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ASYMMETRIC BEHAVIOR OF EXCHANGE RATE IN TUNISIA: A NONLINEAR APPROACH

Wissem Boukraine*

ABSTRACT

This paper aims at analyzing Tunisia's exchange rate pass-through to inflation on quarterly data from 2011Q4 to 2019Q4. For this purpose we adopt a smooth transition autoregressive approach, this model enables us to distinguish two regimes and determine both the threshold and transition's speed between both regimes. Our results suggest the existence of significant short run causality among inflation, economic growth, real effective exchange rate and external debt growth. The non-linearity tests we conducted favors the logistic smooth transition autoregressive specification (LSTAR) which fits better the behavior of exchange rate pass-through to inflation in Tunisia during the last decade. We have also found that the exchange rate pass-through to inflation is high but slightly declines by switching from the first to the second regime when external debt reaches a certain threshold level, what rises concern is the rise in its volatility when the switch occurs. The policy recommendations derived from these findings are the inevitability of slowing down the external debt growth by mainly reducing government spending, increasing production and diversify exportation.

KEY WORDS: *Exchange Rate Pass-through, Regime Change, LSTAR, Tunisia*

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1. INTRODUCTION

According to Goldberg and Knetter (1997), exchange rate pass-through reflects a change in local currency import prices following a variation of the exchange rate between the exporting and the importing countries. These variations in import prices are passed on to producer and consumer prices. In the absence of fixed exchange rate, the latter affects not only aggregate demand but also aggregate supply as a channel of monetary policy. In fact, easing the monetary policy, can depreciate the exchange rate, increase the costs of imports in national currency, and consequently, push companies to raise prices. Besides,

since exchange rate volatility is seen as a signal of future inflation volatility, wages and prices can rise even before the costs of imports does. Such phenomenon is on one hand a major concern to emerging economies in general (Taylor, 2000), and a special concern for the Tunisian economy in particular as it is a key factor in understanding inflation dynamics and therefor in conducting monetary policy.

Convinced that exchange controls constitute a real handicap which affects the competitiveness and performance of the economy, the Tunisian monetary authorities, since 1987, have progressively liberalizing trade and relaxing exchange rate controls. Therefore, certain measures have been undertaken in order to allow certain flexibility in the management of firms that use imported products and to stimulate productivity gains and encourage local production in the face of to foreign competition. These measures were accompanied by the establishment of an institutional and regulatory framework in order to better take advantage of developments in the global economy. Before adopting price stability as its main goal in 2006, the Tunisian central bank perused many objectives at the same time via discretionary monetary policy. Among those objectives, it focused on preserving the competitiveness of the Tunisian economy by reducing the inflation gap relatively to the commercial partners, in that spirit, several adjustments of the nominal effective exchange rate were made. Recently, the shortage in foreign currencies reserves, the deficits of both the trade and the payment balances are among the main factors due to which the Tunisian national currency lost a great portion of its value during the last ten years. The International Monetary Fund, in its 2018 country report stated that public and external debt ratio in Tunisia represented respectively 70% and 80% of the county's gross domestic product. While both core and level inflation exceeded 7% year on year evolution following the continuous depreciation of the national currency. In such circumstances, a high debt ratio might lead to inflationary pressure, especially in emerging countries, as suggested by the economic literature. In fact, many of the authors who focused on the causality between debt and inflation confirm that debt growth was inflationary in many cases, such as in Malaysia (Tan, 2006), in India (Kannan and Singh, 2007), in Iran (Nouri and Samimi, 2011) and in Pakistan (Jalil, Tariq, and Bibi, 2014).

The impact of exchange rate on inflation has been largely studied for the Tunisian case mainly in linear context, and while important results and conclusions have been driven, still the nonlinear approach more appealing. For

the Tunisian case, some studies focus on the first stage pass-through of exchange rate into import and export prices at the aggregate or the disaggregated levels, other focus on the second stage pass-through of exchange rate into overall consumer or producer prices. This paper fits in the second group of studies, nevertheless, this work differs from its predecessors as it follows a nonlinear methodology based on the smooth transition autoregressive model. First we test for nonlinearity then we estimate the exchange rate pass-through to inflation and the impact of external debt growth on its behavior. The smooth transition autoregressive approach appeared initially in Bacon and Watts (1971), later on, the work of Teräsvirta (1994, 1998) enriched the model which gained more popularity in explaining fluctuations.

To our knowledge, this two regimes econometric procedure has never been applied, for the case of Tunisia. In fact we will not only determine the degree of exchange rate pass-through to inflation like previous works, but we will also analyze the effect of external debt evolution on its behavior. More precisely we will determine at which level of external debt the exchange rate switches between the two regimes and does this transition reduce or not its volatility. Taking into account the asymmetry of exchange rate via two regime model might give new insight for the conduct of monetary policy as the exchange rate is a monetary transmission channel. Knowing at which level of the threshold variable the switch between regimes occurs and the volatility associated with this transition becomes crucial.

The paper is organized as follows. In the second section, we will review the related literature, in the third section we will present the methodology, in the fourth section we will discuss the results, while in the fifth and last section we will conclude with remarks and policy recommendations.

2. LITERATURE REVIEW

The exchange rate determines the price of imported goods as well as inflation expectations and the competitiveness of domestic firms. But the capital flows induced by changes in the exchange rate can trigger credit and asset price bubbles. On the other hand, if the debts of companies or banks are largely denominated in foreign currencies and they are not equal to their holdings of foreign currencies, exchange rate depreciations can increase the debt burden and possibly forcing them into bankruptcy. For Sargent and Wallace (1981) a

rise in debt leads to inflationary pressure especially in highly indebted economies. Reinhart and Rogoff (2009) and Reinhart and Rogoff (2010) found a causality between debt and inflation in the emerging economies. These countries in particular struggles when it comes to external debt reimbursing as it drains their foreign currencies reserves and limits their central banks capability of defending the external value of their national currency.

The degree to which prices adjust to the exchange rate variations is necessary to understand inflation's dynamic and therefor to the conduct of monetary policy. The issue of exchange rate pass-through to inflation was considered by many authors for the Tunisian case especially in a linear context and their results are mainly an estimation of its degree. Abida and Sghaier (2012) found no evidence of a statistically significant nominal exchange rate pass-through to consumer or producer prices in Tunisia and morocco on both quarterly and annual data over the period 1980 to 2010. For the case of Tunisia the pass-through to consumer prices is about 0.238. Helali et al. (2014) on quarterly data from 1994 to 2010 found a short term exchange rate pass-through to inflation of about 15% for the year 1994 and 25% for the year 2010. They also found a long term exchange rate pass-through to inflation of 38% in 1994 and 60% for the year 2010. Guizani (2015) used a vector error correction model on Tunisian monthly data from 2000 to 2013 found a high exchange rate pass-through to consumer prices around 2011. Marrakchi Charfi and Kadria (2016) used a structural vector autoregressive model on monthly data from 2000 to 2013. The authors found a lower incomplete exchange rate pass-through to consumer prices than to import prices or to producer prices. The exchange rate pass-through to inflation was also approached in a nonlinear context for the Tunisian case but in rare occasions. Khemiri and Ben Ali (2013) using a Markov regime switching model for Tunisia on monthly data from 2001 to 2009, found evidence of two inflation regimes associated with low and high exchange rate pass-through to consumer prices.

By considering the exchange rate pass-through to inflation, the past works did not give much attention to external debt growth, mainly because it was not an issue back then, but lately things have changed since the external debt reached unprecedented levels in terms of GDP percentage. Therefore we find it necessary to include it in our estimation, not only to distinguish this work from its predecessors but also to determine its impact on the issue of exchange rate pass through to inflation.

3. METHODOLOGY

Our approach is nonlinear; in fact we use a smooth transition autoregressive model, in which our dependent variable, inflation, switches between two extreme and endogenously determined regimes. We estimate the exchange rate pass-through to inflation and the impact of external debt growth on its behavior via the following specification:

$$\begin{aligned}\pi_t &= \phi' z_t + \theta' z_t G(y, c, s_t) + \varepsilon_t \\ &= \{\phi + \theta G(y, c, s_t)\}' z_t + \varepsilon_t\end{aligned}\tag{1}$$

All data are quarterly, year on year evolution. π_t denotes inflation, $DEBT_t'$ denotes the external debt's, GDP_t' denotes the economic growth, $REER_t'$ denotes the real effective exchange rate.

Where $z_t = (w_t', DEBT_t', GDP_t', REER_t')'$ is a vector of explanatory variables; with $w_t' = (1, \pi_{t-1}, \dots, \pi_{t-p})'$, $DEBT_t' = (DEBT_{1t}, \dots, DEBT_{kt})'$, $GDP_t' = (GDP_{1t}, \dots, GDP_{kt})'$ and $REER_t' = (REER_{1t}, \dots, REER_{kt})'$ vectors of exogenous variables and $\varepsilon_t \sim iid(0, \sigma^2)$.

While $G(y, c, s_t)$ represents the transition function with y and c the speed of transition and the threshold, respectively. The latter's value is determined, using model selection techniques, among several candidates variables for s_t . The estimations of the model's parameters, the threshold and the transition speed between regimes are done following nonlinear least squares method. The transition function is related to the model's specification which can vary from logistic (LSTR), normal (NSTR or STR), exponential (ESTR) or even logistic, second-order (L2STR). The choice between these specifications is conducted with the Teräsvirta (1994) linearity tests based on the first-order Taylor approximation.

4. RESULTS

Data, namely external debt growth, inflation, real effective exchange rate and economic growth measured by the gross domestic product's evolution, are retrieved from the Tunisian national institute of statistics, the Tunisian central

bank and the international monetary fund. Before estimating the exchange rate pass-through to inflation and the effect of external debt growth on its behavior, we find it necessary to test for stationarity, to determine the optimal lag length and to find short run causality.

Table 1. Unit root test in level and in first difference

| | In level | | | In first difference | | |
|------------------------------|----------------|---------------------|----------------|---------------------|---------------------|----------------|
| | Intercept | Trend and intercept | None | Intercept | Trend and intercept | None |
| external debt | -1.94 (.31) | -2.99 (.15) | -0.13 (.63) | -5.68 (.00) | -5.72 (.00) | -5.53 (.00) |
| inflation | -1.20 (.66) | -1.54 (.79) | 0.69 (.86) | -4.61 (.00) | -4.55 (.01) | -4.46 (.00) |
| real effective exchange rate | -0.43 (.89) | -1.17 (.90) | 0.58 (0.84) | -3.28 (.03) | -3.71 (.04) | -3.32 (.00) |
| economic growth | -2.43 (.14) | -2.50 (.33) | -1.67 (.09) | -6.93 (.00) | -7.08 (.00) | -6.93 (.00) |

Table 1 display the results of Phillips-Perron (1988) unit root test and prove the absence of stationary in level for every variable in the sample and suggest that they are all integrated of order one, with different level of significance, external debt growth and economic growth both at 1% level, while inflation and real effective exchange rate at 5% level. Next, in order to determine the lags to include in the smooth transition autoregressive estimation we follow the criteria in the table 2.

Table 2. Optimal lag length selection criteria results

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|-----|--------|--------|-------|-------|-------|-------|
| 0 | -70.56 | NA | 16.8 | 5.66 | 5.80 | 5.70 |
| 1 | -56.86 | 23.19* | 6.34 | 4.68 | 4.88 | 4.74 |
| 2 | -54.61 | 3.64 | 5.77* | 4.59* | 4.83* | 4.65* |
| 3 | -54.08 | 0.81 | 6.00 | 4.62 | 4.91 | 4.70 |
| 4 | -54.07 | 0.00 | 6.51 | 4.70 | 5.04 | 4.80 |

The criteria displayed in table 2, namely the final prediction error (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SC) and the Hannan-Quinn information criterion (HQ) suggest that two is the optimal lag length which minimizes the log likelihood (LogL). Now the final step, before estimating the exchange rate pass-through to inflation and the effect of external debt growth on its behavior, is proving the existence of a short run cointegration between the sample's variables.

Table 3. Short run cointegration test

| Null Hypothesis | F-Stat (p-value) | Null Hypothesis | F-Stat (p-value) |
|---|---------------------|---|---------------------|
| inflation does not cause real effective exchange rate | 0.05 (.95) | real effective exchange rate does not cause inflation | 3.22 (.06) |
| economic growth does not cause real effective exchange rate | 0.08 (.92) | real effective exchange rate does not cause economic growth | 0.06 (.95) |
| external debt does not cause real effective exchange rate | 0.53 (.59) | real effective exchange rate does not cause external debt | 0.48 (.62) |
| economic growth does not cause inflation | 0.31 (.74) | inflation does not cause economic growth | 0.25 (.79) |
| external debt does not cause inflation | 1.79 (.19) | inflation does not cause external debt | 0.68 (.52) |
| external debt does not cause economic growth | 0.85 (.44) | economic growth does not cause external debt | 2.35 (.12) |

Table 3 present the results of the Granger (1969) causality test with two lags and prove the existence of short run cointegration for all variables at a 5% significance level. In order to estimate the smooth transition autoregressive model we must determine the value of the constant and the delay parameters.

According to Teräsvirta (1998) the delay parameter is chosen following the smallest p-value of the LM statistic.

Table 4. Linearity Tests

| Null Hypothesis | F-statistic | p-value |
|-------------------------------|-------------|---------|
| $H04: b1 = b2 = b3 = b4 = 0$ | 20.44 | 0.00 |
| $H03: b1 = b2 = b3 = 0$ | 20.44 | 0.00 |
| $H02: b1 = b2 = 0$ | 20.44 | 0.00 |
| $H01: b1 = 0$ | 2.10 | 0.12 |
| Terasvirta Sequential Tests | | |
| $H3: b3 = 0$ | 20.19 | 0.00 |
| $H2: b2 = 0 \mid b3 = 0$ | 20.19 | 0.00 |
| $H1: b1 = 0 \mid b2 = b3 = 0$ | 2.10 | 0.12 |
| Escribano-Jorda Tests | | |
| $H0L: b2 = b4 = 0$ | 1.79 | 0.40 |
| $H0E: b1 = b3 = 0$ | 14.21 | 0.07 |

The Linearity tests results in table 4 prove that the logistic smooth transition autoregressive LSTAR is the appropriate specification for our model. In fact, tests using the third-order Taylor expansion ($b4 = 0$) rejected the linear specification at 5% level using $H03$, and opted for the first-order logistic specification as $Pr(H3) \leq Pr(H2)$. The fourth-order Taylor expansion also rejected the linear specification at 5% level using $H04$ and opted for the first-order logistic specification with a nonzero threshold as $Pr(H0L) \geq Pr(H0E)$ with $Pr(H0E) \geq 0.05$. In order to avoid the serial correlation and the heteroskedasticity problems, we based our estimation on the HAC (Newey West) covariance method using observed Hessian.

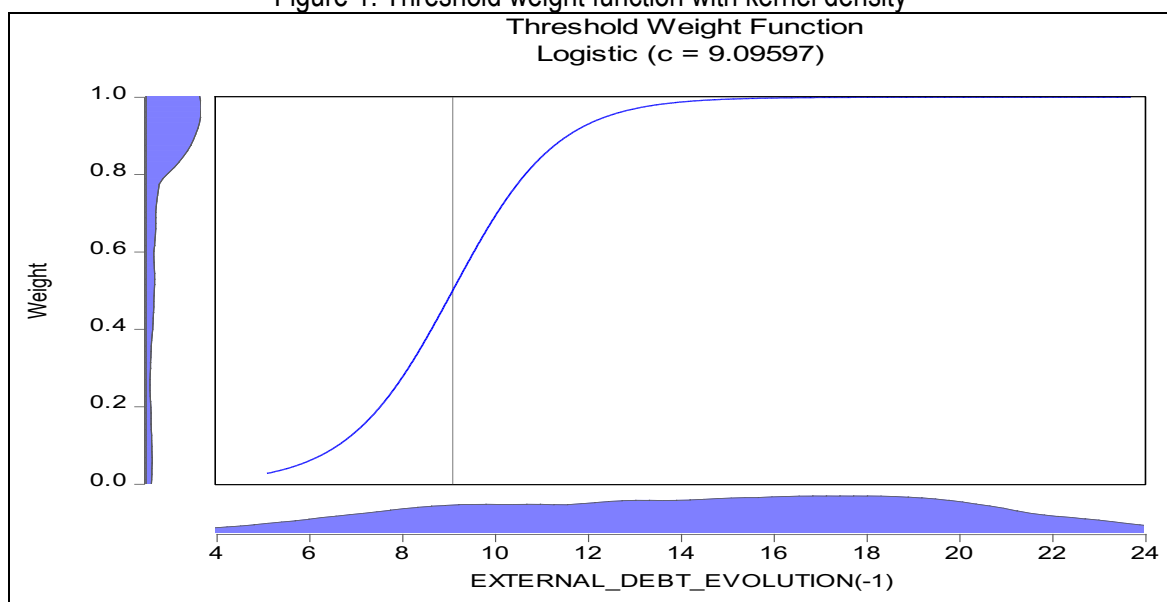
The result displayed in table 5 proves the existence of two regimes, linear and nonlinear, where the switch between them occurs via the threshold variable namely external debt growth's first lag at a significance level of 1% in each regime.

Table 5. Logistic smooth transition autoregressive estimation

| Variable | Coefficient | Std. Error | t-statistic | p-value. |
|-----------------------------------|-------------|------------|-------------|----------|
| Linear part | | | | |
| economic growth | 0.79 | 0.12 | 6.44 | (.00) |
| external debt (-1) | 0.94 | 0.09 | 10.36 | (.00) |
| external debt (-2) | -0.58 | 0.05 | -12.06 | (.00) |
| real effective exchange rate (-1) | -0.74 | 0.11 | -6.67 | (.00) |
| Nonlinear part | | | | |
| economic growth | -0.35 | 0.21 | -1.71 | (.12) |
| external debt (-1) | -0.82 | 0.10 | -8.20 | (.00) |
| external debt (-2) | 0.66 | 0.07 | 9.47 | (.00) |
| real effective exchange rate (-1) | 0.80 | 0.13 | 6.06 | (.00) |
| SLOPE | 0.89 | 0.24 | 3.74 | (.00) |
| THRESHOLD | 9.10 | 0.40 | 22.76 | (.00) |

The transition lag and the fluctuations in both regimes are determined according to the sum of squared residuals. The estimation results have an R-squared of 0.9 and an Adjusted R-squared of 0.79. The persistence level is determined by the sum of the threshold lag's coefficients in both regimes. The results of table 5 also confirm that the switch happens when external debt's growth reaches 9,1% as displayed in Figure 1.

Figure 1. Threshold weight function with kernel density



The parameter γ corresponding to the speed of transition from the first to the second regime equals 0,89, while the persistence level is 0,11, it is worth noticing that the second regime is characterized by a higher level of volatility with a sum of squared residuals of 0,51 compared to 0,37 in the first one. The pass-through is 94% in the first regime and 82% in the second regime. Our results are similar to those of Guizani (2015) who used a linear approach and found a high exchange rate pass-through to inflation since 2011. Never the less, our study proves that even if the exchange rate pass-through declines when switching from the first to the second regime, its volatility rises. This in turn creates uncertainty and has a negative impact on the economic performance. In fact, during the period on which we consider, Tunisia experienced higher inflation and lower economic growth following the sporadic evolution of both investment and exportation, despite the multiple central bank interventions to end the recession.

5. CONCLUSION

During the last decade the Tunisian economy experienced high levels of inflation following both the depreciation of its national currency and the unprecedented external debt growth. In this paper we used quarterly data for the period 2011Q4 to 2019Q4 in order to test for asymmetry in the exchange rate and to estimate its pass-through to inflation in Tunisia and how external debt affect its behavior, using a smooth transition autoregressive procedure. The Granger test we conducted suggested causality at 5% level of significance among the sample variables. The non-linearity tests confirmed that the logistic smooth transition autoregressive specification is the appropriate specification in our case. Our main findings are the existence of a high pass-through in both regimes, but when the transition happen volatility raises considerably, the transition starts at a growth of 9.1% in external debt. The policy recommendations derived from these findings are the inevitability of slowing down the external debt growth, as the rise of exchange rate volatility threatens the economy, by mainly reducing government spending, which grew considerably since 2011, and by increasing both production and exportation to raise the necessary financial resources to pay off the debt.

DISCLOSURE OF CONFLICT

The author declares that he has no conflicts of interest.

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