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Modeling the Volatility of Exchange Rates: GARCH Models

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Abstract *The modeling of the dynamics of the exchange rate at a long time remains a financial and economic research center. In our research we tried to study the relationship between the evolution of exchange rates and macroeconomic fundamentals. Our empirical study is based on a series of exchange rates for the Tunisian dinar against three currencies of major trading partners (dollar, euro, yen) and fundamentals (the terms of trade, the inflation rate, the interest rate differential), of monthly data, from jan 2000 to dec-2014, for the case of the Tunisia. We have adopted models of conditional heteroscedasticity (ARCH, GARCH, EGARCH, TGARCH). The results indicate that there is a partial relationship between the evolution of the Tunisian dinar exchange rates and macroeconomic variables.*

Key words Exchange rate, fundamental macroeconomic variables, conditional heteroskedasticity models

JEL Codes: O24

1. Introduction

These past decades, the volatility of the exchange rate is characterized by erratic changes and excessive volatility greater than that of the fundamental. This led to questions about the determinants of the exchange rate. ARCH conditional models (autoregressif conditional Heteroskedasticity and GARCH, EGARCH, TGARCH, IGARCH extensions) represent Econometrics to study the volatility of variables over time, affecting areas of the financial market, and mainly that of volatility clustering of the returns of a financial asset. Different macroeconomic variables together to explain the volatility of exchange rate. However, they do not have the same degree to the explanation of the evolution of exchange rate.

Ramprasad *et al.* (2004) showed the effect of nominal interest rate to the exchange rate flutters. Their study is on weekly data from three parities in the exchange rate, that, such DEM, UKP, against the US dollar and YEN. By adopting the EGARCH model, they proved that a change (appreciation, depreciation) shock can be caused by a deviation from nominal interest rates

Chen (2006) joined the same result in his study on the markets of emerging countries (Indonesia, South Kourea, Philippine and Thailand), and even on Mexico and Turkish market where he proved that nominal interest rate plays as a crucial factor in the appreciation or depreciation of the currency during the period from 1990 to 2000.

Recently, Cho and West (2003) have proved, for high-frequency data, a relationship significant between the nominal exchange rate and the interest rate for the case of Korea and Philippines. They noticed an appreciation of the currency at deviation of interest rates, and a depreciation of the local currency to Thailand. Properly, note that the studies that fail to clarify the relationship that can be found between the volatility of exchange rate and the interest rate were based on linear models, and statistically simple.

In addition, Nikolaos and Athanasios (2011), by exploiting the GARCH model, for data of the Polish Zloy/euro and Hungarian forint/euro exchange rate testify the results found in the literature and that predicts the relationship existing between the volatility of exchange rate and the interest rate differential. Also, Kocenda and Valachy (2006) have studied these results in their studies of the economic monetary union (EMU) countries such as Poland, Hungary, Slovakia and Crech Republic where they found the importance of exchange rate policy determined by the monetary authorities to fluctuations of the exchange rate, by applying the asymmetric model TGARCH to capture any asymmetric series of returns of exchange rate effect. In fact, they announce that interest rate differential has a greater effect on volatility courses when Exchange rate policy is floating and less impact when the regime chooses is a fixed plan.

According to Duarte *et al.* (2008), the relationship between the volatility of exchange rate and the interest rate differential is studied under a managed floating exchange regime which they concluded a significant and negative link between the volatility of exchange rate and the interest rate differential.

Applying the model VAR, Jon F. and John H.R (2003) declare a decisive role of interest rate differential ($i - i^*$) in the explanation of the volatility of exchange rate US - UK and US-German, during the study period ranging from 1974 to 1997, for a monthly frequency. These results show what is proved by previous studies (Clarida and Gali, 1994; Eichenbaum and Evans, 1995; Rogers, 1999; Kim and Roubini, 2000).

Mishkin and Savastano (2001) are interested to study the correlation between the volatility of exchange rates and the rate of inflation for the countries of Latin America. They concluded a fairly negative relationship between these two instruments. They testify that any rise in inflation provokes a depreciation of the domestic currency, as they suggest that the latter may come from changes in the nominal exchange rate, by adopting conditional heteroskedasticity models.

In addition to study exposed by Chadha and Nolan (1999), the choice of a policy of inflation targeting that aims to ensure the credibility of monetary policy and the Central Bank's commitment to price stability and full transparency of their objectives. But when transparency becomes quickly excessive and so destabilizing in inducing a significant volatility in the exchange rate. This excessive volatility of exchange rates threat control of inflation especially in the emerging countries as well as countries of small open economies (Petursson, 2009).

Young (2002) studied the impact of macroeconomic variables (inflation, interest rates, unemployment), on the DEM/Dollar and Dollar/Euro exchange rate volatility during the period 1999-2002 of very high frequency. He concluded through this study a statistically significant effect with a positive shock to interest rate volatility, where the exchange rate appreciates. However he noted a statistically significant effect of negative coefficient of inflation on volatility. In operator model FIGARCH of Baillie *et al.* (1996). These results match one of Andersen *et al*. (2003) of their study of exchange rate DEM/Dollar.

The terms of trade (TOT) may have an impact on exchange rate volatility? According to Kamar (2011), an improvement in the terms of trade can increase the country's wealth and subsequently appreciates the local currency. According to the literature, the change in the terms of trade in emerging countries is three times that of industrial countries (IDB, 1995; Hausmann *et al*., 2006) caused by the actual level of Income of countries. According to Edwards (2010), the economy of Latin American countries has been exposed to shocks in their terms of trade more than thirty years.

Joshua *et al.* (2012) showed, during their study of the countries of Latin America during the period 1970-2009, a significant link between the terms of trade (TOT) and exchange rate volatility. In fact, these authors have deviated from these results by what has been shown in the literature which they have pointed out that a positive shock of the terms of trade influences more than a negative shock on exchange rate volatility.

According to a study by Virginie *et al.* (2009), the terms of trade of foreign countries are the ratio of the price index of their exports to those of their imports. In fact, any change is reflected in the evolution of their exchange rates. Similarly, a deterioration in the terms of trade results in a depreciation of the exchange rates of the exporting countries. It is therefore useful to clarify the link between terms of trade and changes in the exchange rates of countries. For exporting countries, terms of trade are the most important determinant of the exchange rate. In the case of energy exporting countries, a rise in prices also leads to an appreciation of the exchange rate, but slightly lower.

2. The modeling

The concept of volatility was seen across different models including GARCH models have shown their adaptability. Our choice then is on this modeling. Engle (1982) presents a model family ARCH or ARCH-type for addressing the problems of heteroskedasticity and abusing the phenomenon of clustering of volatilities and leptokurtic properties (more fat tails than a normal distribution and importance tails are often measured through kurtosis, the more it is, the more tails are thick) financial data. ARCH-type models were applied on different time series, their applications in finance were particularly successful as they were the center of any introduction.

● ARCH process (Engel, 1982) is given by:

$$\sigma_t^{\,2} = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^{\,2} = \alpha_0 + \alpha(L)\varepsilon_t^{\,2} \tag{1}$$

Where: $\alpha_0 \rangle 0$ and $\alpha_i \geq 0 \quad \forall i$

The constraints on the coefficients ensure the positivity of the conditional variance. We can also show that this variance is finite if $\sum_{i=1}^{q} \alpha_i \langle 1$.

Bollerslev (1986) generalized the ARCH model, developing the GARCH (p, q). This extension includes the introduction of lagged values of the variance in the equation that is similar to the extension of the AR or ARMA. This allows a more parsimonious description of the structure of delays.

● GARCH process (p, q) is defined by:

$$\sigma^2{}_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}{}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}{}^2 \qquad (2)$$

Where: $\alpha_0 \rangle 0$, $\alpha_i \geq 0$, $\beta_j \geq 0$, $\forall_i, \forall_j$

Constraints on the coefficients guarantee the positivity of the conditional variance, noting that, if p = 0, the process GARCH (p, q) becomes the process ARCH (q). The models EGARCH (Exponential GARCH), TGARCH) differs from the usual ARCH models by rejecting the hypothesis of symmetry related to the quadratic specification of the conditional variance.

● EGARCH process

It is a log-linear model presented by Nelson (1991) in a study on the returns on financial assets. The specification concerns the logarithm of the conditional variance and thus avoids the constraints of positivity on the coefficients αi and βj.
The model EGARCH (p, q) can be written as:

$$\ln \sigma_t{}^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \left(\phi z_{t-i} + \gamma \left\| z_{t-i} \right| - E\left| z_{t-i} \right\| \right) + \sum_{j=1}^{p} \beta_j \ln \sigma_{t-j}{}^2 \qquad (3)$$

● TGARCH (p, q) is represented as follows:

$$\sigma^2{}_t = \alpha_0 + \sum_{j=1}^{q} \left(\alpha_j + \gamma_j d_{t-j} \right) \varepsilon^2{}_{t-j} + \sum_{i=1}^{p} \beta_i \sigma^2{}_{t-i} \qquad (4)$$

Where: $d_{t-j} = \begin{cases} 1 si \varepsilon_{t-j} \langle 0 \\ 0 si \varepsilon_{t-j} \geq 0 \end{cases}$

We will use the ARCH, GARCH, EGARCH and TGARCH models to model the behavior of the volatility of exchange rate series returns. After presenting these models, we will attempt to examine its robustness.

3. The applied econometric methodology

3.1 Data and methodology

Our empirical study will be based on monthly exchange rate data, as well as macroeconomic variables (inflation rate, interest rate differential, terms of trade). The euro (EUR), the US dollar (USD), and the Japanese YEN (YEN), compared to the Tunisian dinar (TND). These data were provided to us by the Central Bank of Tunis (BCT) exchange service, the INS and IMF International Financial Statistics (IFS). In a first step, we are interested in studying the statistical characteristics of different variables. The tests used in this paragraph make it possible to demonstrate the properties which characterize these variables, in particular non-normality and stationarity.

3.1.1 Graphical analysis

The empirical literature on exchange rates finds no linear dependence between observations (no autocorrelation, or has a very low correlation), but it shows a second-order temporal dependence which can be explained by a heteroskedasticity. According to our forecasts, Fig1 represents the evolution of the exchange rates EURO/TND, USD/TND, and YEN/TND. It shows a clear trend over the period, characterized by a clear upward trend in the exchange rate (EUR/TND). An upward trend in the exchange rate (USD/TND) in the first part (up to the point near January 2002), followed by a downward trend in the second part (up to the point near January 2009) an upward trend. A downward trend in the exchange rate (YEN/TND) in the first part (going up to the point near January 2008) and then an upward trend.
Figure 1 shows that the three series are non-stationary in mean and variance (notably in variance). As it shows volatility groupings, indicating that these series are volatile. On the other hand, we note that this volatility changes over time. What allows us to say that a GARCH type process could be adapted to the modeling of the exchange rate series.

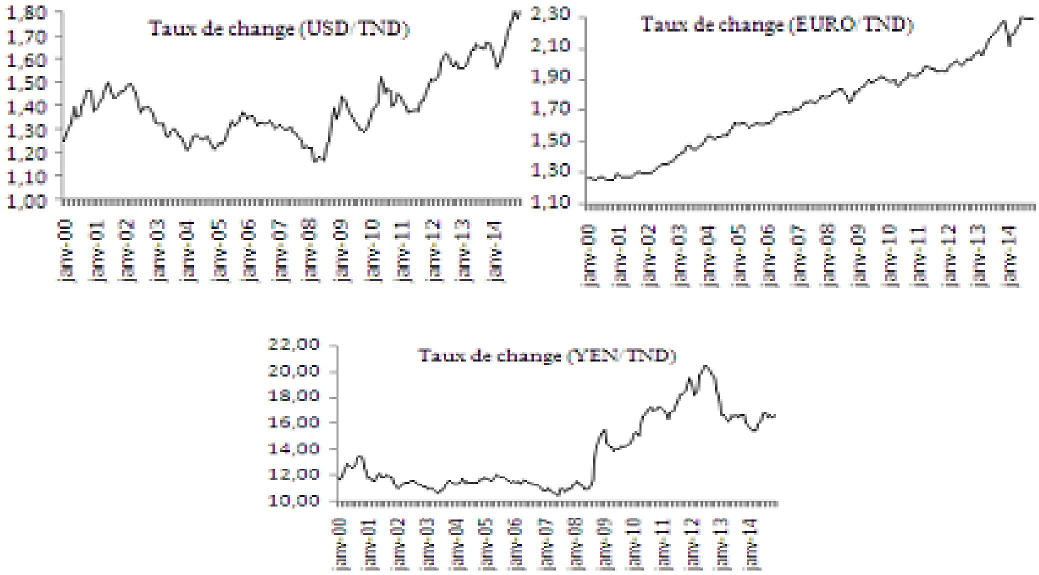

Figure 1. Fluctuations of exchange rates

3.1.2 Hypothesis of non-normality

Table 1 shows a number of statistical indicators of the three series of exchange rates, namely the skeweness coefficient, the kurtosis coefficient and the Jarque-Bera statistic. From Table 1, we note that the standard deviations are close to one another but are far from average. This shows some volatility within the series studied. The Skewness values of these three series are positive. This means that the distribution is non-symmetric on the one hand and on the other hand it is spread to the right. This indicates a high probability of a large expansion in returns earlier than a recession. The positive sign of the asymmetry coefficient of Skewness also indicates that the Tunisian Dinar exchange rate reacts more to a positive shock than to a negative shock. This asymmetry can be an indicator of non-linearity.

Table 1. Descriptive Statistics for Data Series

	Moy	Med	Max	Min	St.Dev	Skewness	Kurtosis	J–B
USD	1.39	1.37	1.80	1.15	0.140	0.76	3.06	17.62
EUR	1.72	1.75	2.31	1.24	0.299	0.02	2.02	7.09
YEN	13.63	11.87	20.43	1.46	2.800	0.74	2.20	21.19
TMMUSD	2.96	3.93	5.03	-0.66	1.766	-0.84	2.17	26.45
TMMEUR	2.86	2.92	4.96	0.77	1.107	0.01	2.14	6.49
TMMYEN	4.85	4.87	6.23	3.07	0.669	-0.16	2.85	6.94
TOT	0.95	0.95	1.05	0.82	0.041	-0.43	3.53	7.79
TI	3.80	3.90	6.60	0.80	1.444	-0.10	2.09	6.53

Source: Statistics provided by Eviews (version 7.0)

In addition, Kurtosis values are narrower than 3 for the two exchange rate series (EUR/TND), and YEN/TND, but far from that of (USD/TND). This shows that for these two series, the distribution of monthly exchange rates has tails less thick and sharper than normal, so they are distributions of a platikurtic nature. However, the value of Kurtosis is greater than 3 for the exchange rate series (USD/TND), which shows that for this series the monthly exchange rate distribution has tails that are thicker and sharper than normal, so it is a distribution of leptokurtic nature.

For the other variables of the model, the coefficients of asymmetry (Skewness) and of flattening (kurtosis) are significantly different from their levels predicted by the normal distribution. This means that the distributions of the different series are asymmetric. Similarly, the values of the Skewness coefficients (asymmetry) are all strictly different from zero. This means

that the distributions of the different series are asymmetric. Indeed, the values of the Kurtosis coefficients are greater than 3 for the series USD and TOT, which indicates the presence of tails thicker and sharper than normal of leptokurtic distributions. For the other series, the values of the Kurtosis coefficients are less than 3 which support the presence of tails less thick and less pointed than normal, they are platikurtic distributions.
The statistical value of Jarque Bera calculated for the series of data is greater than the tabulated value of the Chi two law with 2 degrees of freedom (the tabulated value is equal to 5.99). In the light of this result, the null hypothesis of the normality of the exchange rate series studied is rejected. Clearly, all variables in the model do not follow the normal distribution. From the analysis of graph 1 and table 1 of the three series of the exchange rate, we conclude that a non-linear ARMA process of ARCH type can be adapted in our case.

3.1.3 Hypothesis of stationarity

The stage which follows the study of normality is that which corresponds to the study of the stochastic characteristics of the series. Let us recall that if the expectation and the variance of a series are modified over time, the series is therefore considered as non-stationary. This means that the series has neither tendency nor seasonality and its moments of order 1 and 2 are constant over time. The presence of a unit root is verified using the Dickey and Fuller test (1979 and 1980, the ADF test). Other than the presence of unit root, this test allows the time series to be stationary.
Another solid test for heteroskedasticity is that of Philips and Perron. Our choice of tests is explained by the fact that for the first test the null hypothesis corresponds to the presence of a unit root while the null hypothesis of the second test corresponds to the stationarity. Indeed, the first test favors the null hypothesis, so it is imperative to consider both types of tests. These tests also distinguish between long-memory and short-memory processes. Four scenarios are possible depending on the results of the two tests:
1. The ADF test rejects the hypothesis of unit root while the PP test accepts the hypothesis of stationarity. In this case, we deduce that the process is stationary.
2. The acceptance of the null hypothesis of unit root presence and the rejection of the null hypothesis of stationarity indicates that the process is non-stationary: it is integrated of order one.
3. ADF and PP tests can reject the null hypothesis. The process neither integration of order 0 non of order 1. One can envisage the presence of long memory.
4. The acceptance of the null hypothesis by the two tests often reveals the presence of problems of data.

3.1.3.1 Unit root test

Before applying a model to the data in our study, we perform the unit root test to ensure that each variable is stationary, and to avoid a fallacious regression. The unit root tests are based on the tests of Dickey-Fuller (1979) (ADF) and Phillips-Perron (1988) (PP). The results of the two tests applied to the data series are reported in Table 2.

Table 2. Unit root test result applied to data series:

Indices	**ADF**		**PP**	
Series	Statistic	Value P	Statistic	Value P
USD	-1.324	0.878	-1.164	0.913
EUR	-3.757	0.061	-3.084	0.113
YEN	-2.110	0.536	-1.955	0.621
TMMUSD	-3.203	0.087	-1.847	0.677
TMMEUR	-2.546	0.305	-2.427	0.364
TMMYEN	-2.028	0.581	-1.788	0.706
TOT	-5.141	0.201	-7.122	0.123
TI	-3.261	0.076	-3.714	0.238

Source: Statistics provided by Eviews (version 7.0)

The empirical results from Table 2 indicate that the ADF and PP test statistics are all wider than their critical values at the 5% threshold. Correlograms of autocorrelations and partial autocorrelations indicate nonstationary behavior. Even if the

autocorrelations are not close to unity, but very close to each other, we conclude in favor of non-stationarity of the series of data. However, this non-stationarity can be explained by the heteroskedasticity of the residues.
To stationary the data series, we apply a first-order differentiation filter of the series in order to remedy their heteroskedasticity before re-testing them to ensure that these series require a second differentiation. That is, reduce their variability, which corresponds to ultimately studying exchange rate returns. These new series are called logUSD, logEUR and logYEN and denoted respectively Rusd; Reur and Ryen. In the following, the Rusd yield for example is defined by:

$$R_{t\,(usd)}= log(S_t / S_{t-1}) \quad (5)$$

Where: St (usd) and St-1 (usd) are the monthly exchange rates at time t and t-1.

For the rest of the variables in the data series, we use the differentiation method to stationarize the series. We check the stationarity of our time series. Indeed, a series is said to be stationary if its characteristics (mean, variance, covariance of order 1) do not depend on time, in other words, if the data fluctuate around the mean and the series does not exhibit a tendency or seasonality. Indeed, the non-stationarity of the series implies the presence of a unit root. This means that innovation has a persistent effect over time. To test the presence of unit roots, we used the Dickey-Fuller augmented test and Phillips-Perron (1988) (PP) as before.

Table 3. Unit root tests applied to the yield series of the three exchange rates

	ADF		PP	
Series	Statistic	Value P	Statistic	Value P
RUSD	-5.632	0.000	-9.9.6	0.000
REUR	-7.669	0.000	-11.481	0.000
RYEN	-9.252	0.000	-9.313	0.000
DTMMUSD	-3.262	0.076	-7.034	0.084
dif(DTMMUSD)	-7.404	0.000	-56.149	0.000
DTMMEUR	-4.578	0.000	-15.608	0.000
DTMMYEN	-10.934	0.000	-10.978	0.000
DTOT	-6.445	0.000	-53.240	0.000
DTI	-7.808	0.000	-11.221	0.000

Source: Statistics provided by Eviews (version 7.0)

First, we apply these two tests for each variable in the data set. The results of these tests show that our series do not have a unit root. We reject, therefore, the null hypothesis that the series studied is non-stationary. However, we find that the variable DTMMUSD is non-stationary. In these cases, we use a second difference to stationary this variable.
After making the second difference of the variable DTMMUSD denoted dif (DRMMUSD), it appears from Table 3 that the assumption of the unit root presence is rejected for the variables of the data series. The ADF and PP test statistics are all below the critical threshold values of 5%. As a result, we can conclude that all variables in the data series are stationary.

3.1.4 Heteroskedasticity test

Moreover, given the nature of the financial data characterized by high volatility, we will apply the residuals of the selected models, a heteroskedasticity test (ARCH test). The latter consists of testing the significance of a particular form of residual variance. The LM test retains a particular specification of heteroskedasticity, motivated by the observation that in many financial series the magnitude of residuals appears to be related to the magnitude of residues in recent years.
To test the hypothesis that there is no ARCH effect up to the order p in the residuals, we recover the residues resulting from the estimation. Then, we estimate the following regression:

$$\varepsilon t = \alpha_0 + \sum_{i=1}^{p} \alpha i \; \varepsilon_{t-i} \quad (6)$$

With εt: residual of each estimated model. It is a regression of the squares of the residues on a constant and the square of the residues delayed to the order p.

Table 4. ARCH Test Results

	USD		EUR		YEN	
Series	F-stat	T*R2	F-stat	T*R2	F-stat	T*R2
ARCH(1)	2.882	2.868	20.035	18.192	24.214	21.527
ARCH(2)	3.565	6.969	10.213	18.595	12.122	21.647

The null hypothesis of no ARCH effect is rejected for all three exchange rates. The application of the LM-ARCH test shows that for all three series the probability associated with the test statistic T * R2 is very small (close to 0): the null hypothesis of homoscedasticity is therefore rejected. Alternative hypothesis of conditional heteroskedasticity and consequently the rejection of the null hypothesis mean the existence of ARCH effect.
This conditional heteroskedasticity, also known as the ARCH effect, consists of the presence of autocorrelations in the squared residuals. This shows the presence of a volatility cluster (Volatility clustering). On the other hand, the presence of the asymmetric character detected by the preliminary statistics (Skewness) next to the existence of ARCH effect requires the modeling of the three series by the application of the ARCH models.

3.1.5 Estimation of models

The appropriate model for each series of exchange rates Rusd, Reur, and Ryen, respectively, are: GARCH, TGARCH and ARCH. The following table presents the estimate of the variables (TI, TMM, TOT) for each series.
To determine the individual significance of the estimators, the probability directly provided by Eviews is used. The results of the exchange rate estimates are presented in Table 5.

Table 5. Results of estimation of the parameters of the three selected models

Variables	Estimated Coefficients	T of Student	Probabilities
GARCH (USD)			
C	**0.0094*** **	**5.45112**	**0.0000**
TOT	**-0.0065*** **	**-3.6356**	**0.0004**
TI	**-0.0031**	**-1.6534**	**0.1000**
TMM	**0.0057**	**0.0154**	**0.9877**
TGARCH(EUR)			
C	**0.0604*** **	**7.3164**	**0.0000**
TOT	**-0.0623*** **	**-7.1504**	**0.0000**
TI	**-0.0097**	**-0.3557**	**0.7225**
TMM	**-0.0091** **	**-2.0142**	**0.0455**
ARCH(YEN)			
C	**0.0029*** **	**2.22700**	**0.0000**
TOT	**-0.0025 * **	**-1.7937**	**0.0746**
TI	**0.0095**	**0.2072**	**0.8361**
TMM	**0.0014**	**1.0929**	**0.2759**

Note: Statistics provided by Eviews (version 7.0), ***, **, * the significant level of 1%, 5% and 10% respectively.

Moreover, the results obtained in Table 5 clearly show that at 1%, the constant is significant in all three models. The TOT variable is well correlated in the GARCH and TGARCH model because the associated probabilities are less than 1%. At the 5% level, only the TMM variable is significant in the TGARCH model of the EUR/TND exchange rate because the associated probability is less than 5%. However, the TI variable is not significant in any model adopted.
To study the determinants of exchange rate volatility, we therefore interpret the results obtained in the three models for the different series studied in order to judge the conformity of the results with economic theory. Therefore, in order to interpret the estimation results of the three models individually, we write the relationship between exchange rate volatility and explanatory variables. For the GARCH (USD) model, the relationship is as follows:

$$\sigma t(usd) = 0.0094 - 0.0065TOT - 0.0031TI + 0.0057TMM$$

For the TGARCH model of the EUR exchange rate, the relationship between volatility and economic determinants can be written as follows:

$$\sigma t(eur) = 0.0604 - 0.0623TOT - 0.0097TI - 0.0091TMM$$

Finally, for the ARCH model of the YEN exchange rate, the relationship between volatility and explanatory variables can be written as follows:

$$\sigma t(yen) = 0.0029 - 0.0025TOT + 0.0095TI + 0.0014TMM$$

In the case of the terms of trade variable, the student test shows that in the two models GARCH (USD) and TGARCH (EURO), the terms of trade variable is significant at the threshold of 1%, but is negatively correlated with exchange rate volatility (-0.0065 and -0.0623 respectively).
In other words, an improvement in the terms of trade implies a decrease in the volatility of the exchange rate. It follows that deterioration in the terms of trade of a point will lead to an increase in the volatility of the exchange rate of around 0.007 and 0.006 point respectively in both models, everything else is equal. At the 10% threshold, this variable is significant but is negatively correlated (-0.0025) with exchange rate volatility (ARCH Model (YEN)). That is, an improvement in the terms of trade implies a decrease in the volatility of the exchange rate. It follows that deterioration in the terms of trade of a point will lead to an increase in the exchange rate of the order of 0.0025 point, anything else equal. We have reported, that a negative shock of the terms Tunisian case.
A second result concerns the inflation rate, which is negatively correlated with the exchange rate volatility (-0.0031, -0.0097) in both GARCH and TGARCH models, and positively correlated with this variability (0.0095). However, it is insignificant and has no explanatory power over the volatility of the Tunisian exchange rate, which is contradicted by the theory. The Money Market Rate (MMR) has no significant explanatory power to the variability of the exchange rate in the Tunisian case. However, the evolution of the interest rate, from the year 2000, underlines the strong Reticence of the BCT in the use of the interest rate as the main instrument in the conduct of monetary policy, for reasons of financial stability. However, it appeared to be significantly negative in the TGARCH model. In fact, this relationship is not strong enough to declare the existence of a verifiable relation of the nominal exchange rate and the MMR.

5. Conclusions

Any movement in the interest rate triggers the variability of the exchange rate, which is only valid if capital flows are liberalized. Nevertheless, the channel of the exchange rate noticed in Tunisia is not that of the exchange rate within the meaning of the opening of the capital account. The empirical results contradict that predicted by theory. And then, the interest rate differential does not affect the volatility of the exchange rate in the Tunisian case. It is a peculiarity in developing countries and especially Tunisia.
The terms of trade (TOT) seem fairly well correlated with exchange rate developments. What their effects on the exchange rate for the three series studied, in accordance with the existing literature, well underline, is not only consistent with the theory, but also statistically significant. The explanation is accentuated especially when the nominal exchange rate is considered in relation to the euro. As a result of the decline in export prices in order to maintain Tunisia's competitiveness vis-à-vis the euro area and to increase exports, the deterioration in the terms of trade leads to the depreciation of The domestic currency (the exchange rate increases). In the case of the improvement of TOT means, an increase in export price, the currency appreciates (exchange rate decreases). We have thus pointed out that a negative shock of the terms of trade influences more than a positive shock on the variability of the exchange rate in the Tunisian case.
The inflation rate is not significant in the three models, which is contradicted by the Tunisian case, whose inflation plays a crucial role in nominal exchange rate variability. As it can come as a result of movements of this rate. In fact, any exchange rate depreciation shock induced by domestic inflation. This reveals the impotence of heteroskedastic models and then calls for other more powerful and robust approaches in order to overcome the inadequacy of these approaches.

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