Management Studies and Economic Systems (MSES), 1 (4), 213-228, Spring 2015

The Impact of Full Convertibility of the Dinar on the Macro-Economic Situation in Tunisia

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Received 10 November 2014, Accepted 19 December 2014

ABSTRACT:
Convertibility is an important factor in international trade where instruments valued in different currencies will be exchanged. Convertibility can be either total manner or a partial manner. However, whatever the type of convertibility, there will be advantages and disadvantages to the economy of a country of which has made a convertibility of its national currency. Convertibility was studied by means of the causal relationship between the exchange rate and the level of domestic inflation. Our research is devoted to the study of the impact of full convertibility on the macro-economic situation in Tunisia. In this study a VAR model is used to test the dynamic relationship between the nominal effective exchange rate and the inflation rate. The present study is based on monthly data for a period of 13 years (2000-2012). Three endogenous variables and three exogenous variables are used. The results indicated that the existence of a bidirectional relationship between the nominal effective exchange rate and the inflation rate. This relationship reflects the impact of the convertibility of the Dinar on the macro-economic situation in Tunisia.

Keywords: *Exchange rate regime, Convertibility, Exchange rate, Inflation rates, VAR modeling, Causality*

JEL Classification: C32; E31; E42; F31; O24

INTRODUCTION

The exchange rate is an important asset prices and that may be the price of the most important assets. It is also a distinctive asset prices. However, the exchange rate has separate well-defined plans that are chosen by the government and managed by the central bank. However, some countries fix their exchange rate (for example, Denmark, Hong Kong), while others do not (Canada, New Zealand). Several countries have changed their minds on the subject of choice of exchange rate regimes (Thailand in July 1997, Argentina in January 2002). The official authorities revealed through their policies they care exchange rate.

During the last decade, a number of classifications of exchange rate regimes have been developed, each based on the actual behavior facto. The three most well known of the de jure classification alternatives are those developed by Levy-Yeyati and Sturzenegger (2003, "LYS"), Reinhart and Rogoff (2004, "RR") and Shambaugh (2004).

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Each is based on a different technique. The alternative is based on LYS combines data on exchange rates and international reserves using a cluster analysis, this way they can be an intervention on the foreign exchange market and the exchange rate changes. RR (2004) is supported on the movements of exchange rates determined by the market; they often diverge from those official when there are parallel or dual markets due to capital controls.

Shambaugh (2004) classified a country pegged if its official exchange rate remains within a small group for a sufficiently long period. All methods classify regimes nominal exchange rate.

However, the interest of the economic literature on exchange rate regime reflects its importance in open economies. Thus, the system change from one country defines the framework within which to conduct trade, financial and economic relations with the rest of the world.

Indeed, the exchange rate in arbitrations that guide the decisions of economic agents in their transactions on goods and services or placement of their savings. Furthermore, the exchange system affects both domestic and external performances of countries. The effects of system changes on inflation, trade, investment, growth, fiscal and monetary policy were analyzed by extensive theoretical and empirical literature.

Moreover, the findings are not consensual. Conflicting results are also common. Some points of consensus emerge also appear. This is the favorable impact of fixed exchange rate systems on average inflation, especially in developing countries.

But a recent economic development shows that inflation has a significant decrease in all regions of the world, regardless of the exchange rate system. This development was accompanied by the adoption of independent central banks, one of the main tasks is to reduce inflation and maintain a low and stable (Chang and Velasco, 2000).

The analysis of the economic literature on the topic of convertibility allowed us to observe several works in which this topic is of great importance. Convertibility was studied by means of the causal relationship between the exchange rate and the level of domestic inflation.

In this alignment, it is crucial to consider the type of relationship between the fluctuations of the exchange rate with the index of consumer prices taking into account some economic variables.

In other words, this chapter is to answer the following question: What is the impact of exchange rate changes on inflation, and that is the evolution of the exchange rate that causes the inflation or vice versa?

A literature review is given in the second section. In the third section the sampling method and the model is outlined. The analysis of results is presented in the fourth section. The last section is reserved to conclusion.

Literature Review

The study of the problem of full convertibility of the exchange rate focuses on the study of the relationship between the exchange rate and the index of consumer prices as the convertibility defined by the liberalization of exchange rates has a direct impact on the indices of consumer prices.

Therefore, the impact of exchange rate changes on the index of consumer prices is justified by the attention drawn by researchers and monetary authorities in the recent years. Thus, most of the work is devoted to the study of a dynamic relationship between the nominal effective exchange rate and the index of consumer prices.

However, the available literature on the subject is divided into two categories. The first category focuses on a single country and the second one concerns a group of countries.

In the first category it is noticed that there is little influence of exchange rate changes on the index of consumer prices.

Bhundia (2002) used a Structural VAR model to test the causal relationship between changes in exchange rates and inflation in South Africa for a period of 31 years (1980-2000). Bhundia has shown that exchange rate fluctuations are absorbed by the intermediate stages of production. However, variations in exchange rates have an impact on the price index for consumption but a little weak and it remains significant.

Mwase (2006) studied the impact of exchange rate changes on inflation in Tanzania. He used a Structural VAR model for a period of 16 years (1990-2005). This author has shown that fluctuations in exchange rates have an

incomplete effect on the price index for consumption.

Khundrakpam (2007) prepared a study on the economy of India where he studied the impact of exchange rate changes on domestic price index. This study was done on a period of 87 months (8: 1990-3: 2005). This author has analyzed the Pass-Through in a recursive framework variety evaluating impulse responses from exchange rate shocks. The results obtained by this author have shown the lack of an impact of exchange rate changes on domestic prices.

According to Gagnon and Ihrig (2004), there is no endogeneity is a demonstrated between the exchange rate and inflation. Their study is made for the period 1971-2003 in several countries. They use a simple regression for them to get robust estimates of the degree of impact of exchange rate changes on the index of consumer prices. Gagnon and Ihrig (2004) demonstrated that the transmittance is crucial that central banks should consider placing monetary and exchange rate policies.

In the same alignment, and Kara Ogunc (2005) developed a VAR model to determine the point at which the Turkish economy was affected by fluctuations in exchange rates due to the convertibility of the exchange rate in Turkey. The choice of this type of model Ogunc and Kara (2005) is justified by the research of the dynamic between the inflation rate and the exchange rate. Both authors aim is to study the impact of exchange rate changes on the index of consumer prices following the choice of exchange rate regime to free-float.

We remark the existence of studies from a group of countries. Thus, this type of study strongly supports the argument of Taylor (2000) stated that a credible low inflation regime is suitable for low impact. This author has used a model of corporate behavior and based on a small variety.

Choudri and Hakura (2001) used a linear regression model for quarterly data for the period 1979-2000. They used a VAR model and concluded that fluctuations in exchange rates had a positive impact on domestic prices.

Devereux (2001) found that in an open economy with strong impact by changes in exchange rates on the inflation rate. This impact is recorded following the convertibility of currency exchange rates. This author has used a large sample of countries. The results of this author have proved the existence of a significant trade-off between output volatility and inflation volatility.

Goldfajn and Werlang (2000) demonstrated that the most important variable in explaining the impact of exchange rate is the misalignment of the real exchange rate in developing countries and the initial inflation in developed countries by using a sample of 71 countries.

Leigh and Rossi (2002) conducted Johansen cointegration test to an error correction model to show that the degree of transmission is higher for emerging markets than for developed markets.

Frankel et al. (2005) showed that the per capita income, the tariff, wages, trade liberalization and changes in the exchange rate in the long term can cause the phenomenon of repercussion or transmission.

All the studies cited above are designed to test the dynamic causal relationship that may exist between the nominal effective exchange rate and the index of consumer prices following the convertibility policy adopted by the country while putting the focus on exchange rate regimes chosen.

The analysis of this relationship is based on the use of macro-economic indicators vary from one study to another depending on the availability of data and on the econometric approach adopted.

RESEARCH METHOD

Sampling and Presentation of the Model

During the 80s and 90s Tunisia pursues a strategic policy to ensure economic and financial stability. Among the policies adopted by Tunisia include reforms implemented in the economic and financial sector. These reforms have led to rapid economic growth.

However, the opening of Tunisia on international markets has allowed him to regain the paths needed to accelerate economic growth so that it can support the situation of the labor market.

Following the international financial globalization and further economic integration of Tunisia in international markets, the Tunisian government has had the opportunity to move to full convertibility of the Tunisian Dinar. The following question arises in this regard.

- ✓ What is the impact of convertibility on the economic cycle?
- ✓ Does convertibility affect the price index for household consumption due to changes in the exchange rate?

The study is conducted to determine if there is a relationship between changes in the exchange rate and the index of consumer prices and focuses on the full convertibility of the exchange rate in Tunisia. This study will be led by an empirical validation covers monthly data for a period of 13 years (2000-2012).

The data is collected from the manual of financial statistics and exchange service of the Central Bank of Tunisia (BCT) and the National Statistics Institute (NSI).

The model used in this study was inspired by that of Choudhri and Hakura (2001), and Kara Ogunc (2005) and Choudri and Hakura (2006). This is a VAR (Vector Autoregressive) which highlights the dynamic relationship between inflation (measured by the index of consumer prices in our model chosen) and the change in the nominal effective exchange rate, and incorporating other macroeconomic variables such as aggregate M4, the value of imports and the value of exports.

Therefore, the model to be used is as follows:

$$\begin{cases} \ln(\mathrm{IPC})_t = f(\mathrm{IPC}, \mathrm{TCEN1}, \mathrm{TCEN2}, \mathrm{M4}, \mathrm{M}, \mathrm{X}) \\ \ln(\mathrm{TCEN1})_t = f(\mathrm{IPC}, \mathrm{TCEN1}, \mathrm{TCEN2}, \mathrm{M4}, \mathrm{M}, \mathrm{X}) \\ \ln(\mathrm{TCEN2})_t = f(\mathrm{IPC}, \mathrm{TCEN1}, \mathrm{TCEN2}, \mathrm{M4}, \mathrm{M}, \mathrm{X}) \end{cases}$$

With,

$$\ln(\mathrm{IPC})_t = \alpha_0 + \alpha_1 \ln(\mathrm{IPC})_{(t-k)} + \alpha_2 \ln(\mathrm{TCEN1})_{(t-k)} + \alpha_3 \ln(\mathrm{TCEN2})_{(t-k)} + \alpha_4 \ln(\mathrm{M4})_{(t-k)} + \alpha_5 \ln(\mathrm{M})_{(t-k)} + \alpha_6 \ln(\mathrm{X})_{(t-k)} + \varepsilon_t$$

$$\ln(\mathrm{TCEN1})_t = \beta_0 + \beta_1 \ln(\mathrm{IPC})_{(t-k)} + \beta_2 \ln(\mathrm{TCEN1})_{(t-k)} + \beta_3 \ln(\mathrm{TCEN2})_{(t-k)} + \beta_4 \ln(\mathrm{M4})_{(t-k)} + \beta_5 \ln(\mathrm{M})_{(t-k)} + \beta_6 \ln(\mathrm{X})_{(t-k)} + \omega_t$$

$$\ln(\mathrm{TCEN2})_t = \gamma_0 + \gamma_1 \ln(\mathrm{IPC})_{(t-k)} + \gamma_2 \ln(\mathrm{TCEN1})_{(t-k)} + \gamma_3 \ln(\mathrm{TCEN2})_{(t-k)} + \gamma_4 \ln(\mathrm{M4})_{(t-k)} + \gamma_5 \ln(\mathrm{M})_{(t-k)} + \gamma_6 \ln(\mathrm{X})_{(t-k)} + \vartheta_t$$

Where:

Endogenous Variables

- ✓ $\mathbf{ln(IPC)_t}$ **:** Consumer price index at time t. This index is considered a general indicator that measures changes in the prices of all goods and services consumed by households in a given country. This indicator is used to measure price changes obtained by comparing the retail price of a basket of typical provisions of goods and services on two different dates. This variable will be used to measure the rate of inflation.
- ✓ $\mathbf{ln(TCEN)_t}$ **:** Nominal effective exchange rate Euro / Dollar or Dinars / Dinars at time t. This indicator is the value of a national currency against another foreign currency. Thus, the variation in the exchange rate of a currency relative to a single foreign currency remains a meaning and a limited scope. However, the variation of the exchange rate against a basket of currencies can be operated in a different manner to that of a single currency. This variable will be used to explain the amount of foreign currency per unit of local currency, plus an increase in this rate implies a nominal appreciation. In our research, we use the nominal effective exchange rate
- ✓ $\mathbf{ln(TCEN1)_t}$ **:** Nominal effective exchange rate Euro / Dinars at time t.
- ✓ $\mathbf{ln(TCEN2)_t}$ **:** Nominal effective exchange rate Dollar / Dinars at time t.

Exogenous Variables

- ✓ $\mathbf{ln(M4)_{t-k}}$ **:** The monetary aggregate M4 at time t-k. this aggregate is considered the largest and most stable. It includes M3, treasury bills and commercial paper. In Tunisia, the aggregate M4 is the best leading indicator to measure inflation.
- ✓ $\mathbf{ln(M)_{t-k}}$ **:** The value of imports at time t-k. The value of imports is considered an advanced indicator for inflation. Imports have an impact on inflation from changes in

exchange rates. The importance of imports is explained by the level of imported inflation to describe the process of transmission. The transmission of changes in exchange rates is usually done on import prices to then affect consumer prices. Thus, the exchange rate has an impact on consumer prices through imported goods and services.

- ✓ $\mathbf{ln(X)_{t-k}}$ **:** The value of exports at time t-k. As for imports, exports play an important role in the transmission of changes in the exchange rate indices of consumer prices. In this case, there is a causal relationship between the exchange rate and the consumer price which is described in the literature. Moreover, depreciation of the exchange rate may lead to an increase in domestic demand for goods and services which will in turn increase the price of tradable and thereafter will indirectly increase the price index for consumption.

Other Parameters

- ✓ $\boldsymbol{\alpha_0}$, $\boldsymbol{\beta_0}$ and $\boldsymbol{\gamma_0}$ **:** are Constants.
- ✓ $\boldsymbol{\alpha_i}$ **:** The coefficients of the variables used in the model 1 with i = 1 ... 6.
- ✓ $\boldsymbol{\beta_i}$ **:** The coefficients of the variables used in the model 2 with i = 1 ... 6.
- ✓ $\boldsymbol{\gamma_i}$ **:** The coefficients of the variables used in the model 3 with i = 1 ... 6.
- ✓ **k:** This is the number of delays related to each variable in all three models.
- ✓ $\boldsymbol{\varepsilon_t}$ **:** The error term of the model at time t 1.
- ✓ $\boldsymbol{\omega_t}$ **:** The error term of the model at time t 2.
- ✓ $\boldsymbol{\upsilon_t}$ **:** The error term of the model at time t 3.

This paper is dedicated to the study of causal relationships between the effective exchange rate and inflation (as measured by the index of consumer prices by integrating other macroeconomic variables). This analysis is conducted in terms of the natural logarithm.

RESULTS AND DISCUSSION

Empirical Results

Throughout this section we will try to analyze and interpret the different results obtained from the estimates made on the three endogenous variables.

Therefore, we will specify the type of the model used for estimation is a VAR model that can only be estimated on time series or time series. The choice of this model or regression is justified by the presence of only one dimension in which the data used is the temporal dimension (a period of 13 years) and the search for a causal relationship to Granger between endogenous variables used. This study focuses on the causal relationship between the nominal effective exchange rate and the index of consumer prices in Tunisia during the period 2000 to 2012.

Thus, table 1 summarizes the descriptive statistics for each variable used in the estimation of the model chosen.

The variable ln(ICP), which expresses the index of consumer prices in Tunisia throughout the study period, can reach a maximum value of 2.023739, as its minimum value is 1.941014. The risk level of the variable ln(IC) which is measured by the standard deviation is equal to 0.0578391.

For the variable ln (TCEN1), which expresses the exchange rate Euro / Dinar all throughout the study period, can reach a maximum value of 0.3112451, as its minimum value is 0.0891984. The risk level of the variable ln (TCEN1) which is measured by the standard deviation is equal to 0.0682896.

The same applies to the variable ln (TCEN2), which expresses the exchange rate Dollar / Dinar all throughout the study period, can reach a maximum value of 0.2787536, as its minimum value is 0.0637086. The risk level of the variable ln (TCEN2) which is measured by the standard deviation is equal to 0.1322843.

According to the results presented in Table 1, we can see that the nominal effective exchange rate Euro / Dinar is the riskiest of the three endogenous variables selected. Changes in these three indices during the study period are shown in figure 1.

Thus, we have shown how the three indicators ln (IPC), ln (TCEN1) and ln (TCEN2) in figure 2. This representation was made for each
year.

Table 1: Descriptive statistics

Variable	Obs	Min	Max	Mean	Sd	Skewness	Kurtosis
ln (ICP)	156	1.941014	2.138618	2.023739	0.0578391	0.2584759	1.83326
ln (TCEN1)	156	0.0891984	0.3112451	0.213178	0.0682896	-0.3531785	1.794651
ln (TCEN2)	156	0.0637086	0.2787536	0.1322843	0.0338619	0.6317627	4.293778
ln (M4)	156	7.186457	7.703503	7.429185	0.1594527	0.2104042	1.659747
ln (M)	156	2.932524	3.558517	3.235162	0.1742977	0.0940273	1.673232
ln (X)	156	2.725176	3.396269	3.106421	0.1805295	-0.1336556	1.730576

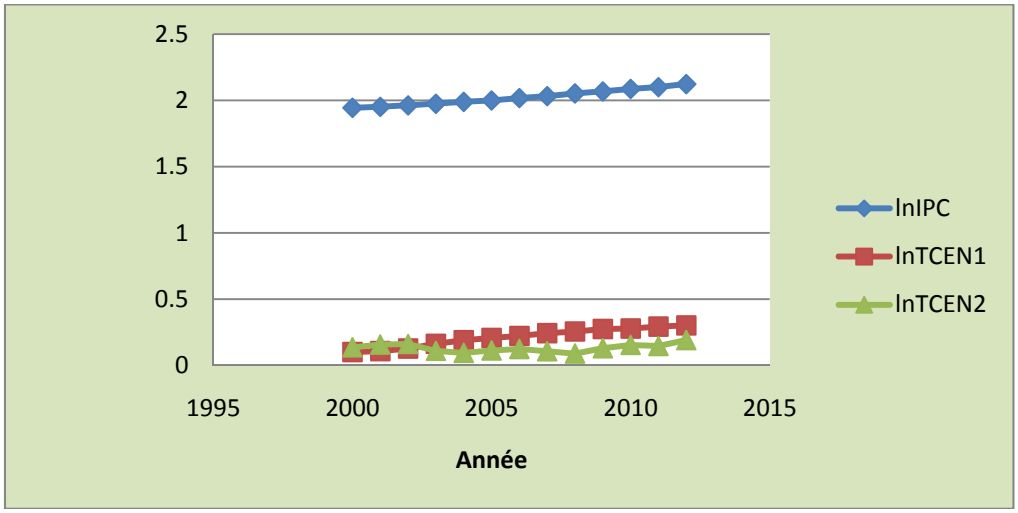

Figure 1: The evolution of ln (IPC), ln (TCEN1) and ln (TCEN2)

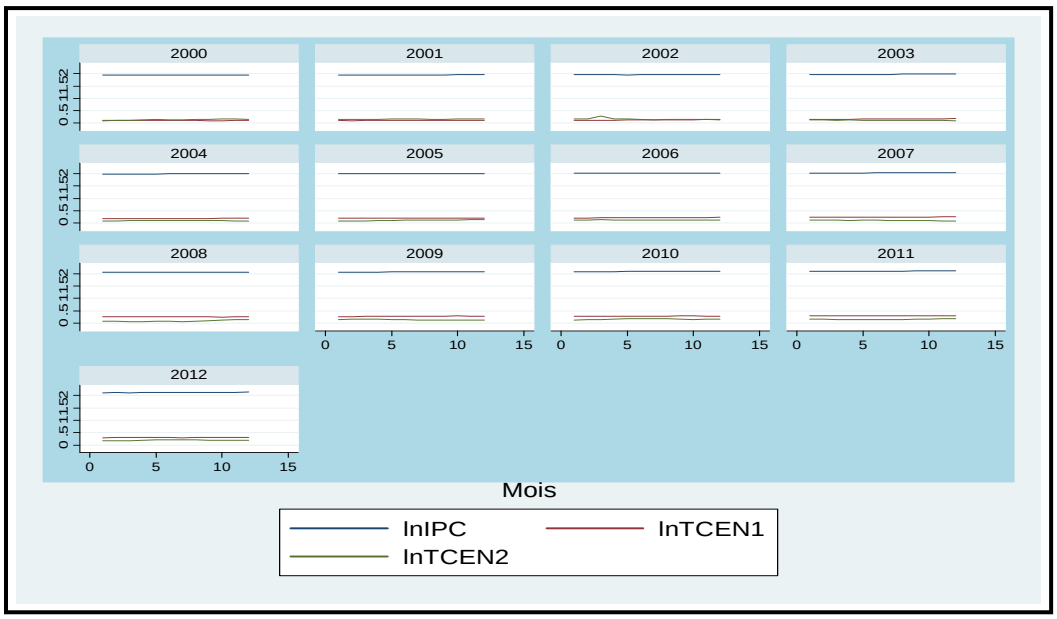

Figure 2: The evolution of ln (IPC), ln (TCEN1) and ln (TCEN2) for each year

We conducted a test of the correlation between variables. Table 2 summarizes the results.

The parameters of a VAR model can only be estimated on stationary time series. Furthermore, the study of stationary is the basis of any analysis of time series. This study of stationary must be paid to the examination of hope and the variance of the variables. In addition, a time series is called stationary or if it has a tendency, or more precisely no seasonality factor changes as a function of time.

Subsequently, to investigate the stationary of the variables of the model used, we performed the test Augmented Dickey Fuller (ADF, 1981) test and the Phillips-Perron (PP, 1988). From these two tests, we can know the stationary of the variables.

The results of these tests are presented in table 3. From this table, we noticed that all the values of the p-value is less than 10% and we also noticed that all the t-student values calculated are lower than the values of t-student reviews. In this case, we reject H0 the presence of unit roots and thereafter, all these variables are stationary and they are no problem when estimating.

Table 2: The correlation matrix

	ln (IPC)	ln (TCEN1)	ln (TCEN2)	ln (M4)	ln (M)	ln (X)
ln (IPC)	1.0000					
ln (TCEN1)	0.9636 (0.0000) *	1.0000				
ln (TCEN2)	0.2501 (0.0016) *	0.0370 (0.6464)	1.0000			
ln (M4)	0.9941 (0.0000) *	0.9632 (0.0000) *	0.2415 (0.0024) *	1.0000		
ln (M)	0.9528 (0.0000) *	0.9341 (0.0000) *	0.1759 (0.0281) **	0.9562 (0.0000) *	1.0000	
ln (X)	0.9354 (0.0000) *	0.9462 (0.0000) *	0.0888 (0.2704)	0.9421 (0.0000) *	0.9695 (0.0000) *	1.0000

Significant at a threshold value: (*) 1%; (**) And 5% (***) 10%

Table 3: Testing the unit root

		Augmented Dickey-Fuller test			Philippi-Perron test		
Variables	**Observations**	**Value-statitic[a]**	**Value-critical[b]**	**p-value[c]**	**Value-statitic[d]**	**Value-critical[e]**	**p-value[f]**
ln (CPI)	155	2949	2576	0.0937	2792	2576	0.0983
ln (TCEN1)	155	2786	2576	0.0233	3782	2576	0.0243
ln (TCEN2)	155	2640	2576	0.0849	2869	2576	0.0833
ln (M4)	155	2898	2576	0.0814	3385	2576	0.0809
ln (M)	155	2924	2576	0.0350	3372	2576	0.0516
ln (X)	155	2890	2576	0.0768	2939	2576	0.0432

[a] This is the calculated t-Student's test for the ADF unit roots value method.
[b]This is the critical value of t-Student test for the unit root by the ADF method.
[c]This is compared to the threshold value of 10% p-value.
[of]This is calculated for Student t-test unit roots by Philippi-Perron value method.
[e]This is the critical value of t-Student test for the unit root in the Philippi-Perron method.
[f] This is compared to the threshold value of 10% p-value.

Following the study of the stationarity of the variables, then we can use the method of ordinary least squares to estimate the VAR model chosen. But prior to estimation we first determine the number of delay to remember.

Thus, determining the number of delay refers to the use of us to criteria Akaike (AIC), Schwarz (SC), Hannan-Quin (HQ) and criterion-Final Predictor-Error (FPE) to determine the optimal number of delay per our model. Thus, the results relating to the determination of the number of delay are presented in the table 4.

Generally, the procedure for selecting the order of representation is to estimate a VAR model by including ln(TCEN1) for an order from 0-4 (we note that 4 is the number of maximum allowable delay in this case) and the VAR model by including ln(TCEN2) for an order from 0 to 4 (4 being the maximum number of late).

According to the three tables above, we can assume the optimal number of delay that corresponds to the minimum criteria AIC, SC, HQ and FPE. This number of delay is equal to three (p = 3). Furthermore, the delay for the selected variables is 3 since we have observed that the minimum of the selected criteria are located on the line 3 to the two models.

After testing the stationary of the variables used and since we have determined the number of delay to remember, we made an estimate of the VAR model adopted. The results of the estimation are shown in table 5.

Table 4: Determination of the number of delay for Model 1, integrating ln (TCEN1)

Number of delays	AIC	SC	FPE	HQ	P
0	-12.7054	-12.5462	1.0e-08	-12.6407	
1	-16.2754	-16.0367	2.9E-10	-16.1784	0.000
2	-16.3944	-16.0761	2.6e-10	-16.2651	0.000
3	-16.4148 *	-16.0869*	2.5e-10 *	-16.273 *	0025
4	16,385	-15.9076	2.6e-10	-16.1911	0.482

Table 5: Determination of the number of delay for the Model 2, integrating ln (TCEN2)

Number of delays	AIC	SC	FPE	HQ	P
0	-11.4358	-11.2767	3.7e-08	-11.3711	
1	-14.0613	-13.8226	2.7e-09	-13.9643	0.000
2	-14.2344	-13.9161	2.3E-09	-14.1051	0.000
3	-14.2788 *	-13.9809*	2.2e-09 *	-14.117 *	0005
4	-14.2341	-13.7566	2.3E-09	-14.0401	0877

Table 6: Results of the estimation of the VAR model

	Coef.	t-Student	P
ln (IPC)			
$\ln (IPC)_{t-3}$	0.8126812	(17.16) *	0.000
$\ln (TCEN1)_{t-3}$	0.0564366	(2.25) **	0025
$\ln (TCEN2)_{t-3}$	0.0228588	(1.74) ***	0081
$\ln (M4)_{t-3}$	0.0439393	(2.70) *	0007
$\ln (M)_{t-3}$	0.009658	(1.29)	0.196
$\ln (X)_{t-3}$	-0.00846	(-1.22)	0224
Cons	0.0337409	(0.48)	0.629
Obs.	155		
R^2	0.9969		
chi2	49231.65		
P> chi2	0.0000		
ln (TCEN1)			
$\ln (IPC)_{t-3}$	0.0545655	(0.78)	0438
$\ln (TCEN1)_{t-3}$	1.009211	(27.02) *	0.000
$\ln (TCEN2)_{t-3}$	0.0217905	(1.12)	0264
$\ln (M4)_{t-3}$	-0.0297134	(-1.23)	0219
$\ln (M)_{t-3}$	0.0062607	(0.56)	0.573
$\ln (X)_{t-3}$	-0.0025177	(-0.24)	0.808
Cons	0.0944857	(0.91)	0.363
Obs.	155		
R^2	0.9950		
chi2	30878.66		
P> chi2	0.0000		
ln (TCEN2)			
$\ln (IPC)_{t-3}$	0.4394153	(2.19) **	0028
$\ln (TCEN1)_{t-3}$	-0.4550786	(-4.28) *	0.000
$\ln (TCEN2)_{t-3}$	0.6977806	(12.57) *	0.000
$\ln (M4)_{t-3}$	0.0575435	(0.84)	0.403
$\ln (M)_{t-3}$	-0.0058132	(-0.18)	0.854
$\ln (X)_{t-3}$	-0.004054	(-0.14)	0.890
Cons	-1.147905	(-3.88) *	0.000
Obs.	155		
R^2	0.8370		
chi2	795.7887		
P> chi2	0.0000		

Significant at a threshold value: (*) 1%; (**) And 5% (***) 10%

Table 6 contains the results of the different estimation of the VAR model. Thus, we used three endogenous variables ln (CPI), ln (TCEN1) and ln (TCEN2) and three exogenous variables ln (M4), ln (M) and ln (X).

We conducted a test to show the validity of the estimated models and justify the significance of the estimates. We tested the correlation between the explanatory variables and residuals. This type of test is based on the value (Prob> chi2). If this probability is less than 5%, so we accept H0 that verifies the absence of correlation between the residuals and the explanatory variables. If this probability is greater than 5%, in this case there is a problem of correlation between the residuals and the explanatory variables that must be corrected.

In all three models, the probability values (Prob> chi2) are all less than 5%. So there are no problems of correlation between the explanatory variables and residuals.

Thus, we found that the coefficient of determination R2 is equal to0.9969 in the first model and 0.9950 in the second model and 0.8370 in Model 3. In this case, the models chosen are characterized by a good linear fit.

In the first model, we found that there are four variables that are significant and have an impact on inflation measured by the index of consumer prices in Tunisia.

First, we found that the value of the inflation at the time (t-3) positively affects the value of inflation at time t. This is justified by the results presented above. However, the value of $\ln(IPC)_{t-3}$ has a positive and significant impact on the variable ln(IPC) t with a threshold of 1% and a value of t-student which is equal to 17.16. In this case, the increase in the value of the inflation at the time (t-3) induces an increase in the value thereof at the time t.

Thus, we found that the exchange rate Euro/Dinar ln(TCEN1) has a positive and significant impact on inflation ln(IPC) with a threshold of 5% and a value of t-student which is equal to (2.25). That is to say that an appreciation of TCEN1 translates into a high level of local inflation, which is consistent with the theory of Devereux and Yetman (2003) and Kara and Ogunc (2005). However, we can confirm these results based on the positive correlation between the exchange rate Euro/Dinar and the inflation rate as measured by the index of consumer prices ln (IPC).

In the same equation, we noticed that the exchange rate Dollar/Dinar ln (TCEN2) has a positive and significant impact on the inflation threshold of 10% and a t-student value of which is equal to (1.74). That is to say that an appreciation of TCEN2 translates into a high level of local inflation, which is consistent with the theory of Devereux and Yetman (2003) and Kara and Ogunc (2005). However, we can confirm these results based on the positive correlation between the exchange rate Euro/Dinar and the inflation rate as measured by the index of consumer prices ln(IPC).

For the exogenous variables, we noticed that there is one significant variable. This variable is the ln(M4) which is statistically significant and positive at the 1% level with a value of t-student which is equal to 2.70. The aggregate M4 (ln(M4)) is positively and significantly to inflation. In fact, the aggregate M4 can be considered a determinant of inflation. This effect suggests that a monetary contraction reduces inflation above the aggregate M4 is the best indicator that reflects the correct orientation of monetary policy in Tunisia.

In addition, the quantity of money determines the price level, and thereafter the rate of inflation depends on the growth rate of monetary aggregates. Moreover, the existence of a surplus in the balance of payments has an inflationary effect exerted by increasing the level of the money supply.

Thus, according to Campa and Goldberg (2004), the exchange rate cannot influence the level of inflation regardless of the growth rate of monetary aggregates.

The other two variables that measure the import and export do not have a significant impact on inflation. Their effect on inflation is limited.

In the second equation, we noticed that the exchange rate Euro/Dinar depends only on its value at the time (t-3). Other words, that the increase in the exchange rate Euro/Dinar at the time (t-3) reflects an increase in the exchange rate at time t. In addition, all other endogenous and exogenous variables used in the second equation are not significant and therefore not have an impact on the nominal effective

exchange rate Euro/Dinar ln (TCEN1). This result was observed even in the presence of a positive correlation between the level of the nominal effective exchange rate Euro/Dollar (ln (TCEN1)) and other variables.

While in the literature the exchange rate may be affected by the level of price indices for consumption. That is to say that inflation can induce a change in the level of the exchange rate and this as shown in the theory of purchasing power parity, which argues that prices determine the exchange rate. In fact, according to the purchasing power parity of a change in the exchange rate is the ratio between the level of foreign prices (inflation abroad) and the local prices (local inflation).

In Equation 3, we found that the value of the inflation (t-3) dated positively affects the actual nominal exchange rate dollar / dinar at time t. This is justified by the results presented above. However, the value of ln $(IPC)_{t-3}$ has a positive and significant impact on the variable ln $(TCEN2)_t$ with a threshold of 5% and a value of t-student which is equal to 2.19. In this case, the increase in value of inflation at the time (t-3) induces an increase in the value of the effective exchange rate at time t.

In this case, there is a close link between fluctuations in the exchange rate and domestic inflation (IPC) based on the theory of purchasing power parity. This means that a IPC increase will cause an appreciation of the TCEN referring to the reflection that can give rigidity of domestic as well as signs of coefficients generated by estimating the parameters of the model used prices.

Thus, we found that the exchange rate Euro/Dinar ln (TCEN1) has a negative and significant impact on the nominal effective exchange rate Dollar/Dinar ln (TCEN2) with a threshold of 1% and a value of t-student who is (-4.28). That is to say that a depreciation of TCEN1 results in an increase in the nominal effective exchange rate Dollar/Dinar. However, we can confirm these results based on the low correlation between the exchange rate Euro/Dinar and the exchange rate Dollar/Dinar.

In the same equation, we noticed that the exchange rate Dollar/Dinar ln (TCEN2) at the time (t-3) has a positive and significant impact on the inflation threshold of 1% and a t-student value which is equal to (12.57). That is to say that an appreciation of the TCEN2 at date (t-3) translates a high level of the exchange rate at time t.

As ln (TCEN1), exogenous variables used have no direct impact on the effective exchange rate Dollar/Dinar.

In light of main results, we can conclude that the majority of coefficients of the variables used in the model have the expected signs and significant.

In the three models estimated, the inflation rate has a significant impact on the three endogenous variables selected. The same for the nominal effective exchange rate dollar/dinar that has a positive and significant impact on inflation and the TCEN. While the exchange rate Euro/Dinar has a positive impact on inflation and a negative impact on the exchange rate Dollar/Dinar.

For the exogenous variables, we found that the aggregate M4 has a positive and significant impact on the index of consumer prices, a negative and insignificant impact on the exchange rate Euro/Dinar and a positive impact not significant on the exchange rate Dollar/Dinar.

The value of imports (ln(M)) has a positive impact but with a low weighting on the IPC and the TCEN1. But it has a negative influence on the TCEN2 with the same weight. However, by analyzing the various theoretical and empirical studies on the subject of transmission of changes in exchange rates, the outcome of full convertibility of the exchange rate, the index of consumer prices, we noticed that the rate of changes affect inflation through imported goods. That is to say, changes in the exchange rate are transmitted to prices of imported goods, then, affect the price index for consumption. In our case, the coefficient of the value of imports is almost nil or insignificant. Faced with this problem, the strategy is to integrate the effect of the monetary aggregate M4 which significantly influences on the index of consumer prices (inflation).

In all three equations, we noticed that the value of exports admits a negative effect but with a low weighting in the IPC, the TCEN1 and the TCEN2. This effect can be explained by the fact that a depreciation of the dinar against the

euro and against the dollar will make exports less produced, thus inducing an increase in domestic prices.

Besides the different results, we performed the autocorrelation Lagrange multiply-test. The results of this test, we found that the probability of test is less than 10% (prob> chi2 = 0.0000). In this case, we accepted the hypothesis H0 of no autocorrelation between the variables selected.

Also, we performed tests Jarque-Berra, skewness and kurtosis of the test for normal distribution, that is to say, the test heterosciedasticity at this distribution. We noticed that all probability values chi2 (Prob> chi2) are all below 10%. So we accept the hypothesis of symmetry and kurtosis of a normal distribution.

Finally, the direct relationship between inflation (IPC) and the nominal effective exchange rate for the basket of major currencies dinar (Euro and Dollar) and other macro-economic variables used in the three equations will be analyzed from the Granger causality test. The results of this test are shown in table 7.

For our research, we studied the existing relationships between different variables in the model with an emphasis on the interactions between the index of consumer prices and the nominal effective exchange rate TCEN1 (Euro/Dinar) and TCEN2 (Dollar/Dinar).

Thus, to study the causal relationship between economic variables in the model, we used the test of Granger causality which has become over time a framework for discussion as interesting as the one on the highlighted links econometric.

However, the concept of Granger causality should be interpreted with caution that is to say: "A variable X is the cause of Y if Y is improved predictability when information on X is incorporated in the analysis ".

Our goal is to test if there is a close link between the development levels of inflation and changes in exchange a rate due to the full convertibility of the Tunisian dinar.

According to table 8, we can conclude that the evolution of TCEN1 (Euro/Dinar) causes inflation in a probability of 97.5%. Similarly, inflation causes a change in the exchange rate Euro/Dinar 56.2%.

According to table 9, we can conclude that the evolution of TCEN2 (Dollar/Dinar) causes inflation in a probability of 91.9%. Similarly, inflation causes a change in the exchange rate Dollar/Dinar 97.2%.

Table 7: Granger causality test

Equation	Null hypothesis H0	chi2	Prob> chi2
ln (IPC)	ln (TCEN1) does not cause ln (IPC)	5.0435	0025
ln (IPC)	ln (TCEN2) does not cause ln (IPC)	3.0353	0081
ln (TCEN1)	ln (IPC) does not cause ln (TCEN1)	0.60076	0438
ln (TCEN1)	ln (TCEN2) does not cause ln (TCEN1)	1.2484	0264
ln (TCEN2)	ln (IPC) does not cause ln (TCEN2)	4.8074	0028
ln (TCEN2)	ln (TCEN1) does not cause ln (TCEN2)	18,315	0.000

Table 8: The Granger causality test between the IPC and the TCEN1

ln (IPC)	ln (TCEN1) does not cause ln (IPC)	5.0435	0025
ln (TCEN1)	ln (IPC) does not cause ln (TCEN1)	0.60076	0438

Table 9: The Granger causality test between the IPC and the TCEN2

ln(IPC)	**ln(TCEN2) does not cause ln (IPC)**	3.0353	0081
ln(TCEN2)	**ln(IPC) does not cause ln(TCEN2)**	4.8074	0028

Table 10: The Granger causality test between the TCEN1 and the TCEN2

ln(TCEN1)	**ln(TCEN2) does not cause ln(TCEN1)**	1.2484	0264
ln(TCEN2)	**ln(TCEN1) does not cause ln(TCEN2)**	18,315	0.000

Table 11: Estimation of the new VAR (ln (CPI) and ln (TCEN2))

	Coef.	**t-Student**	**P**	**Coef.**	**t-Student**	**P**
ln(IPC)						
$ln(IPC)_{t-3}$	0.8596712	(19.91) *	0.000	0.8241216	(17.40) *	0.000
$ln(TCEN2)_{t-3}$	0.0012574	(0.14)	0.890	0.0157374	(1.29)	0198
$ln(TCEN1)_{t-3}$				0.0397268	(1.75) ***	0081
$ln(M4)_{t-3}$	0.0506129	(3.11) *	0002	0.0470524	(2.90) *	0004
$ln(M)_{t-3}$	0.0052316	(0.71)	0475	0.0081274	(1.09)	0275
$ln(X)_{t-3}$	-0.0033532	(-0.50)	0615	-0.0068811	(-1.00)	0.320
Cons	-0.0976102	(-2.51) **	0012	-0.0080515	(-0.13)	0900
Obs.	155			155		
R^2	0.9968			0.9968		
chi2	47675.31			48615.66		
P> chi2	0.0000			0.0000		
ln (TCEN2)						
$ln(IPC)_{t-3}$	0.0605094	(0.32)	0.750	0.5501175	(2.90) *	0004
$ln(TCEN2)_{t-3}$	0.8719644	(21.84) *	0.000	0.6725374	(13.74) *	0.000
$ln(TCEN1)_{t-3}$				-0.5471393	(-6.00) *	0.000
$ln(M4)_{t-3}$	0.0037305	(0.05)	0958	0.0527682	(0.81)	0.417
$ln(M)_{t-3}$	0.0298795	(0.93)	0.354	-0.0100036	(-0.34)	0737
$ln(X)_{t-3}$	-0.0452326	(-1.54)	0124	0.0033548	(0.12)	0.904
Cons	-0.0887495	(-0.52)	0.604	-1.322201	(-5.14) *	0.000
Obs.	155			155		
R^2	0.8177			0.8521		
chi2	695.3136			892.9832		
P> chi2	0.0000			0.0000		

Significant at a threshold value: (*) 1%; (**) And 5% (***) 10%

According to table 10, we can conclude that the evolution of TCEN2 (Dollar/Dinar) causes the exchange rate TCEN1 (Euro/Dinar) in a probability of 73.6%. Similarly, TCEN1 causes variation in the exchange rate Dollar/Dinar 100%.

By observing the above results, we can conclude that there is a bidirectional relationship between variables for each other because almost the same intensity for the TCEN2 and the IPC and an intensity slightly different for IPC and TCEN1 and the TCEN1 and TCEN2.

Firstly, changes in the exchange rate causes a change in the level of inflation. That is to say, an appreciation (depreciation) of TCEN2 causes increase (decrease) price indices for consumption. These results are consistent with results found by Leigh and Rossi (2002) and Gagnon and Lhrig (2004).

Secondly, the index of consumer prices due to fluctuations in the nominal effective exchange rate. This is in accordance with the theory of purchasing power parity. Note in this regard that the impact of inflation on the Rate Exchange does not always mean that this impact generates an appreciation of the nominal effective exchange rate, but it can lead to a depreciation of the latter in some cases.

Following the results for the Granger causality test, we found that only two variables ln (IPC) and ln (TCEN2) have a causal Granger justifies the existence of a strong two-way relationship. In addition, we conducted another estimate a VAR model consists of two endogenous variables ln (CPI) and ln (TCEN2) and four exogenous variables are ln (TCEN1), ln (M4), ln(M) and ln (X). The estimation results of this new VAR model are presented in table 11.

Table 11 summarizes the various estimates of the two models considered. Thus, we conducted a Wald test to show the validity of the estimated models and justify the significance of the estimates. We tested the correlation between the explanatory variables and residuals. This type of test is based on the value (Prob> chi2). If this probability is less than 5%, so we accept H0 that verifies the absence of correlation between the residuals and the explanatory variables. If this probability is greater than 5%, in this case there is a problem of correlation between the residuals and the explanatory variables that must be corrected.

In both models, the probability values (Prob> chi2) are all less than 5%. So there is no problem of correlation between the explanatory variables and residuals.

Thus, we found that the coefficient of determination R2 is equal to0.9968 in the two estimates of the first model in 0.8127 the first estimate and the second model 0.8521 in the second estimate of the second model. In this case, the models chosen are characterized by a good linear fit.

Concerning the significance of the different variables, we noticed that all the variables kept the same level of significance. Thus, we used the TCEN1 (Euro/Dinar) as an exogenous variable. This variable has the same impact in both cases: endogenous or exogenous variable. Table 12 summarizes the results of the various estimates in terms of significance.

Table 12: Summary of results of the estimation of the second VAR model

Variables	Impact on the variable ln(IPC)				Impact on the variable ln (TCEN2)			
	No significant positive impact	No significant negative impact	Significant positive impact	Significant negative impact	No significant positive impact	No significant negative impact	Significant positive impact	Significant negative impact
ln(IPC)t-3			*		*		*	
$ln(TCEN2)_{t-3}$	*						*	
$ln(TCEN1)_{t-3}$			*					*
$ln(M4)_{t-3}$			*		*			
$ln(M)_{t-3}$	*				*	*		
$ln(X)_{t-3}$		*			*	*		

Our goal in this paper is to study the concept of full convertibility of the Tunisian dinar. This study leads us to study the causal relationships which may exist between the nominal effective exchange rate, mainly the exchange rate Euro/Dinar exchange rate and the dollar/dinar, and the inflation rate as measured by the index of consumer prices. This study was developed using three endogenous variables (ln(IPC), ln(TCEN1) and ln(TCEN2)) and three exogenous variables (ln(M4), ln (M) and ln (X)).

To define the variables and after the presentation of the different types of econometric tests for the use of a VAR model, we concluded that there is a causal link between the evolution of inflation and exchange rate exchange taking into account the effect of other macroeconomic indicators such as the monetary aggregate M4, imports and exports.

CONCLUSION

The fundamental question that we tried to identify and bring some answers throughout this third chapter is: To what extent changes in exchange rates may affect the level of domestic prices?

We did use a VAR model to make clear and study the dynamics of inflation and the exchange rate in Tunisia. The results are consistent with other results found by other researchers who have found in their studies on different countries. Successful outputs results allow us to conclude that the convertibility of the dinar can be justified by the presence of two-way dynamics of inflation and the exchange rate. In the first sense, changes in the exchange rate issue and reflect the changes in the index of consumer prices, while for the second sense; we can say that the indices of home prices can cause fluctuations in the rate nominal effective exchange rate taking into account the theories of purchasing power parity.

Thus, as the fluctuations in the exchange rate affects the level of inflation, the reverse relationship is also checked but with a different coefficient of significance. Therefore, the level of the index of consumer prices has an impact on the exchange rate, that is to say, the goal of achieving a low inflation could affect policy changes adopted.

In this respect, the full convertibility of the dinar has mainly impact on the level of price indices for domestic consumption. In addition, the convertibility policy changes that must be done by a monetary policy that allows a country to avoid any risks to the monetary system and exchange rate system.

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