International Journal of Economics, Finance and Management Sciences
2020; 8(4): 128-137
http://www.sciencepublishinggroup.com/j/ijefm
doi: 10.11648/j.ijefm.20200804.11
ISSN: 2326-9553 (Print); ISSN: 2326-9561 (Online)

Review Article

Volatility and Long Memory Modeling of Exchange Rate Case of Algerian Interbank Market

Djaballah Mustapha

Department of Economy, Faculty of Economics and Management, University of Muhamed Boudiaf, M'sila, Algeria

Email address:
Mustapha.djaballah@univ-msila.dz

To cite this article:
Djaballah Mustapha. Volatility and Long Memory Modeling of Exchange Rate Case of Algerian Interbank Market. *International Journal of Economics, Finance and Management Sciences*. Vol. 8, No. 4, 2020, pp. 128-137. doi: 10.11648/j.ijefm.20200804.11

Received: February 27, 2020; **Accepted**: March 20, 2020; **Published**: July 13, 2020

Abstract: In this paper we will try to identify and modeling the phenomenon of dependence of short and long term exchange rate volatility through a well-founded approach on the long memory process. The reform of the interbank market is part of the economic recovery program launched by the authorities in 1988. The reorganization of the money market which served to supplement the liquidity needs of banks after exhaustion of refinancing possibilities "counter rediscount ", has undergone significant changes since its reorganization from 1989 to date, in particular, with new players. This note identifies its organization and prospects, as well as the new methods of intervention by the Bank of Algeria. Besides the interbank market, a market for negotiable debt securities will be set up and will thus form a new money market, in the broad sense., the market for negotiable debt securities presents itself as a hinge between the short and long term capital markets where a range of short and medium term securities are offered to agents with financing capacity, such as treasury bills, cash and certificates of deposit. Our empirical study concerns a sample covering average prices GBP, USD and EUR during the overall period of market functioning Algerian interbank exchange rates (March 2008- March 2018). the results obtained testify the presence of a certain phenomenon of long-term persistence in the volatility of exchange rate. FIGARCH-type processes seem to surround this phenomenon.

Keywords: Volatility, Long Memory, Algerian Interbank Market, Fractional Integration

1. Introduction

Currently, the idea commonly accepted in the literature relating to the problem thorny exchange rate dynamics is that changes in daily exchange rates, just like many high frequency financial series, present a set of well-established statistical properties. In this regard, Meese and Singleton (1982), Meese and Rog off (1983, 1988), Corbae and Ouliaris (1986), Baillie and Bollerslev (1989) and others, have shown that time series of nominal exchange rates often exhibit the presence of root unitary while the variations are stationary. These results imply that the exchange rate dynamics seem to be well captured by a simple market process random and therefore the best forecast for tomorrow's exchange rates and the today. Other researchers such as Cornell and Dietrich (1978), Levich (1979).

Dooley and Shafer (1983) have shown that variations in exchange rates are characterized often by the absence of autocorrelation phenomena. This conclusion was not, however, confirmed by Poole (1967), Baillie and McMahon, Palm and Vlaar (1997). These authors were able to detect the presence of some first-order autocorrelation. In this same wake, other researchers have turned to the study of phenomena autocorrelation, heteroskedasticity and variance over time conditional giving, consequently, two families of nonlinear models. The first supported by Taylor (1986), Harvey, Ruiz and Shephard (1994) brings together the models with stochastic volatility (VS). The second relates to heteroskedasticity models conditional autoregressive (ARCH). This modeling approach has known during last two decades of spectacular developments. So the ARCH processes, originally introduced by Engle (1982) and generalized by Bollerslev (1986) with the GARCH processes, were, therefore, extended by Engle and Bollerslev (1986) to the case of asymmetric variance processes (EGARCH). In addition to this line of research, empirical investigations have been directed towards the study of the statistical properties of distributions of variances. After a large number of studies, researchers conclude often to the presence of atypical properties with respect to the Gaussian distributions in distributions of exchange rate changes. The presence of grouping of extreme values Often these distributions provide thick tails and some asymmetry. We quote, by way of illustration, the work of Westerfield (1977), Cornell and Dietrich (1978), Bollerslev (1987), Boothe and Glassman (1987), Hsieh (1988), Altan, Avouyi-Dovi and Ducros (1992),… etc. As regards the conformity of these distributions with the distribution of a normal law. angular hypothesis of several models in finance (asset valuation model services international financial asset valuation model

Arbitration Valuation Model Foreign Exchange Options Valuation Model Garman Kohlhagen (1983), Grabbe (1983), Whaley (1987),… etc.), the authors confirm often the rejection of the normality assumption. As for the hypothesis of interdependence and identical distribution (i.i.d.), it is often rejected which implies that there is often a excessive reconciliation between data (Hsieh (1989), De Grauwe et al. (1993), Preumont (1996),… etc.). The junction between studies on the temporal properties of exchange rate variations and conditional heteroskedasticity models shows that the simple process of random walking with excessive kurtosis and time-varying heteroskedasticity seems to capture the dynamics of exchange on short term horizons. Based on this conclusion, other studies by Boothe, Kaen and Koeveos (1982) and Cheung (1993) sought to improve the performance of these models by integrating the ypothesis of a possible presence of fractional integration and, along the way, from a long memory in the daily exchange rate variations. In this In this regard, empirical research has turned towards a new line of research which consists to integrate the phenomenon of long-term dependence through type processes Fractionally integrated GARCH (FIGARCH) originally introduced by Baillie, Bollerslev and Mikkelsen (1996). FIGARCH processes are an intermediate case between GARCH and IGARCH process. They have the merit of performing the function between short-term and long-term volatility dynamics. The short term dynamics is surrounded by the GARCH process. That of the long term being taken into account by the coefficient fractional integration. Currently, the empirical literature provides countless attempts to specify exchange rate dynamics based on type processes FIGARCH. We cite, by way of example, the work of Bollerslev and Mikkelsen (1996), Tse (1998), Maheu (2002), Andersen, Bollerslev, Diebold and Labys (2002), Martens and Zein (2002), Pong, Shackleton, Taylor and Xu (2002),… etc. The results obtained show that the FIGARCH processes appear to be able to capture the highly persistent nature of the exchange rate volatility. Our empirical study is in line with these works. We will try to identify and model the phenomenon of long-term persistence the volatility of changes in exchange rates using FIGARCH-type processes. Apart from the obvious advantage of confronting the specificities of the Algerian context, our study presents the merit of being based on a daily frequency sample covering the period overall functioning of the interbank foreign exchange market (March 1994- March 2004). This paper is organized as follows: section 2 describes the foundations of the long memory and defines FIGARCH processes. Section 3 provides a review of the empirical literature on the issue. Section 4 begins our empirical study by detecting the presence of long memory in the behavior of the variance of yields. Section 5 will be reserved for FIGARCH modeling.

2. Modeling the Volatility Long Memory Using FIGARCH Processes:

The taking into account of a possible fractional integration of the conditional variance was originally discussed by Ding and Granger (1996) and Ding, Granger and Engle (1993) formally, the FIGARCH models were introduced by Baillie, Bollerslev and Mikkelsen (1996). The starting point is a GARCH process (p, q). It can be written as follows:

$$\sigma^2_{i=\alpha_0 \sum_{i=1}^{q} \alpha_i \varepsilon^2_{t-1} + \sum_{j=1}^{p} \beta_i \sigma^2_{t-j} = \alpha_0 + \alpha(L)\varepsilon^2_t + \beta(L)\sigma^2_t \alpha\varepsilon_{i-1}} \quad (1)$$

Where, σ^2 is the conditional variance; 0; 0; 0; i 1, 2,..., q α0 f αi ≥ β j ≥ =

GARCH processes (p, q) are short memory processes since the effect of a shock on the variance decreases at an exponential rate. The GARCH process (p, q) can be written also as follows

$$[\![1-\alpha(L)-\beta(L)]\!]\varepsilon^2_t \alpha_0 + \alpha(L)\varepsilon^2_{L} {}_{+}\beta(L)\sigma^2_t \quad (2)$$

Consequently, when the lags polynomial [1 −α (L) - β (L)] contains a unit root, the integrated GARCH process (noted IGARCH (p, q)) is written:

$$[\![1-\alpha(L)-\beta(L)]\!]\varepsilon^2_t = \alpha_0 + [1-\beta(L)]\mu_t \quad (3)$$

$$\phi(L)(1-L)\varepsilon^2_t = \alpha_0\,[1-\beta(L)]\mu_t \quad (4)$$

FIGARCH processes are an intermediate case between GARCH processes and IGARCH. By replacing (1-L) with the operator (1 - L) d, where (d) is the integration parameter fractional, the FIGARCH process is written

$$\phi(L)(1-L)^d\varepsilon^2_t = \alpha_0 + [1-\beta(L)]\mu_t \quad (5)$$

The roots of the polynomials Φ L and [1− β (L)] being outside the unitary disc. So if d = 0, the FIGARCH process (p, d, q,) is reduced to a GARCH (p, q,). If d = 1, the FIGARCH becomes an IGARCH. By replacing μt with its value as a function of 2 σ t, we can write equation (4) as

$$[1-\beta(L)]\sigma^2_t = \alpha_0[1-\beta(L)\phi(L)(1-L)^d]\varepsilon_t \quad (6)$$

Where

$$\sigma^2_t = \alpha_0\,[1-\beta(L)]^{-1} + \lambda(L)\varepsilon^2_t$$

With $\lambda(L) = [\![1 - [1 - \beta]^{-1} \phi(L)[1 -]^{d}]\!] = \lambda_1 L + \lambda_2 L + \cdots$. and $\lambda_k \geq 0, k = 2, \ldots, n$

The variance equation is then given by Bollerslev and Mikkelsen (1996) note that the sequences of a shock on the variance conditional of the FIGARCH process (p, d, q,) decrease at a hyperbolic rate when: $0 \leq d < 1/2$ (Bollerslev and Mikkelsen (1996), p. 155)

3. State of the Question

Numerous studies have tested the persistence of the volatility of changes in nominal changes (Engle and Bollerslev (1986), Bollerslev (1987), McCurdy and Morgan (1987), Hsieh (1988), Baillie and Bollerslev (1989), Hsieh (1989), and others). These authors have been led to conclude in favor of GARCH type processes integrated into variance IGARCH. However, these processes seem to be really incapable of properly determining the highly persistent volatility in exchange rates. Indeed, according to lessons from an IGARCH process, the effect of a shock on the volatility of the change in exchange rate persists over time almost infinitely, which seems little realistic. As a result, this type of behavior cannot be identified through a process of short memory of type ARCH, IGARCH or EGARCH. These models assume a rapid decrease in the effect of a shock on conditional variance. As for the processes IGARCH type, they assume an infinite persistence of the shock. In this regard, Poon and Granger (2002), in an article survey argue: "[…], Volatility persistence is a feature that many time series models are designed to capture. A GARCH model features an exponential decay in the autocorrelation of conditional variances. However, it has been noted that squared and absolute returns of financial assets typically have serial correlations that are slow to decay similar to these of I (d) process. A shock in the volatility series seems to have very long memory and impact on future volatility over long horizon "(Poon and Granger (2002), p. 11). In view of these results, empirical research relating to the problem of the dynamics of exchange has turned towards a new line of research which consists in identify the phenomenon of long-term dependence via FIGARCH processes. About that, Mikkelsen and Bollerslev consider that FIGARCH-type processes, which by authorizing the presence of fractional integration, can be a reconciliation solution between GARCH and IGARCH type processes (Mikkelsen and Bollerslev (1996), p. 157). In reality, it was not until the work of Baillie, Bollerslev and Mikkelsen (1996) that better specify exchange dynamics. Thus, the first attempts to apply the FIGARCH processes date back to 1996 with these authors. Based on series nominal exchange rate temporals covering DEM / USD parity for the period (1979: 03-1992: 12), the authors conclude that there is a FIGARCH type process with a positive fractional integration coefficient (d). In 1998, Tse engaged in a comparative analysis of predictive performance of the ARCH and FIGARCH processes for a JPY / USD parity sample covering the period (1978: 01-1994: 06). The author concludes in favor of the FIGARCH process. Indeed, the results obtained reveal the presence of a positive and statistically significant fractional integration coefficient. In this same track, Maheu (2002) conducted a comparative analysis of CGARCH processes (Component GARCH) introduced by Engle and Lee (1999) and FIGARCH processes on a support empirical with time series of returns of certain financial assets (three stock market indices and two exchange rates: DEM / USD and JPY / USD). Concerning the Exchange rate, the study period runs from January 1979 to June 2001. At the end of these investigations, the author shows that the CGARCH-type process allows, in certain conditions, to identify the long-term dependence of financial assets. Andersen, Bollerslev, Diebold and Labys (2002), by testing the performance of the FIGARCH process on data covering the JPY / USD and DEM / USD parities covering the period (1986: 12- 1999: 06), confirm the good performance of FIEGARCH type processes. In using intraday time series (tick by tick data) relating to contracts Futures covering the underlying JPY / USD covering the period (1996: 01-2000: 12), Martens and Zein (2002) conclude that an ARFIMA-GARCH type process is present. This process also seems to be valid for Futures contracts on crude oil. In the same line of work as Martens and Zein (2002), Pong, Shackleton, Taylor and Xu (2002) have attempted to model the behavior of the USD / GBP parity during the two sub-periods in sample (1987: 07-1993: 12) and out sample (1994: 01-1998: 12). They confirm the presence of a fractional integration of the intraday series of returns and propose a ARFIMA-GARCH type model. Using the average assessment criteria of squares of deviations and the mean of absolute errors, Vilasuso (2002) performs a comparative analysis of FIGRACH, GARCH and IGARCH processes. Empirical support retained covers the periods in the sample (1979: 03-1997: 12) and out of sample (1981: 01-1999: 1

4. Short and Long Term Dependence on Interbank Volatility

4.1. Data

Our empirical study will be conducted on a sample covering the following three parities DZD / USD, DZD / GBP and DZD / EUR for the period from March 1, 2008, to March 1, 2018, overall period of operation of the interbank market. As for the Euro, it will without saying that the study period begins on 04 January 1999, the date of the launch of the Euro on international currency markets. The data collected are frequent daily. They were provided to us by the exchange services of the Central Bank of Algeria (CBA). Our time series of dollar, pound and euro parities contain a total of 2432, 1742 and 1212 observations respectively. Lessons correspond to interbank "mid" 1. In what follows, we define the Interbank average return as follows:

$$rt = 100 \log \frac{st}{st - 1}$$

Where, St and St − 1 are the average interbank spot prices at times (t) and (t –1).

4.2. Descriptive Statistics

Descriptive statistics relating to the different series of interbank returns are listed in following table.

Table 1. *Descriptive Statistics.*

	EURO	GBP	USD
OBS	1300	1300	1300
MEAN	0.188	0. 13	0.23
MEDIAN	0.234	0.23	0.55
MAXIMUM	0.77	3.11	2.7
MINIMUM	-0.11	-3.78	-3.6
Standard deviation	0.004	0.02	0.08
Skewness	0.45	0.33	0.9
F-stat	56.45	47.31	34.5
Kurtosis	3.11	7.02	4.7
t-student	47	6.5	2.87
J-B	42.58	78.77	56.12
Prob	0.000	0.000	0.000

In the light of these descriptive statistics, we note that the DZD / USD parities and DZD / GBP exhibit the highest standard deviations. These two parities seem to be more volatile than the Euro on the interbank foreign exchange market. Referring to the test flattening of Kurtosis (noted K), we note the presence of strong excess of Kurtosis for the three selected parities. Indeed, according to t-Student statistics relating to Kurtosis, the calculated values of the statistic (K) deviate significantly from the value of reference for a normal distribution (i.e. K = 3), which testifies to the presence of a character leptokurtic in the unconditional density functions of the series. Concretely, this character is due to the presence of tails thicker than those of the normal law, which leaves predict the importance of extreme values compared to the average. In regards to the symmetry hypothesis, the calculated values of the Skewness statistic (denoted S) deviate significantly from zero, whatever the parity chosen. The significance of the deviations of the Skewness from its reference value being tested by the bias in the related t-Student statistic. The negative sign of the statistics observed at Pound level indicates that the distribution is spread to the left. She is spread out on the right for the case of DZD / EUR, hence the asymmetric nature of these two series. This asymmetry presupposes the presence of non-normality in the process evolution of the average interbank variations. It is indeed possible to reconcile the notions of asymmetry and non-linearity since we know that Gaussian linear models can only generate symmetric behavior of the series and therefore cannot render account for asymmetry. This possible non-linearity can, in fact, confirm the Presence of an ARCH effect, frequently encountered in financial series. Regarding the normality test of Jarque and Béra (JB), remember that, under the null hypothesis of normality, statistics (JB) follows a Chi-square law with two degrees of freedom. From the table below, we categorically reject the normality assumption for all distributions in question. Indeed, the calculated values of (JB) are strongly high and lead to a rejection of the null hypothesis at a significance level of 1%. These first observations confirm the idea commonly accepted in the empirical literature. We quote, as for example, Mandelbrot (1963), Fama (1965), Boothe and Glassman (1987), Friedman and Vandersteel (1982), Atlan, Avouyi and Ducos (1992), Bollerslev (1986, 1988), Jorion (1995) and other.

4.3. Stationarity

On test of Stationarity of daily interbank variations, we used in the unit root tests of Dickey and Fuller (DF) (1979, 1981), of Phillips and Perron (note PP) (1988) and Kwiatkwski et al. (noted KPSS) (1992). The choice of these tests can be explained by the fact that the first two tests (DF and PP) aim to test the validity of the null hypothesis of unit root and this, against the alternative hypothesis of absence of unit root while the KPSS test procedure imposes Stationarity under the null hypothesis. In fact, the major drawback in the usual ADF and PP tests is that they are biased in favor of accepting the null unit root hypothesis. To get around this difficulty, Kwiatkowski et al. (1992) suggested an alternative test procedure based on the idea of imposing stationarity under the null hypothesis. The use of these tests also to the fact that they distinguish short memory processes from those of memory long. In this regard, four cases arise: (i) rejection of the null hypothesis of unit root by the ADF and PP tests and acceptance of the null hypothesis of stationarity by the test KPSS: we are in the presence of a stationary process (i.e. I (0)), (ii) non rejection of the null hypothesis of unit root by the tests of ADF and PP and rejection of the null hypothesis of stationarity by the KPSS test: the three tests converge and confirm the presence of a integrated process of order one (i.e. I (1)), (iii) rejection of the null hypothesis by the ADF, PP and KPSS, the process in question is neither I (0) nor I (1), which suggests that presence of a long memory process, (iv) acceptance of the null hypothesis by three tests: this result presumes a data problem. These may not contain sufficient information on the long-term characteristics of the process in question. The results of the Stationarity tests are given in this table.

Table 2. *Stationarity test results (unit root).*

Serie	lags	ADF		PP		KPSS
		With c	Whithout c	With c	With out c	ημ
GPB	4	-18.4	-18.55	-17.99	-17.81	0.121
USD	4	-18.56	-18.11	-17.45	-17.22	0.151
EUR	3	-18.44	-18.45	-18.33	-17.61	0.199

The critical values of the ADF and PP tests are taken from the tabulated values provided by McKinnon (1991). For the constant model, these critical values are equal to -2.56 and -1.94 at the respective thresholds of significance of 5% and 10%. These values are respectively -3.43 and -2.86. If the residues are from the regression with constant. The critical values of the KPSS statistic are 0.739, 0.463 and 0.347 for confidence levels of 99%, 95% and 90% respectively. Tests performed on Eviews (version10.0) and RATS (version 5.0).

At this level, it should be noted that these tests were conducted in the presence of the lags orders of 1, 5, 10, 15 and 20 in the primary differences of the dependent variable of the regression underlying the ADF test and in the Newey-West window (respectively, that of Bartlet) for the tests of PP and KPSS. The hypothesis relating to the presence or not of a constant was also taken into account. Referring to the calculated values of the ADF and PP tests, we unambiguously reject the null hypothesis of a unit root in the differentiated series of exchange rates which whether the model considered (with or without constant) and the order of the structure of lags selected. This result is confirmed by KPSS tests since we accept the null hypothesis of Stationarity at 99% confidence level, with the exception of the Euro or this assumption is accepted at a significance level of 5%. For all series, the situation (i) seems to hold: the process governing the series of returns is stationary (i.e. I (0)). In other words, spot prices are I (1). The results of these tests therefore reinforce the current consensus around the Stationarity of daily variations in exchange rate.

4.4. The Statistical Properties of Volatility: The Short and the Long Term

4.4.1. A Preliminary Analysis

In order to justify the empirical relevance of the choice of the long memory process in the volatility of exchange rate variations, we proceeded by a descriptive analysis preliminary. Using the same approach of Bollerslev and Mikkelsen (1996), we used the absolute variations of the tr series as a measure of volatility (Bollerslev and Mikkelsen (1996), pp. 155-156). Indeed, according to Taylor (1986), the variations absolute values exhibit greater autocorrelation than the square of variations. So we have graphically presented the forms of the autocorrelation functions of the variations absolute, prime differences of absolute variations ie $(1 - L|rt) \equiv \|rt - rt - 1\|$ fractionally differentiated absolute variations ie $((1 - L)^d|rt|)$. The coefficient of fractional integration was arbitrarily chosen (d = 0.5). The maximum lags order retained being 1000, that is, approximately four years (cf. Figures 1, 2 and 3). Confidence interval corresponds to that of Bartlett $(\frac{1.96}{T})^{0.5}$, T being the number of observations the persistence of each series has been formally tested using the Box-Pierce test (noted BP). The appearance of the autocorrelation functions calls for the following comments:

We note phenomena of grouping of volatility which testifies to the non consistency of volatility over time and suggests the presence of an ARCH effect (ii) the autocorrelation structures of these series decrease rapidly from the first lag but exhibit hyperbolic decay for high lags orders. remember, at this level, that the IGARCH and GARCH processes often involve a decrease exponential of the conditional variance autocorrelation function and can therefore hardly account for this dynamic, (Bollerslev and Mikkelsen (1996), p. 155) (iii) for very high lags orders, the absolute return series show statistically significant autocorrelation coefficients (i.e. 95% confidence level),(iv) With regard to functions relating to differentiated return series (fully or fractionally), we find that the apparent persistence in the functions autocorrelation of absolute variations has been reduced considerably. The teachings of the graphical analysis seem to be confirmed by the calculated values of the statistic of Box-Pierce. Indeed, the statistics of this test are very high and highly significant for absolute return series. The fact remains that these values have downward trend while remaining significant. In total, this first descriptive analysis suggests that the volatility of average interbank yields is fractionally integrated or with long memory. Thus, FIGARCH type processes appear to be quite capable of identifying such behavior by endogens value of the fractional integration parameter.

Table 3. *Results of Box-Pierce tests of absolute variations in average prices interbank.*

Q-STAT	USD	GBP	EUR
$\|rt\|$	566.23 (0.000)***	444.78 (0.000)***	763.9 (0.000)***
$(1 - L\|rt) \equiv \|\|rt - rt - 1\|\|$	78 7.14 (0.000)***	677.78 (0.000)***	334.38 (0.000)***
$((1 - L)^d\|rt\|)$	334.56 (0.000)***	555.76 (0.000)***	565.771 (0.000)***

Q is the Box-Pierce stat calculated for a delay order of 1000. (equation) absolute value of performance. L is the delay operator. The numbers in parentheses denote the marginal levels of significance. *** significant at a 99% confidence interval. Tests performed on RATS (version 5.0)

4.4.2. ARCH Effects

relatively volatility. We are also observing volatility groupings: the strong variations tend to be followed by large variations and small variations by small variations, which indicates a non-consistency of volatility over time. These findings suggest that an ARCH type process could be adapted to the modeling of these series. In addition, descriptive statistics (S, K, JB) support us in the estimation of a nonlinear model and more particularly of an ARCH type model. In order to put implementing the ARCH test, we were led to specify the AR (p) processes specific to each output series. To do this, we used the correlogram profiles of autocorrelations and partial autocorrelations as well as the information criteria Akaike (AIC) and Schwartz (SIC). This procedure allowed us to retain orders for lags 1, 2 and 3 for the Dollar, the Euro and the British Pound respectively. The results of ARCH tests are grouped in following table.

Table 4. *ARCH effect (Heteroskedasticity test).*

Parity	Obs *R²	Prob.
USD	21.18***	0.0044
GBP	55.9 ***	0.0018
EUR	10.35 ***	0.0022

Obs number of observations, R2 coefficient of determination associated with the autoregressive process of the squared of resid

We find that the probability associated with the test statistic (TR) 2 is zero, which leads us to reject the null hypothesis of homoscedasticity in favor of the alternative heteroskedasticity.

4.4.3. Short-term Dynamics and Process of GARCH

Table 5. *Comparison criteria of the estimated models.*

	R²	LogL	AIC	BIC
AR(1)-ARCH(1)	0.00601	-237.899	13.34	14.01
AR(1)-GARCH(1,1)	0.00847	-239.122	13.02	14.11
AR(1)-EGARCH(1,1)	0.00998	-238.445	13.88	14.81
AR(1)-TGARCH(1,1)	0.00776	-238.986	13.77	14.08
AR(1)-GARCH(1,1)-M	0.00678	-239.114	13.15	14.32

R^2 is the corrected coefficient of determination. LogL is the value of the log-likelihood at the optimum, AIC and SIC are the information criteria of Akaike and Schwartz, respectively. * designates the model to be used according to selected criteria. Models estimated on Eviews

Our goal now is to estimate the variance equation in conjunction with the equation of the average. To do this, we use the maximum likelihood technique four estimates have been made: ARCH, GARCH, GARCH-M, EGARCH and TGARCH processes. Regarding the US Dollar, we have retained the following processes: AR (1) -ARCH (1), AR (1) GARCH (1,1), AR (1) -TGARCH (1,1), and AR (1) -EGARCH (1,1). What model should we ultimately retain for modeling conditional variance? To the extent that the asymmetry phenomenon is present, we can think that the most suitable models are the EGARCH and TGARCH processes. The choice between these models can be made at using model comparison criteria. As an indication, we also retain the calculated values of the criteria for each of the processes. Table 5 describes the whole of the results obtained. the comparison of the selection criteria between the different models (Table 5) we leads to selecting the AR (1) -ARCH (1,1) -M process for the DZD / EUR parity, AR (1) - EGARCH (1,1) for parity DZD / USD and AR (1) -EGARCH (1,1) for parity DZD / GBP.

5. FIGARCH Modeling

5.1. Analysis in Terms of R / S and Modified R / S

Estimation of the FIGARCH process requires the application of the test procedure beforehand (R / S) modified in order to formally highlight the presence of long memory in the volatility of interbank exchange rates. Analysis (R / S) is particularly interesting insofar as it allows, via the Hurst coefficient (H), to classify the time series according to the nature of their memories. In reality, the use of the modified R / S statistic is due to three reasons. (i) the traditional (R / S) statistic is extremely sensitive to short-term dependence (ii) the probability distribution of (R / S) is unknown (iii) it is robust to a large number of forms of heteroskedasticity in especially conditional heteroskedasticity (Cheung (1983). Essentially, statistics (R / S) is written as follows

$$\widetilde{Q_{mT}} = R/\sigma_T = \frac{1}{\sigma_{T(q)}} [\![max_{1\le k\le T} \sum_{i=1}^{k}(X_{i-}\overline{X_T}) - min_{1\le k\le T} \sum_{j=1}^{k}(X_j - \overline{X_T})]\!]$$

Where;

$$\sigma_t^2(q) = \frac{1}{T}\sum_{j=1}^{T} \quad (X_{j-}\overline{X_T})^2 + \frac{2}{T}\sum_{j=1}^{q} \omega_i(q) [\![\sum_{j+1}^{T}(X_j - \overline{X_T})(X_{ij} - \overline{X_T})]\!]$$

With $wj(q) = 1 - \frac{j}{q+1}$; q<1

Xt being the time series in question $\overline{X}\,T$ is the mean and $\sigma 2 \ \ T$ is a variance compared to classical (R / S) statistics, modified (R / S) admits a limit distribution known (denoted V)

$$V = \frac{Q_T}{\sqrt{T}}$$

This value is tabulated by Lo (1991). Therefore, it is quite possible to test the null hypothesis of short memory versus the alternative hypothesis of long memory. The results of the (R / S) and (R / S) modified tests are shown in following table.

Table 6. *Test results (R / S) and (R / S) modified.*

	(R/S)	(R/S) modified	
	H	H	V
USD	0.667	0.542	1.17*
GBP	0.665	0.546	1.71**
EUR	0.668	0.547	1.55**

*, ** rejection of the null hypothesis at the respective thresholds of 10% and 5%. The R / S and R / S modified tests have been performed on and LMA (version 2.0)

The results reported in Table 6 indicate that the Hurst exponent estimated using of traditional (R / S) analysis is always greater than (0.5) thus suggesting the existence of a long memory in all series. However, as we have mentioned earlier, this method is sensitive to short term dependence. This can be checked against the estimate of (H) by the modified (R / S) method. We note that whatever the series of returns, the exponent (H) estimated by the method of Lo (1991) being higher than that calculated using traditional (R / S), testifying to the fact that yields are not independent over time. With regard to the term analysis (R / S) modified, the three series of interbank returns seem to appear from the long memory and, for a level of confidence of 95% for the case of the Euro and the Pound sterling. As for the Dollar, the statistic (H) being significant only at a threshold of 10%.

5.2. FIGARCH Modeling

To estimate FIGARCH processes judiciously, we will implement two estimation procedures. The first is based on spectral behavior at bass frequencies of the Geweke and Porter-Hudack (1983) yield series (note GPH). The second procedure being that of the exact maximum likelihood method

(Sowel (1992)). The idea being to ensure the relevance of the estimates used and to decide divergence of results

5.2.1. Spectral Density Behavior and GPH Method (1983)

The implementation of the GPH (1983) method requires prior specification of the ordinates (m) of the periodogram in order to frame the square root of the number of observations (T). In general, we retain a number of ordinates of the periodogram belonging to the interval $[\![T^{0.5}\ T^{0.55}]\!]$. However, Hurvich et al. (1988) have shown that the optimal order of (m) is rather $(T^{0.8})$. As far as we are concerned, we voluntarily retain values of

(m) equal $T^{0.45}$ $T^{0.5}T^{0.55}$ and$T^{0.8}$. In reality, this choice was motivated by the concern for examination the stability of the estimates obtained when the number of ordinates in the periodogram varied. The results relating to the application of the Geweke and Porter-Hudak procedure are shown in table 7.

Table 7. *Results of the GPH procedure.*

(m)	$T^{0.45}$	$T^{0.5}$	$T^{0.55}$	$T^{0.8}$
USD	0.341 (3.675)*	0.301 (3.285)*	0.129 (2.885)*	---
GBP	0.229 (3.515)*	0.276 (3.443)*	---	---
EUR	---	0.052 (3.779)*	- --	---

T: designates the number of observations. The figures in parentheses denote the t-Student statistics of coefficients (d). (m) is the number of ordinates of the periodogram. (---) fractional integration coefficient not significant. Estimates were made on RATS

With regard to the British pound, the results obtained show the presence of a memory long in the series of returns. The fractional integration coefficient being positive and statistically significant, which suggests a phenomenon of persistence of volatility. As for the Dollar, the fractional integration coefficient is positive and statistically significant for three values of (m). This coefficient presents a relatively stable value. It is around (0.3), hence a phenomenon of persistence. As for the Euro, the only significant integration coefficient is obtained at a level $T^{0.5}$ of periodogram. This coefficient rises to 0.05 and also indicates the presence of a persistence of volatility

5.2.2. FIGARCH Estimation: Exact Maximum Likelihood Method

In order to be able to decide between the diverging results, we now propose to apply the method of estimating the exact maximum likelihood. The advantage of the method lies in the joint estimation of the determining parameters of the FIGARCH process.

Table 8. *FIGARCH modeling: maximum likelihood method.*

		AIC	BIC
Parity	FIGARCH	(1; 0.5024;1)	(1; 0.4543;1)
	t-Student	4.3453*	4.1698*
	Log L	-287.74	-296.32

Log L is the value of the log likelihood at the optimum. * fractional integration coefficient statistically significant; Estimates made on the Lombardi J. Software (2002). The digital resolution was carried out at using the BHHH algorithm (Berndt, Hall, Hall and Hausman (1974))

This table summarizes all the results obtained. In this table, we have retained the FIGARCH process to jointly minimize the information criteria of Schwartz (SIC) and Akaike corrected (AIC) the results reported in Table 8. show that whatever the criterion used (criterion Schwartz Information System (SIC) or Akaike Criterion (1973) corrected by Hurvich and Tsai (1989)), the series exhibit a henomenon of long-term dependence in their volatilities conditional. We also note a certain stability of the integration coefficient fractional. The fractional integration parameters being positive and statistically significant, which confirms the first results in terms of the Hurst coefficient and spectral analysis (i.e. GPH). So we are in the presence of a phenomenon of persistence of the volatility of the dollar, the pound and the euro vis-à-vis the dinar. Turning our attention to the corrected AIC criterion, we can conclude that the three series simultaneously exhibit the presence of a long-term dependence on volatility conditional and a significant ARCH effect. These interbank yields admit a long-term dynamics (surrounded by the integration parameter) and another short-term (surrounded by process parameters (GARCH). The results we achieved, are generally compliant, cited in the literature. We cite, by way of illustration, Bollerslev and Mikkelsen (1996), Maheu (2002), Martens and Zein (2002), Caporin (2003),…etc.

6. Conclusion

In this paper, we have tried to identify and model the phenomenon of persistence of short- and long-term dependence on the volatility of changes in exchange rates a review of the literature relating to the question shows that FIGARCH processes appear to be particularly relevant for modeling time series with a long-term dependency structure. These models help to identify jointly the short and long term dynamics of volatility. The dynamics of long term is surrounded by the fractional integration coefficient, that of short term being taken into account by the GARCH type process. Our empirical study was conducted in the context of the Algerian interbank foreign exchange market (March 2008-March 2018) for the three main currencies: USD, EUR and GBP. The results obtained show the relevance of FIGARCH type process. The fractional integration coefficient is often positive and statistically significant. This parameter being almost equivalent for the three parities (from around 0.10), which suggests the same degree of volatility persistence at through the parities and thereby, a certain homogeneity between the variations in exchange rates interbank means. However, the persistence of the detected volatility shocks should make this volatility predictable, at least in part. As a result, the robustness of the long memory component in conditional volatility should be tested for periods outside the sample. Furthermore, the predictive capacity of FIGARCH models, compared to other models including GARCH, IGARCH or step models random should be analyzed. These tests will be the subject of further research.

Appendix

DZD / USD

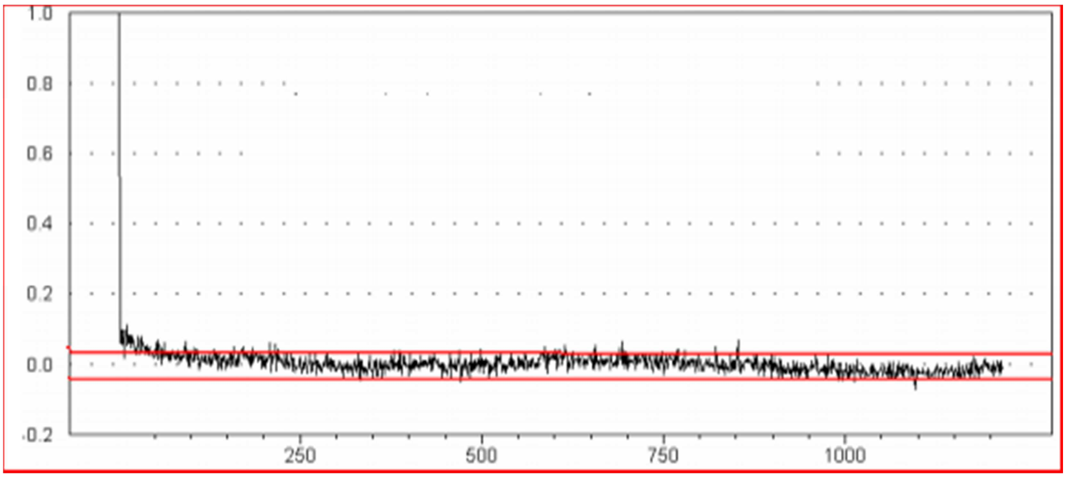

Figure 1. *Appearance of the autocorrelation function of absolute variations in the case of parity.*

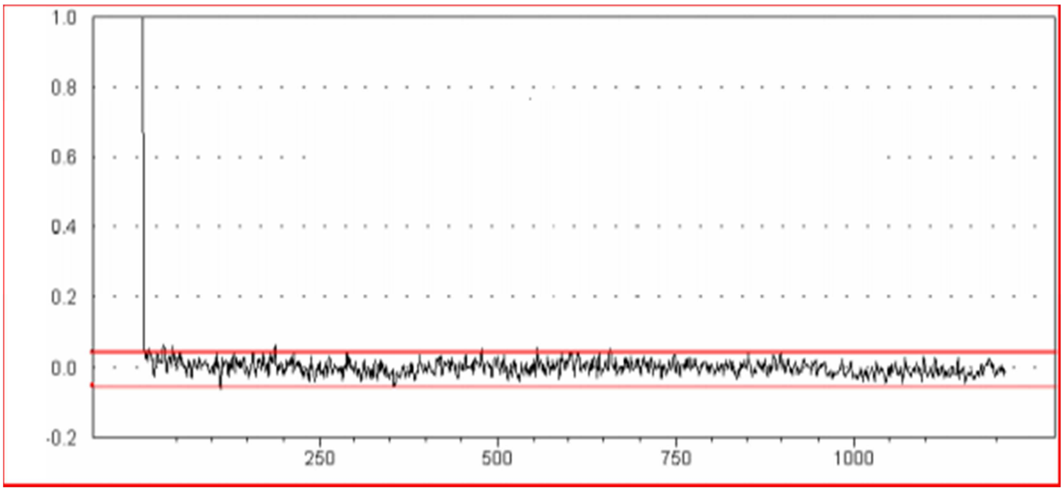

Figure 2. *Autocorrelation function of differentiated absolute variations.*

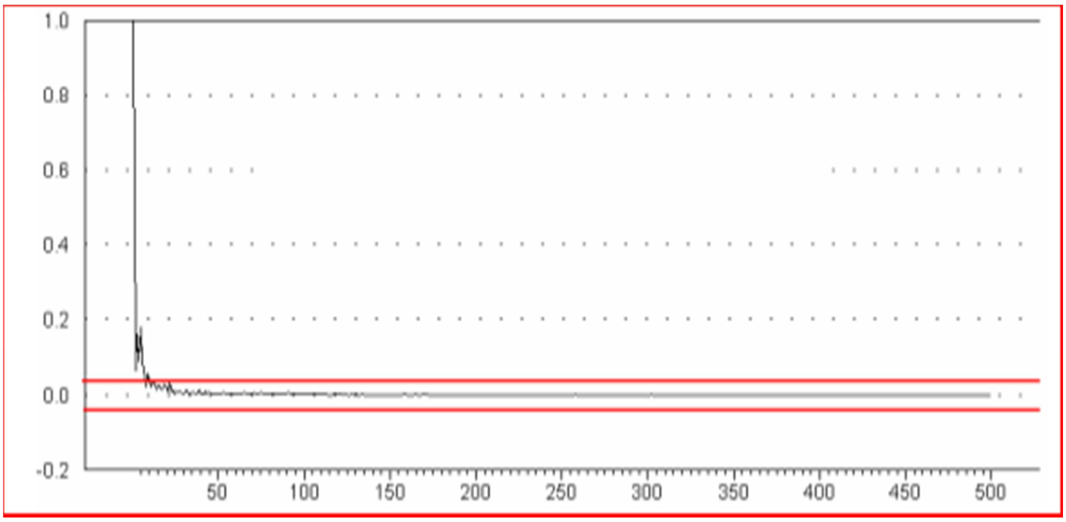

Figure 3. *Autocorrelation function of fractional absolute variations differentiated.*

The autocorrelation functions of the absolute variations were provided by LMA software (Long Memory Analysis) (version 2.0).
JB: Jarque and Béra statistics. Prob. level of probability associated with the Jarque and Béra test. Statistics provided by STATA14

References

[1] Andersen, T. G., T. Bollerslev, F. X Diebold et P. Labys (2001), «The Distribution of Realized Exchange Rate Volatility», Journal of American Statistical Association, Vol. 96, pp. 42-57.

[2] Andrews, D. (1991), «Heteroskedasticity and Autocorrelation Consistent Matrix Estimation», Econometrica, Vol. 59, pp. 817-858.

[3] Atlan, F., Avouyi-Dovi, S. et Ducos, P. (1992), «Dynamique des Taux de Change: Propriétés Statistiques des Taux de Change», Dans E. Girardin (eds), Finance internationale: l'état.

[4] actuel de la théorie, Economica. Baillie, R. T, McMahon, P. (1989), «The Foreign Exchange Market», Cambridge University Press, Cambridge.

[5] Baillie, R. T. et Bollerslev, T. (1989), «The Message in Daily Exchange Rates: A Conditional Variance Tale», Journal of Business and Economic Statistics, Vol. 7, pp. 297-305.

[6] Baillie, R. T., Bollerslev, T et Mikkelsen, H. O. (1996), «Fractionally Integrated Generalized Autoregressive Conditional Heteroskedasticity», Journal of Econometrics, Vol. 73, pp. 3-20.

[7] Berndt, E. K, Hall, B. H., Hall, R. E. et Hausman, J. A., (1974), «Estimation Inference in Nonlinear Structural Models», Annals of Economic and Social Measurement, Vol. 4, pp. 653-665.

[8] Bollerslev, T et Mikkelsen, H. O., (1996), «Modeling and Pricing Long Memory in Stock Market Volatility», Journal of Econometrics, Vol. 73, pp. 151-184.

[9] Bollerslev, T. (1987), «A Conditionally Heteroskedastic Time Series Model for Speculative Prices and Rates of Return», Review of Economics and Statistics, Vol. 69, pp. 542-547.

[10] Bollerslev, T., (1986), «Generalized Autoregressive Conditional Heteroskedasticity», Journal of Econometrics, Vol. 5, pp. 1-50.

[11] Bollerslev, T., (1987), «A Conditionally Heteroskedasticity Time Series Models for Speculative Prices and Rates of Return», Review of Economics and Statistics, Vol. 69, pp. 542-547.

[12] Bollerslev, T., (1988), «On the Correlation Structure for the Generalized Autoregressive Conditional Heteroskedastic Process», Journal of Time Series Analysis, Vol. 9, pp. 121-131.

[13] Boothe, G, Kaen, F. R. et Koveos, P. E., (1982), «R/S Analysis of Foreign Exchange Rates UnderTwo International Monetary Regimes», Journal of Monetary Economics, Vol. 10, pp. 297-319.

[14] Boothe, P et Glassman, D. (1987), «The Statistical Distribution of Exchange Rates: Empirical Evidence and Economic Implications», Journal of International Economics, Vol. 22, pp. 297-319.

[15] Caporin, M., (2003), «Stationarity, Memory and Parameter Estimation of FIGARCH Models», Working paper N°03-09, GRETA, Venise, Italie.

[16] Cheung, Y. W., (1993), «Long Memory in Foreign Exchange Rates», Journal of Business and Economic Statistics, Vol. 11, pp. 93-101.

[17] Corbae, D et Ouliaris, S. (1986), «Robust Tests for Unit Roots in the Foreign Exchange Markets», Economic Letters, Vol. 22, pp. 375-380.

[18] Cornell, W. B. et Dietrich, J. K (1978), «The Efficiency of the Foreign Exchange Market Under Floating Exchange Rates», Review of Economics and Statistics, Vol. 60, pp. 111-120.

[19] De Grauwe, P., Dewchter, H, et Embrechts, M. (1993), «Exchange Rate Theory, Chaotic Models of Foreign Exchange Markets», Blackwell, Oxford, U.K and Cambridge, USA.

[20] Dickey, D. A. et Fuller, W. A., (1979), «Distribution of the Estimates for Autoregressive Time Series with a Unit Root», Journal of American Statistical Association, Vol. 74, pp. 427-482.

[21] Ding, Z., Granger, C. W. J. et Engle, R. F., (1993), «A Long Memory Property of Stock Markets Returns and a New Model», Journal of Empirical Finance, Vol. 1, pp. 83-106.

[22] Dooley, M. P et Shafer, J. (1983), «Analysis of Short Run Exchange Rate Behavior: Marsh 11973 to November 1981», dans D. Bigman et T. Taya (eds.), Exchange Rate and Trade Instability: Causes, Consequences and Remedies, Cambridge, MA: Ballinger.

[23] Engle, R. F. et Bollerslev, T., (1986), «Modeling the Persistence of Conditional Variances», Econometric Review, Vol. 5, pp. 1-50.

[24] Engle, R. F., (1982), «Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of U.K Inflation», Econometrica, Vol. 50, pp. 987-1008.

[25] Engle, R. F., et Bollerslev, T., (1988), «modeling the Persistence of Conditional Variances», Econometric Review, Vol. 5, pp. 1-50.

[26] Fama, E., (1965), «Portfolio Analysis in a Stable Paretian Market», Management Science, pp. 404-419.-Freidman, D et Vandersteel, S. (1982), «Short-run Fluctuations in Foreign Exchange Rates», Journal of International Economics, Vol. 13, pp. 171-186.

[27] Garman, M et S. Kohlhagen, (1983), «Foreign Currency Option Values», Journal ofInternational Money and Finance, Vol. 2, pp. 231-238.

[28] Geweke, J. et Porter-Hudak, S., (1983), «The Estimation and Application of Long Memory Time Series Models», Journal of Time Series Analysis, Vol. 4, pp. 221-238.

[29] Granger, C. W. J., Joyeux, R. (1980), «An Introduction to Long Memory Time Series Models and Fractional Differencing», Journal of Time Series Analysis, Vol. 1, pp. 15-29.

[30] Harvey, A. C., Ruiz, E et Shephard, N. (1994), «Multivariate Stochastic Variance Models», Review of Economic Studies, Vol. 61, pp. 247-264.

[31] Hosking, J. R. M. et Granger, C. W. J., (1996), «Modeling Volatility Persistence of Speculative Returns: A New Approach», Journal of Econometrics, Vol. 73, pp. 185-215.

[32] Hsieh, D. A., (1989), «Modeling Heteroskedasticity in Daily Foreign Exchange Rates», Journal of Finance, Vol. 5, pp. 1839-1877.

[33] Hurvich, C. M., Deo, R. S. et Brodsky, J., (1998), «The Mean Squared Error of Geweke andPorter-Hudak's Estimator of the Memory Parameter of Long Memory Time Series», Journal of Time Series Analysis, Vol. 19, pp. 19-46.

[34] Jorion, P. (1995), «Predicting Volatility in the Foreign Exchange Market», Journal of Finance, Vol. 2, pp. 507-528.

[35] Kwiatkowski, D. P., Phillips, P. C. B., Schmidt, P. et Shin, Y., (1992), «Testing the Null Hypothesis of Stationarity Against the Alternative of the Unit Root: How Sure are we that Economic Time Series are Non Stationary?», Journal of Econometrics, Vol. 54, pp. 159- 178.

[36] Lecourt, C. (2000), Les variations du Taux de Change au Jour le Jour: Une Approche Econométrique à Partir des Processus à Mémoire Longue, Thèse de Doctorat, Université de Lille, France.

[37] Levich, R. (1979), On the Efficiency of Markets for Foreign Exchange, dans R. Dornbush et J. Frankel eds. International Economic Policy, Theory and Evidence, John Hopkins, pp. 246-267.

[38] Lo, A. W., (1991), «Long Term Memory in Stock Market Prices», Econometrica, Vol. 59, pp. 1279-313.

[39] Maheu, J. M., (2002), «Can GARCH Models Capture the Long Range Dependence in Financial market Volatility?, Working Paper, University of Toronto. Mandelbrot, B. B., (1963)», New Methods.

[40] Martens, M., et J. Zein, (2002), «Predicting Financial Volatility: High Frequency Time Series Forecasts vis-à-vis Implied Volatility», Working Paper, Erasmus University.

[41] McCurdy, T et Morgan, I. G., (1987), «Test of Martingale Hypothesis for Foreign Currency Futures With Varying Volatility», International Journal of Forecasting, Vol. 3, pp. 131-148.

[42] McKinnon, J. G. (1991), «Critical Values for Co-integration Tests», Dans Engle et C. W. J. Granger (eds), Long-run Economic Relationships: Reading in Co-integration, Oxford United Press.

[43] Meese, R. A. et Rogoff, R. (1983), «Empirical Exchange Rate Models of the Seventies: Do they Fit Out of Sample?», Journal of International Economics, Vol. 14, pp. 15-24.

[44] Meese, R. A. et Singleton, K. J. (1982), «On Unit Roots and the Empirical Modeling of Exchange rates», Journal of Finance, Vol. 37, pp. 1029-1035.

[45] Palm, F. C, Vlaar, P. J. G. (1997), «Simple Diagnostics Procedures for Modeling Financial Time Series», Allgemeine Statistisches Archives, Vol. 81, pp. 85-101.

[46] Perron, P. (1988), «Trends and Random Walks in Macroeconomic Time Series: Further Evidence from a New Approach», Journal of Economic Dynamics and Control, Vol. 12, pp. 297-332.

[47] Pong, S., M. B. Shackleton, S. J. Taylor et X. Xu (2002), «Forecasting Sterling Dollar Volatility: A Comparison of Implied Volatilities and ARFIMA Models», Working Paper, Lancaster University.

[48] Poole, W. (1967), «Speculative Prices as Random Walks: An Analysis of Ten Time Series of Flexible Series Analysis», Southern Journal of Economics, Vol. 33, pp. 468-478.

[49] Poon, S. H., Granger C. (2002), « Forecasting Volatility in Financial Markets: A Review », Forthcoming.

[50] Peumont, P. Y., (1996), «Dynamique Non Linéaire du Franc Suisse, du Mark Allemand et de la Livre Sterling Durant la Période 1984-1993», Cahiers Economiques de Bruxelles, Vol. 151, pp. 299-324.

[51] Sowel, F., (1992), «Modeling Long-run Behavior with the Fractional ARIMA Models», Journal of Monetary Economics, Vol. 29, pp. 277-302.

[52] Taylor, S. (1986), «Modeling Financial Time Series», Wiley Chichester.

[53] Tse, Y. K, (1998), «The Conditional Heteroskedasticity of the Yen-Dollar Exchange Rates», Journal of Applied Econometrics, Vol. 13, pp. 49-56.

[54] Vilasuso, J. (2002), «Forecasting Exchange Rate Volatility», Economic Letters, Vol. 76, pp. 59-64.

[55] Westerfield, J. M., (1977), «An Examination of Foreign Exchange Risk under Fixed and Floating Regimes», Journal of International Economics, Vol. 7, pp. 181-200.

[56] Whaley, R. E., (1982), «Valuation of American Call Options on Dividend-paying Stocks», Journal of International Economics, Vol. 10, pp. 29-58.

[57] Zumbach, G., (2002), «Volatility Processes and Volatility Forecast with Long Memory», Working Paper, Olsen Associates.