Application of Smooth Transition Autoregressive (STAR) Models for the Real Exchange Rate in Algeria

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Abstract

The purpose of this paper is model non-linearity in the real exchange rates upon monthly data for the period M1:1994 till M4: 2015 an application of logistic Smooth transition autoregressive (LSTAR) and exponential Smooth transition autoregressive (ESTAR) modeling to reel exchange rate in Algeria. Tests result reject linearity null hypothesis in favor nonlinearity alternative hypothesis. Our empirical analysis helps explain how the Algerian policy-makers will wish to take into consideration the nonlinear predictions as a forecasting method.

Keywords: Non-linearity, real effective exchange rates, Smooth transition autoregressive.

JEL Classification: F31; C5.

1. Introduction

As far as the Algerian exchange rate is concerned, the central bank adopted, since 1996, a managed floating exchange rate after a long experience with the former regime (1974-1995; **Kamel et al, 2015)** that was built upon a strong concentration of the US dollar that played an important role due to its 98% in hydrocarbon export receipts. Despite the launch of pertinent economic reforms and the implementation of structural Adjustment Program during the 1990s, which was adopt by the Algerian government in cooperation with the International Monetary Fund (FMI) and the World Bank (WB).The intervention of the Bank of Algeria resulted by devaluation nominal and real exchange rate at an average rate of about 54 and 33 percent in1994 respectively. The US Dollar increased to nine Algerian Dinar in 1990 from 35 in 1994 and 47 dollar again the Dinar year a later.

In addition, the nominal exchange rate index was characterized by increasing in levels to 2 and 8 percent for nominal and real exchange rate respectively during 1997-1999. Between January 2003 and January 2013, the Algerian exchange rate has varied continuously; from January 2003 to September 2008, the U.S dollar depreciated monthly against the Algerian Dinar by about 19%, followed by a depreciation of 6% during the financial crisis. Between January 2010 and January 2013, the Algerian dinar depreciated against the U.S. dollar by 4.2%. The real exchange rate is the products of the nominal exchange rate times (the dollar cost of a euro, for example) the domestic price of the item divided by the foreign ratio of price of the item (FMI, 1997). The overvaluation of the Algerian real exchange rate its equilibrium level in the estimation period has been associated with week of the Algerian Dinar as we've exposed here before and the low persistence level of inflation rate in this period.

Price stability as the actually challenge of the bank of Algeria is not yet a bed variable for the Algerian economy and the people purchasing power were the Algerian inflation has been growing rapidly since the 1990s. Average CPI inflation was 18.55% in the first decade of estimation study (1990s). On the contrary, in the second decade (2000s), inflation had witnessed their lowest average at 3.2 %.

After the end the first decade of the new millennium and beginning of the second decade, inflation was characterized by increasing the inflation rates in levels to 6-8.5 percent. After the end of the first decade of the new millennium and the beginning of the second decade, the inflation rate started to increase to some worrying levels 6 to 8.5 percent**;** furthermore, from 2010 onwards fiscal and monetary policies seem to be blamed, so, as to be considered as important determinants of inflation. This study used smooth transition autoregressive (STAR) to model non-linearity in the real exchange rate in Algeria upon monthly data for the period 1994-2015. The rest of the paper is organized as follows. In section 2, we present Review Literature. Section 3 presents Model and Methodology. Section 4 shows results and discussion. Section 5 contains the main conclusion.

2. Main body of paper

Numbers of early studies have proved the nonlinearity of exchange rate (see **Diebold 1988, Schinasi and Swamy 1989, Engle and Hamilton 1990 Diebold and Nason 1990 Mizrach 1991**)

Recently, **Enders and Pascalau (2015)** used STAR model of monthly data over the period January 1975 to December 2013 for forecasting the real exchange rates of various OECD countries. They found a nonlinear nature of exchange rates, while a nonlinear model clearly outperforms a linear one in terms of multi-step-ahead forecasting accuracies. Using similar principle, **Tayyab et al (2013)** compared between logistic Smooth transition autoregressive (LSTAR) and exponential Smooth transition autoregressive (ESTAR) modeling for finding the model who is more advantage to explain the deviation from series mean. His results demonstrate the ESTAR model it were better for him.

Paya and Peel (2009) rejected the null of linearity and then highlight the nonlinear modeling and forecasting of the dollar-sterling real exchange rate using a long span of data.

Upon monthly data of ASEAN-5 countries plus Japan from the period between January 1977 and end at March 2006, **Khim-Sen Liew et al (2008)** pointed out in their study using STAR model a nonlinear relationship of nominal exchange rate with the monetary fundamentals represented by Consumer Price Index (CPI), M2 and Gross Domestic Product (GDP).

Mikek and Kavkler (2007) Applied Slovenia and Slovakia a nonlinear framework with multivariate A Smooth Transition Vector Error Correction Model (STVAR methodology) using monthly data for the period 1999-2000and arrived to model the nonlinear dynamics of the real exchange rate.

Liew et al. (2003) suggested in his empirical study the nonlinear of nominal exchange rate in the ASEAN-5 countries using smooth transition autoregressive (STAR) model.

Sarno and Taylor (2002) documented the nonlinear relationship between purchasing power parity and the real exchange rate. **Sarantis 1999** modeled the non-linearity in the real effective exchange rates of 10 major industrial countries the G-10 using smooth transition autoregressive (STAR). His result rejected exchange rate linearity for eight exchange rates.

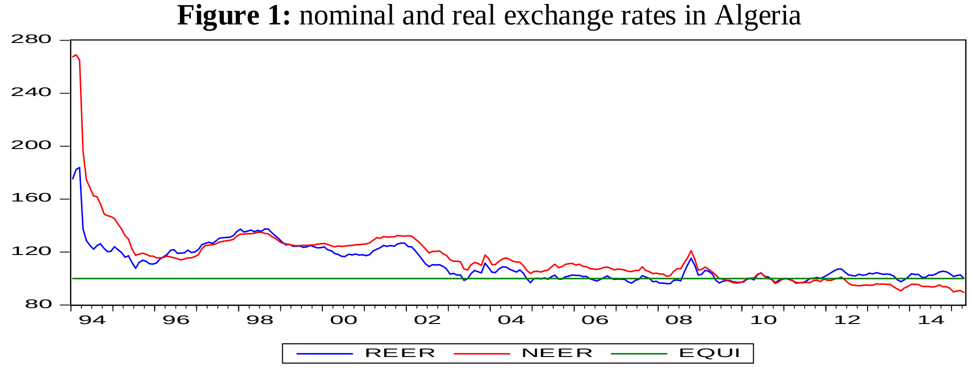
Model and Methodology

We shall present our data sources then the econometric approach

1) Data sources

The sample comprises 256 log monthly observations of the real exchange rate in Algeria for the period M1:1994–M4 2015.The source of this variable is collect from the Bank for International Settlements (BIS)**.**

Figure 1: nominal and real exchange rates in Algeria

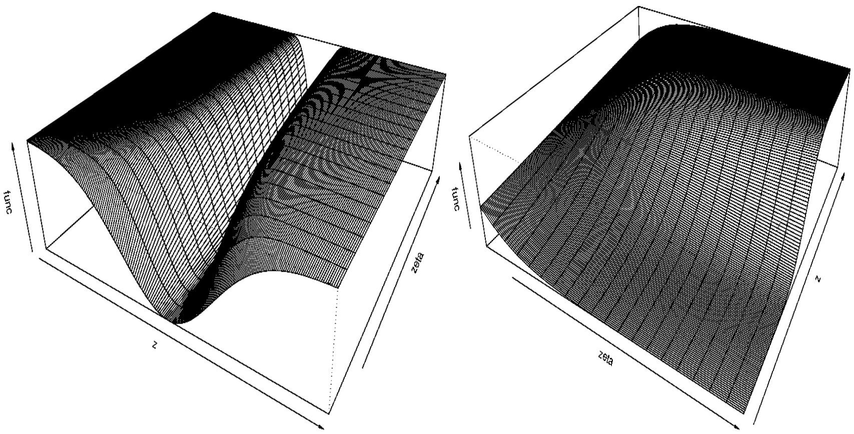


2) The Econometric approach

Most classical modeling techniques use the linearity trend based on stationary processes of time series. As a result, there can be identified autocorrelation coefficients when the variable has a root unity. **See Sollis (2005), Leon and Najarian (2005)**

There are many reasons to simulate macroeconomic variables as the explanation behavior of exchange rates exchange rate with nonlinear models, including transport costs, tariffs or non-tariff barriers, official interventions on the foreign exchange market; **Sarno and Taylor (2002), Liew, Chong and Lim (2003), Bahrumshah et al (2004, 2005, 2006), Salem, and Carrasco (2004), Rapach and Wohar (2002), Taylor(2006).** In our study, repetitive interventions should care of The Bank of Algeria on the interbank exchange market is main reason for reject linearity in favor of STAR models

Smooth transition auto regression model (STAR) was developed by **Terasvitra (1994)** to be the best model of non-linear a time series and allows to smooth changes from one regime to another.



ESTAR LSTAR

A smooth transition autoregressive regression (STAR) model with $m = p + k + 1$ independent variables **(Ronderos 2015)**, where p are lags of the dependent variable and k are exogenous variables. The mathematical representation of STAR model is:

$$y_t = \beta^{'x_t} + (\theta^{'x_t})F(z_t) + \mu_t \quad (1.1)$$

Where:

$$\mu_t \sim iid(0, \sigma^2), \beta = (\beta_0, \beta_1, \ldots\ldots, \beta_m)', \theta = (\theta_0, \theta_1, \ldots\ldots, \theta_m)',$$

$x_t = (1, y_{t-1}, \ldots . y_{t-p}, x_{1t}, \ldots\ldots, x_{kt})'$ and z_t is the transition variable. The function $F(z_t)$ is continuous and might be even or odd.

The odd function $F(z_t) = (1 + \exp\{-\gamma(z_t - c)\})^{-1}$ yields the logistic STR model (LSTR), and the even function $F(z_t) = (1 + \exp\{-\gamma(z_t - c)^2\})^{-1}$ defines the exponential STR model (ESTR). If one chooses the transition variable to be the residuals of the linear model $y_t = \beta x_t + v_t$ then the STR deviation models are obtained, with the following transition functions $F(z_t) = (1 + \exp\{-\gamma(a'v'_{t-1} - c)\})^{-1} - \frac{1}{2}$ for the LSTR-D and $F(z_t) = (1 + \exp\{-\gamma(a'v'^2_{t-1} - c)\})^{-1} - \frac{1}{2}$ for the ESTR-D, where $\sum aj = 1, v'_t = (v_t, \ldots\ldots, v_{t-h+1})$ and $v'^2_t = (v_t^2, \ldots\ldots, v^2_{t-h+1})$.

Results and Discussion

Based on the results in **Table (1)** whit his shows LSTAR and ESTAR tests, we may reject linearity null hypothesis in favor Nonlinearity alternative hypothesis. P-value indicates significant non-linear specification and that there is strong evidence that the real exchange rate has the LSTAR and ESTAR. We note furthermore, the transition variable triplet reject the null and confirmed non-linear logarithm reel exchange rate in the first lag.

Table 1: smooth transition autoregressive (STAR) models

Tests on LREER. H0: Linearty.		
Transition variable: lreer(-1)		
Ha:LSTR		
	LM statistic	P-value
Unknown transition variable: Expansion order 3	93.065	0.000
Unknown transition variable	43.974	0.000
Unknown transition variable: Cubic expantion	93.065	0.000
Transition variable	15.192	0.000
Transition variable: Cubic expantion	56.850	0.000
Transition variable: lreer(-1)		
Ha:ESTR		
	LM statistic	P-value
Unknown transition variable	93.065	0.000
Transition variable: Cubic expantion	49.856	0.000
Transition variable: Deviation from a linear path		
Ha:LSTR-D or bilinearty		
	LM statistic	P-value
Unknown residual lag: 3	210.628	0.000
Specific residual lag: 3	130.621	0.000
Transition variable: Deviation from a linear path		
Ha:ESTR-D or bilinearty		
	LM statistic	P-value
Unknown residual lag: 3	131.789	0.000
Specific residual lag: 3	130.421	0.000

The main results of Logistic Smooth Transition Autoregressive LSTAR identified an equation the reel exchange rate with first lag to represent as transition variable a function from a table2.It shows through coefficients estimation the significant reaction of reel exchange rate to previous itself lag in its lower and upper regimes.

Table 2: LSTAR reel exchange rate

Dependent Variable: LREER				
Method: Least Squares				
Date: 05/29/15 Time: 12:08				
Sample (adjusted): 1994M04 2015M04				
Included observations: 253 after adjustments				
LREER=C(1)+C(2)*LREER(-1)+C(3)*LREER(-2)+C(4)*LREER(-3)/TRANSITION_STR01				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.319974	0.066387	4.819862	0.0000
C(2)	1.170229	0.062566	18.70397	0.0000
C(3)	-0.382521	0.093771	-4.079311	0.0001
C(4)	-0.143757	0.059690	2.408385	0.0168
R-squared	0.945874	Mean dependent var		4.697913
Adjusted R-squared	0.945222	S.D. dependent var		0.103161
S.E. of regression	0.024144	Akaike info criterion		-4.593843
Sum squared resid	0.145155	Schwarz criterion		-4.537979
Log likelihood	585.1212	Hannan-Quinn criter.		-4.571367
F-statistic	1450.473	Durbin-Watson stat		1.444666
Prob(F-statistic)	0.000000			

3. Conclusion

In this paper, we have rejected the linearity hypothesis for the real exchange rate in Algeria during the period of 1994 till 2015. The linear model is not best to be estimate the optimal modeling of the exchange rate in Algeria and confirms how the LSTAR and ESTAR determine nonlinearity of real exchange rate.

This result reflect how the move to the big volatility of exchange rate has impacted on the small volatility a very aggressively or the reverse, that we allows disappointed by the forecasting performance of linear models compared the nonlinear predictions.

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