have to be explicitly tested. In this paper, we proceed in four steps. 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 casuality among these variables. Finally, we estimate the generalized forecast error variance decompositions.

4.1 Data set and stationary properties

To understand the linkages between macroeconomic indicators and trade balance and the possible impacts of the exchange rate policy on the structure of Tunisian trade balance (agriculture and manufacturing), annual data for Tunisian 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 exchange rate (RERB) are collected for 1965-2007 period.[3]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.

Taking into account the data availability requirements (the number of variables and the number of observations), in the present paper we extend the recent work of Baek and Koo (2008) and we consider two systems of variables.[4]

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.[5]

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 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[6], the implementation of the

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

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

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

[6]In April 1972, an off-shore regime for exports was created in order to encourage the emergence of industrial

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).[7] 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.[8]

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):

$$\Delta Y_t = \mu D_t + \Gamma_1 \Delta Y_{t-1} + ... + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi Y_{t-1} + e_t \quad (1)$$

where Y_t is a (k×1) column vector of endogenous variables; D_t is a vector of deterministic variables (intercepts, trend...); and μ is the matrix of parameters associated with D_t ; Γ_i are (k×k) matrices of short-run parameters ($i = 1, ..., p-1$), where p is the number of lags; Π is a (k×k) matrix of long-run parameters and e_t is the vector of disturbances niid(0,Σ).

exports. The first off-shore companies law of 1972 marked the official transition of Tunisia to economic liberalization after cooperativism.

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

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

In the 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×r). β is a matrix representing the cointegrating vectors which are commonly interpreted as meaningful 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.[9]

Table 3 shows the results of Johansen's likelihood ratio tests for cointegration rank. As can be observed, the trace do not reject the hypothesis that there is one cointegrating relation between the variables (r=1).[10] 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

[9] 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.

[10] 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).

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 play a central role in Tunisia's manufacturing trade competitiveness (i.e., since the 70's) and still a functioning policy for the intervention in manufacturing trade competitiveness. The Tunisian dinar depreciation improves manufacturing trade competitiveness, as the domestic prices exported goods become cheaper in foreign currency, thus lowering the price of the countrys exports.

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.[11] 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

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

the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allows for short-run adjustment dynamics.

Empirically, three different non-causality tests can be performed. The short-run Granger non-causality is related with the statistical significance of the lagged dynamic terms. The long-run weak exogeneity 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.is related.

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 product.

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 of in the case of agricultural trade balance. In addition, this pattern may indicate that J-curve phenomenon does not exist in Tunisian agricultural sector.

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 contingents) 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 contingents.

Finally, when considering the causal flow between agricultural trade balance and disposal 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 LATB . 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 disposal 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 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; the agricultural prices and the per capita disposable income in explaining the variation in agricultural trade balance. Innovations in LAGDP explained for the 38% of the variance forecast errors of LATB at the first horizon. However, innovations in RERB explained only for 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 seems 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 seem to rise over time.
- Shocks to LMTB seems 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 social and economic reasons, and the promotion of food security and increase competitiveness of agricultural sub-sectors in which the country had a comparative advantage are important government's objectives. However, an important element of the structural reforms introduced in Tunisia in the late 1980s has been a continuously depreciating exchange rate to improve the country's overall competitiveness.

The impact that this exchange rate policies has on the net external position of the agricultural sector is theoretically ambiguous. In this paper we empirically assess the impact and found that exchange rate depreciations have led to a deterioration of the net external position of Tunisia's agricultural sector, hurting the objectives of food security and increase competitiveness set for this sector.

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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)	0.4375[a]	0.2359[a]
	LAP	0.5125 (0)	0.4137[a]	0.2286[a]
	LMP	-1.1622 (3)	0.4375[a]	0.2359[a]
	LPDI	-3.0455 (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	-6.1933[a] (1)	0.0312	0.0498
	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	-5.6715[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	-5.0869[a] (0)	0.1119	0.1006
	ΔLAGDP	-7.7518[a] (0)	0.0341	0.0483
	ΔLMGDP	-8.3862[a] (0)	0.4172[c]	0.4893[b]
	ΔLAP	-2.6053[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 for 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	-2.2364	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	-1.8870	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]	87.795[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]	44.790	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	14.278	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

$$\alpha = \begin{pmatrix} -0.608^{a} \\ (-2.749) \\ -0.013 \\ (-0.254) \\ -0.195^{b} \\ (-2.226) \\ -0.002^{a} \\ (-0.094) \\ 0.107^{a} \\ (-5.535) \end{pmatrix} \text{ and } \beta' = \begin{pmatrix} 1.000 & 0.909^{a} & -2.566^{a} & 4.384^{a} & 6.626^{a} & -0.384^{a} \\ & (3.669) & (-8.651) & (10.398) & (13.044) & (-13.704) \end{pmatrix} \times \begin{pmatrix} \text{LATB} \\ \text{LRERB} \\ \text{LAGDP} \\ \text{LAP} \\ \text{LPDI} \\ \text{TREND} \end{pmatrix}$$

"MANUF-TRADE" system

$$\alpha = \begin{pmatrix} -0.690^{a} \\ (-9.685) \\ -0.011 \\ (-0.180) \\ -0.052 \\ (-0.977) \\ -0.066^{a} \\ (-2.632) \\ 0.059^{b} \\ (2.253) \end{pmatrix} \text{ and } \beta' = \begin{pmatrix} 1.000 & -0.354^{b} & -1.104^{a} & 0.128 & -0.292 & 0.051^{a} \\ & (-2.118) & (-2.876) & (0.328) & (-0.558) & (3.096) \end{pmatrix} \times \begin{pmatrix} \text{LMTB} \\ \text{LRERB} \\ \text{LMGDP} \\ \text{LMP} \\ \text{LPDI} \\ \text{TREND} \end{pmatrix}$$

[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			
$H_0 : LATB \nrightarrow LRERB$	3.7395[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	65,01%	19,05%	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%	5,82%	0,70%	96,62%	15,69%
2	0,51%	8,95%	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%	89,55%	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	LRERB	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%	9,56%	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 LRERB				
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%	3,42%	94,76%	2,37%	23,94%
4	5,29%	3,86%	93,70%	1,88%	24,36%
5	5,70%	4,29%	92,61%	1,56%	24,86%
10	6,74%	6,05%	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%	28,66%	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	28,24%	4,85%	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%

Figure 1. Trends in the "AGRI-TRADE" system

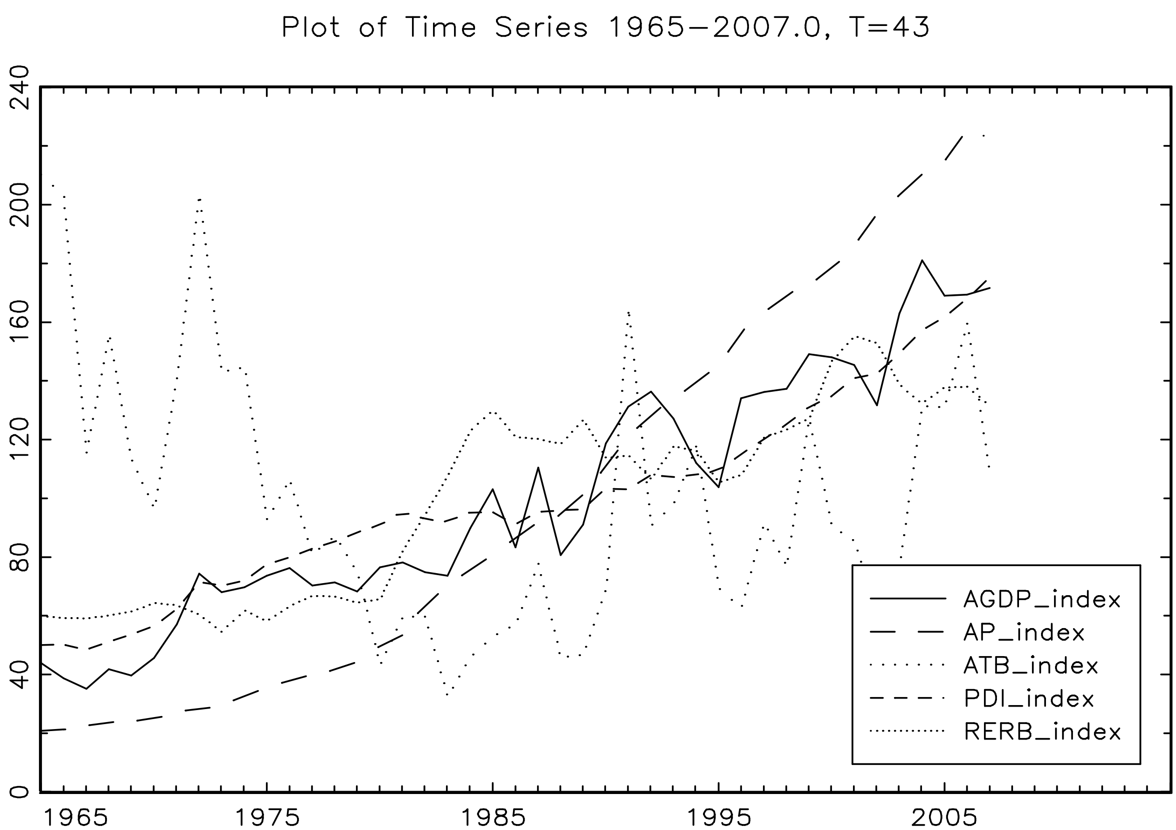
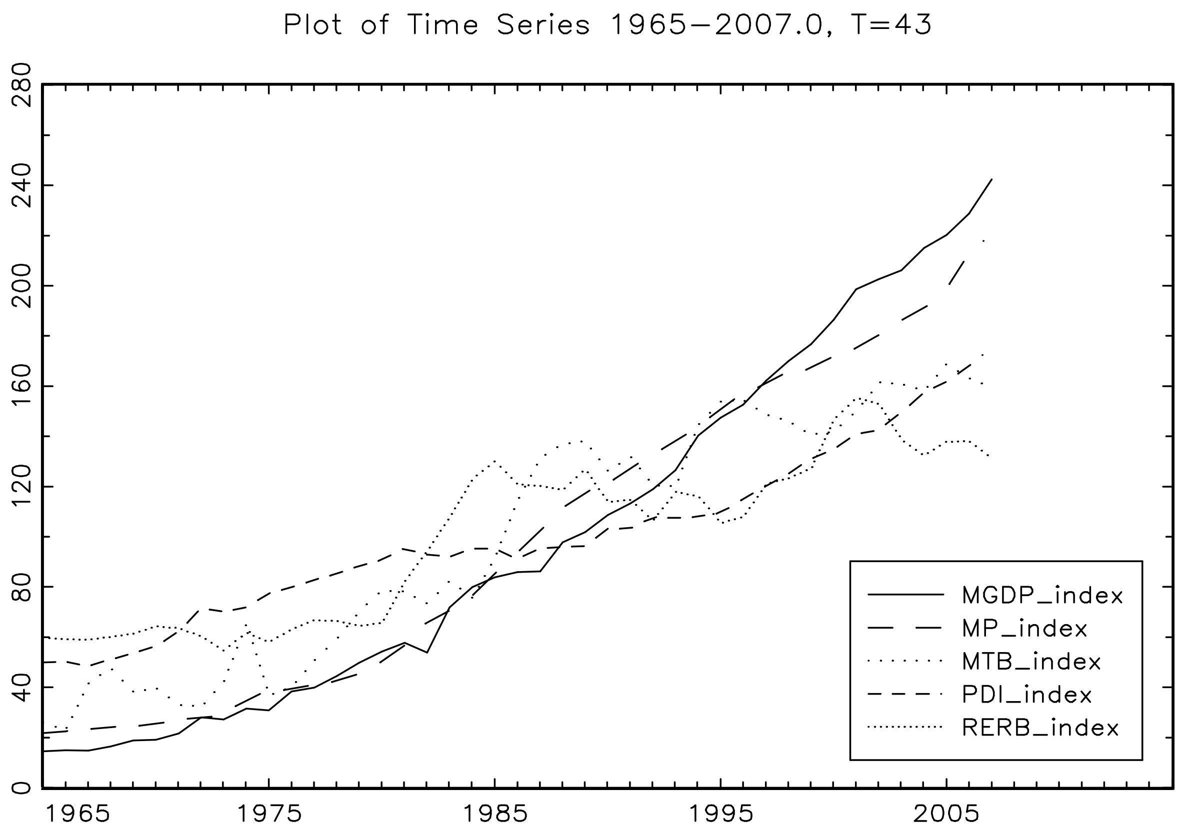


Figure 2. Trends in the "MANUF-TRADE" system



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	RERB	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 RERB is given by: $RERB = \frac{CPI_{EU}}{CPI_{TN}} \times TCN$ 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.