CONDITIONAL VOLATILITY OF MOST ACTIVE SHARES OF CASABLANCA STOCK EXCHANGE

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Summary

Volatility plays an important role in the explanation of prices of securities and their derivatives as well as risk which are relative to them. The stock exchange of Casablanca constitutes a market meadow emergent of MEA zone for which the problem of volatility should not be underestimated for the causes of lack of the making in the order book.

The introduction of the electronic system in 1998 allowed continuous quotation of a number restricted by securities liquidity of which does not seem even so important. We test in this paper the conditional volatility of a certain number of securities considered as active and which to be result from the MADEX index. Results show a certain asymmetric volatility of the major securities. The use of the asymmetric GARCH allowed us better to describe rough variations of prices provoked by large quantities traded in block market. These models throw back quadratic specification of the conditional variance lauded by GARCH standard models. Indeed, with regard to these last ones, exponential model GARCH and threshold GARCH have two advantages. While standard model GARCH puts that only the amplitude of shock and not the sign of the past residuals has an impact on the conditional variance, EGARCH and TGARCH models allows an asymmetric answer to shocks. Second advantage is that not conditional variance is discrete.

Keywords

Volatility ; Asymmetric GARCH ; None Linearity ; MADEX ; The Stock Exchange of Casablanca.
JEL Classification: G14

VOLATILITÉ CONDITIONNELLE DES VALEURS LES PLUS ACTIVES DE LA BOURSE DE CASABLANCA

Résumé

La volatilité joue un rôle important dans l'explication des prix des titres et leurs dérivés ainsi que le risque qui leur sont afférents. La bourse de Casablanca constitue une bourse pré-émergente de la zone MEA pour laquelle le problème de volatilité n'est pas à sous-estimer pour les causes de manque de contreparties dans le carnet d'ordres.

L'introduction du système électronique en 1998 a permis une cotation au continu d'un nombre restreint de titres dont la liquidité ne semble pas encore si importante. Nous testons dans ce papier la volatilité conditionnelle d'un certain nombre de valeurs considérées comme actives et qui sont issues de l'indice MADEX. Les résultats montrent une certaine volatilité de type asymétrique. L'utilisation de la modélisation GARCH asymétrique nous a permis de mieux décrire les variations brutales dans les cours provoquées par les cessions de marché de blocs. Ces modèles rejettent la spécification quadratique de la variance conditionnelle prônée par les modèles GARCH standard. En effet, relativement à ces derniers, les modèles GARCH exponentiels et à seuils ont deux avantages. Alors que le modèle GARCH standard pose que seule l'amplitude de choc et non le signe des résidus passés a un impact sur la variance conditionnelle, les modèles EGARCH et TGARCH permettent une réponse asymétrique aux chocs. Le second avantage est que la variance non conditionnelle est finie.

Mots-clés

Volatilité ; Asymétries ; Non Linéarité ; EGARCH ; MADEX ; La Bourse de Casablanca.
Classification JEL : G14

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INTRODUCTION

Volatility can be simply defined as the variability of security price during a given period. In the models of asset valuation such the CAPM either APM, volatility is likened to risk measured by the standard deviation or its square (its variance) under normal probability.
One distinguishes three types of volatility : none conditional or historic volatility which is observation ex post past variations concerning stock exchange prices; the conditional volatility as ARCH and its extensions which allows to extract the early part of the historic volatility describing the behavior of the conditional variance at the time and finally the implied volatility which supplies the element of forecast.
This present article is dedicated to describe and to test the conditional volatility of the most active shares of stock market of Casablanca. Our study distributed so in two points : the first treats models ARCH and its extensions and the second tests the various classes of these models as for the volatility of the most liquid shares.

1. CONDITIONAL VOLATILITY

The measure of the conditional volatility resulting from econometric models of ARCH types allows to extract the anticipated volatility by pushing aside the influence of unpredictable shocks. This measure allows so to arrest volatility such as it is anticipated by the market ex ante on the basis of the available relevant information. Also, it allows to measure the persistent effect which can have the behavior of stock exchange in the time : at the periods of strong fluctuations, in increase or in decrease, behavior of which is repetitive at the duration and the amplitude succeed one another quiet periods in which prevail weak fluctuations in stock exchange.

1.1. Model ARCH

ARCH Process (AutoRegressive Conditional Heteroskedasticity) introduced by Engle[1] [1982] is a part of a set of process treating the conditional Heteroskedasticity.
Unlike the linear models which are interested only at the first order of the moment (expected value), ARCH model introduces the study of second order the moments (conditionals and not

[1] Engle R., « Autoregressive Conditionnal Heteroskedasticity whih Estimates of The Variance of UK inflation », *Econometrica*, vol. 50, n°1, 1982.

conditionals) of the time series. This type of models allows the variance of a series to depend on the available of information set, and notably of the time. The object of these representations is to mitigate the insufficient of linear ARMA models not capable to describe the behavior of financial series. These last ones are indeed characterized by a variable volatility on the time and by phenomena of asymmetry which can not be taken into account with the ARMA models. Besides, if process followed by the volatility is correctly specified, this one can supply information useful for the determination of the process generating of returns and leaving to be used in the forecast. ARCH model is based on a endogenous parametrisation of the conditional variance. These models were the object of several extensions of which the most famous is GARCH.

Let us consider a model with correlated errors of class AR (1) in which :

$$Y_t = X_t \beta + \varepsilon_t \tag{1}$$

$$\varepsilon_t = a\varepsilon_{t-1} + u_t \tag{2}$$

With,

Y_t : endogenous variable (scalar of dimension n) ;

X_t : vector of the exogenous variables (matrix of dimension $n \times (k+1)$);

β : vector of coefficients which the dimension is $k+1$;

ε_t : innovation or error of specification (which is an unpredictable term) ;

u_t : Process *i.i.d.* of average zero and of finished variance σ_u^2.

(1) Can rewrite :

$$\varepsilon_t = \sum_{n=0}^{\infty} a^n u_{t-n} \tag{3}$$

As $E[\varepsilon_t] = 0$, by hypothesis, we obtains then :

$$V[\varepsilon_t] = E[\varepsilon_t - E[\varepsilon_t]]^2 = E[\varepsilon_t^2] = E[a\varepsilon_{t-1} + u_t]^2 = a^2 E[\varepsilon_{t-1}^2] + \sigma_u^2$$

If process is stationary, we should have :

$$E[\varepsilon_t^2] = E[\varepsilon_{t-1}^2] = V[\varepsilon_t]$$

Hence :

$$V[\varepsilon_t] = a^2 V[\varepsilon_t] + \sigma_u^2 = \frac{\sigma_u^2}{1-a^2}$$

In conditional terms we have :

$$E[\varepsilon_t | \varepsilon_{t-1}] = E[(a\varepsilon_{t-1} + u_t) | \varepsilon_{t-1}] = a\varepsilon_{t-1}$$

$$V[\varepsilon_t | \varepsilon_{t-1}] = E[\varepsilon_t | \varepsilon_{t-1} - a\varepsilon_{t-1}]^2 = E[a\varepsilon_{t-1} + u_t - a\varepsilon_{t-1}]^2 = E[u_t^2] = \sigma_u^2$$

These moments seem so constant and independent of time. To characterize in a correct way the behavior of variable financial, it was necessary to introduce models of regression where the variance of the noise depends on time : these models are heteroskedastic by construction,. It is in this optical that Granger and Andersen[1] puts a model such as the conditional variance of ε_t depends on its past realizations ε_{t-1} :

$$\varepsilon_t = u_t \varepsilon_{t-1} \qquad (4)$$

Where u_t is white noise with zero average and finished variance σ_u^2, et ε_{t-1} is a unpredictable variable which stochastic variations are independent from the u_t. The calculation of the moments of the unpredictable variable ε_t gives us the following thing :

- In not conditional terms, we have :

$$E[\varepsilon_t] = 0$$

$$V[\varepsilon_t] = \sigma_u^2 \varepsilon_{t-1}^2$$

- In conditional terms, we have :

$$E[\varepsilon_t | \varepsilon_{t-1}] = 0$$

[1] Granger C. et Andersen A., *An Introduction to Bilinear Time-Series Models*, Göttingen : Vandenhoeck and Ruprecht, 1978.

$$V[\varepsilon_t | \varepsilon_{t-1}] = \sigma_u^2 \varepsilon_{t-1}^2$$

One notices that the stochastic properties of the conditional and unconditional estimators are the same, what limits their use within the framework of the forecast, notably in the case of financial series, because shock or effect of a large-scale operation on the shares[1] can not be taken into account. This is of as really as this effect is persisting. Engle's ARCH model [1982] appears to supply the means to take into account these phenomena and a frame sharply more adapted for the treatment and the description of the characteristics of financial series. The work of Engle consists obviously in generalizing bilinear model of Granger and Andersen. For that purpose, he poses :

$$\varepsilon_t = u_t h_t \qquad (5)$$

Where u_t follows a normal distribution $N(0,1)$, and h_t replaces ε_{t-1} in the equation (5). Consequently :

$$h_t^2 = a_0 + \sum_{i=0}^{p} a_i \varepsilon_{t-i}^2 = a_0 + a(B)\varepsilon_t^2 \qquad (6)$$

$$h_t = \sqrt{\left[a_0 + \sum_{i=0}^{p} a_i \varepsilon_{t-1}^2 \right]}$$

Such as :

$$a_1 > 0,\ a_i \geq 0\ \forall i\ \ a(B) = a_1 B + a_2 B^2 + ... + a_p B^p$$ And

h_t Process is called ARCH of order p and it is noted *ARCH(P)*. If we adds the hypothesis of normality, ε_t, defined in the equation (5), can be directly expressed according to the available relevant information at the moment t :

$$(\varepsilon_t | I_{t-1}) \rightarrow N(0, h_t^2)$$

[1] All the operations on a share that is a takeover bid (TOB) entailing a limit crossing or a speculative intervention entailing a momentary gap of the price are not taken into account in the calculation of the hoped earning. The change of the variance (which can have for origin a speculative intervention) can not be taken into account because the stochastic properties of conditional and marginal moments are the same.

With :

$$h_t^2 = a_0 + \sum_{i=1}^{p} a_i \varepsilon_{t-i}^2$$

The conditional distribution of ε_t is standard normal (centered). The variance h_t^2 depends linearly on the last values *p* of the process ; so :

$$E[\varepsilon_t | I_{t-1}] = 0$$

$$V[\varepsilon_t | I_{t-1}] = h_t^2 = a_0 + \sum_{i=1}^{p} a_i \varepsilon_{t-i}^2$$

It is possible to present ε_t^2 under the process of $AR(p)$. For this, we set :

$$v_t = \varepsilon_t^2 - h_t^2 \qquad (7)$$

hence :

$$\varepsilon_t^2 = a_0 + \sum_{i=1}^{p} a_i \varepsilon_{t-i}^2 + v_t \qquad (8)$$

v_t has an average and a covariance equal to zero, but its variance is not constant. According to this formulation of *AR(P)*, the model of regression with *ARCH* is obtained supposing that the average of ε_t is a linear combination of exogenous and lagged dependent variables (X_t), multiplied by a vector of unknown parameters (β) :

$$\begin{cases} (\varepsilon_t | I_{t-1}) \rightarrow N(X_t \beta, h_t^2) \\ h_t = h(u_{t-1}, u_{t-2}, ..., u_{t-p}, a) \\ u_t = \varepsilon_t - X_t \beta \end{cases} \qquad (9)$$

The last expression possesses very interesting properties for econometric applications. McNees[1] showed in 1980 that uncertainty closely linked to the forecast varied according to periods and this by report not only on the horizon of forecast but as well on the fact as errors often regrouped in high errors followed by weak errors. The ARCH model, which the

[1] McNees S. K., « A Critique of Alternative Methods of Comparing Macroeconomic Models », in Ramsey J. and Kmenta ed. *Methodology of Macroeconomic Models*, North-Holland, 1980.

variance depends on the time and past errors, allows to realize this phenomenon. Indeed, as show it the expressions bellow, the conditional and marginal moments of order 2 are not identical. For *ARCH(1)* for example, we have the following thing :

- In marginal terms, we have :

$$E[\varepsilon_t] = 0$$

$$V[\varepsilon_t] = \frac{a_0}{1 - a_1}$$

- In conditional terms, we have :

$$E[\varepsilon_t | I_{t-1}] = 0$$

$$V[\varepsilon_t | I_{t-1}] = a_0 \frac{(1 - a_1^h)}{1 - a_1} + a_1^h \varepsilon_{t-h^2}$$

One notices that marginal and conditional variances are not identical; especially since conditional variance is not a constant because it depends on past errors. However, another remark deserves to be indicated : when h aims towards the infinity, conditional variance aims towards the marginal variance :

$$\lim_{h \to \infty} V[\varepsilon_t | I_{t-1}] = \frac{a_0}{1 - a_1} \quad (10)$$

If coefficients a_i are all positive and rather big, there is a certain persistence of alternated levels by volatility : periods of strong volatility followed by periods of weak volatility and periods of weak volatility followed by strong volatility.

Besides, the asymmetrical character of ARCH processes is one a reason of more its interest in the field of the finance because the big majority of stock exchange series present this character[1] : they possess tails of distribution more thick than those of the normal distribution and they are all more important as the kurtosis is big.

[1] It is for Fama that falls this discovery in 1963.

In the same spirit of definition of the normal distribution, the kurtosis of ARCH(1) process defines as the report of standard moment (centered) with order 4 on the square of standard moment centered with order two :

$$E[\varepsilon_t^4] = \frac{3a_0(1+a_1)}{(1-a_1)(1-3a_1^2)}$$

$$E[\varepsilon_t^2]^2 = \left(\frac{a_0}{1-a_1}\right)^2$$

hence :

$$K = \frac{3(1-a_1^2)}{1-3a_1^2} \qquad (11)$$

If $3a_1^2$ is lower than 1, this expression appears value of K always superior to 3 (value of the kurtosis of the normal distribution). It is notably case of financial series.

Being this, model ARCH is not without insufficiencies ; the main difficulty appears when the order of delay of the function of conditional variance is very high. In that case the number of parameters to be estimated is very important. To reduce the number of parameters to calculate, Engle suggested considering the equation of following conditional variance:

$$h_t^2 = a_0 + a_i \sum_{i=1}^{p} w_i \varepsilon_{t-1}^2 \qquad (12)$$

With,

$$w_i = \frac{(p+1)-i}{0{,}5p(p+1)}$$

In this equation, one notices that coefficients w_i decrease linearly and their sum is worth 1 and that a delay of high order can be considered. Furthermore, only two parameters should be estimated. Nevertheless, in practice, it is difficult to realize this estimation. It is the reason for which that Bollerslev [1986] defined a more parsimonious modeling : it is about the modeling GARCH (*Generalized ARCH*).

1.2. Model GARCH

Model GARCH, which is a generalization of the model ARCH was developed by Bollerslev[1] [1986]. This model knew a lot of success as far as it models better Heteroskedasticity. The specification is derived as follows :

$$Y_t = X_t \beta + \varepsilon_t \tag{13}$$

With,

$$\varepsilon_t = u_t h_t$$

$u_t \; N(0,1)$ Follows a normal distribution and :

$$\begin{cases} h_t^2 = \hat{a}_0 + a(D)\varepsilon_t^2 + b(D)h_t^2 \\ h_t^2 = a_0 + \sum_{i=1}^{p} a_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} b_j h_{t-j}^2 \end{cases} \tag{14}$$

Which (14) is the conditional variance of ε_t and who expresses in fact GARCH(*p*, *q*) 's writing

If the polynomial $1-b(D)$ does not equal to zero, we can write :

$$h_t^2 = \frac{a_0}{1-b(1)} + \frac{a(D)}{1-b(D)}\varepsilon_t^2 = a_0^* + \sum_{i=0}^{\infty} d_i^* \varepsilon_{t-i}^2 \tag{15}$$

One observes while process GARCH (*p*, *q*) is a process ARCH of infinite order[2] parameters of which decrease in a geometrical way. This process is an alternative solution which has the advantage to retain a more simple delay structure. It represents in a parsimonious way an high order for an *ARCH* and gives a longer memory. If we have : $q = 0$,

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[1] Bollerslev T., « Generalised Autoregressive Conditionnal Heteroskedasticity », *Journal of Econometrics*, vol. 31, 1986.

[2] What one can demonstrate by recurrence by replacing h_t^2 by h_{t-1}^2; h_{t-1}^2 by h_{t-2}^2 et cetera.

$$GARCH(p,q) = GARCH(p,0) = ARCH(p)$$

And if $q = 0$, $p = 0$ then, ε_t is normally and identically distributed.

The extension of the ARCH model towards the GARCH model given evidence of many resemblances with that of *MA* towards *ARMA*. It is so possible to formulate *GARCH(p,q)* process in term of the *ARMA* process. This last one is the very practical writing to treat the problem of stationarity.

Let :

$$v_t = \varepsilon_t^2 - h_t^2 \qquad (16)$$

Equation (14) becomes :

$$[I - a(D) - b(D)]\varepsilon_t^2 = a_0 + [I - b(D)]v_t \qquad (17)$$

Consequently the GARCH (*p*,*q*) process can be effectively rewritten under the ratio $ARMA(\max(p,q),q)$ on the square of the process ε_t. Afterward, it is possible to define the condition of weak stationarity :

$$a(1) + b(1) = \sum_{i=0}^{p} a_i + \sum_{i=0}^{q} b_i \qquad (18)$$

Since the end of 1980's and the beginning of 1990's, GARCH (*p*,*q*) model showed its powerful capacity to realize new characteristics which affect financial series. Certainly, no process was effective to model the heteroskedasticity in a very high orders of *p* and *q*.

Generally speaking by referring to the different conclusions of the econometric works of numerous authors[1] in the field of the finance, GARCH model which describes in best volatility is *GARCH(1,1)*. Our empirical work in this section consists in testing the various classes of the model ARCH and in finding the one that models in best the volatility of the continuous market of Casablanca.

[1] Bollerslev T. et *alii*. [1991], Dacorogna M. et *alii*.[1993], Drost F. et Nijman T. [1993].

2. STUDY ON THE VOLATILITY OF SHARES QUOTED IN CONTINUOUS IN THE STOCK EXCHANGE OF CASABLANCA

Since 1998, ten companies are quoted in continuous market. The creation of the MADEX index (Most Active Shares Index) allowed the selection of a most active shares quoted in Casablanca. This range of index offers a reputation to the quoted companies.

We present selected companies within the framework of this index ; we chose to push aside from it SAMIR. The choice of the sample is dictated by considerations of liquidity. So, chosen companies appear in the following table :

Series	**Trading volume *MMDH***	**Trading days**	**Number of trades**
BCM	0,6896	226	1771
BMCE	1,2915	246	4942
CMA	0,2497	198	906
HOLCIM	0,4312	230	1718
MANAGEM	0,7591	246	7383
ONA	2,0505	244	4438
SNI	0,6538	241	2391
SONASID	0,6266	243	3596
WAFAA	0,2575	232	1971
WAFABANK	1,1282	240	3106

Table 1: The most active companies (central market of the stock exchange of Casablanca) ; source : SBVC, 2001.

2.1. Used data

The period of observation is of more than 5 years and a half for the group of companies studied with the exception of MANAGEM and of WAFA ASSURANCE of whom periods are : no more than 2 years and a half for the first and more than 4 years and a half for second. The following table shows main companies retained in our sample and corresponding periods.

Series	Period of study	Nb. of observations
BCM	15/07/1997 - 20/03/2003	1390
BMCE	15/07/1997 - 20/03/2003	1391
CMA	15/07/1997 - 20/03/2003	1389
HOLCIM	15/07/1997 - 20/03/2003	1392
MANAGEM	11/07/2000 - 02/04/2003	676
ONA	15/07/1997 - 20/03/2003	1391
SMI	15/07/1997 - 20/03/2003	1391
SONASID	15/07/1997 - 20/03/2003	1392
WAFAA	13/07/1998 - 20/03/2003	1147

Table 2 : Period of study and the number of observations.

2.2. The unit root tests

Two types of unit root tests are more and more used in the literature on the major stationarity studies, namely the tests of Dickey and Fuller [1979 ,1981] and the tests of Phillips and Perron [1988]. Certain studies[1] showed the superiority of the second type on the first the stationarity of series, because financial series often present a strong conditional Heteroskedasticity which results, in particular, from the ARCH effect. So, the approach of Phillips and Perron is sturdy in case there is Heteroskedasticity. Their methodology is based on a none parametric correction which she take into account the structure of autocorrelations and Heteroskedasticity of residuals.

First intuition concerning the stationarity can be supplied by the graphic study of series as well as by its correlogram. This intuition can be verified by using the unit root tests. We shall adopt in this paper Dickey and Pantula's [1987] strategy consisting in testing first the null hypothesis of unit root test on the series in first difference. If the null hypothesis is rejected, we test secondly, the null hypothesis of the unit root in level.

2.2.1. The tests of Dickey and Fuller

One distinguishes two sorts of tests of Dickey and Fuller : simple tests and augmented tests (ADF). The statistics of Dickey and Fuller have for object to test the null hypothesis against the alternative hypothesis. Models being of use to the construction of these tests are among three :

[1] Verdier G., *Econométrie du cycle : le cas de l'indice de la production industrielle des pays de la zone euro*, Thèse de doctorat, Université de Montpellier I, Faculté des Sciences Economiques, LAMETA, 2000.

Model (1) : $(1-\phi_1 B)x_t = \varepsilon_t$ Autoregressive model of order 1 : *AR(1)*

Model (2) : $(1-\phi_1 B)(x_t-\mu) = \varepsilon_t$ Model *AR(1)* with constant, where $E[x_t]=\mu$

Model (3) : $(1-\phi_1 B)(x_t-\alpha-\beta t) = \varepsilon_t$ Model *AR(1)* with trend and ε_t is *i.i.d.*

The principle of tests is simple : if in these three models $\phi_1 = 1$, then polynomial operator's of the process contains an unit root $B=1$ (B is a lag operator such as $Bx_t = x_{t-1}$). Process according to the theorem of Doob[1] is then not stationary.

Dickey and Fuller [1979,1981] derived the ordinary least squares estimators as well as the statistics of Student of coefficients estimated in various models. To facilitate the application of the test, one estimates, in practice, the models (1 , 2 and 3) under the following forms :

Model (1') : $\Delta x_t = \rho_1 x_{t-1} + \varepsilon_t$ $\rho_1 = \phi_1 - 1$

Model (2') : $\Delta x_t = \rho_1 x_{t-1} + c + \varepsilon_t$ $\rho_1 = \phi_1 - 1$

Model (3') : $\Delta x_t = \rho_1 x_{t-1} + \beta t + c + \varepsilon_t$ $\rho_1 = \phi_1 - 1$

And one tests null hypothesis $\rho_1 = 0$ (no stationarity) against the alternative hypothesis $\rho_1 < 0$ (stationarity). However these models are restrictive as far as : on one hand, only the existence of an autoregressive structure of order is envisaged one and on the other hand, errors are supposed to be independently and identically distributed *(i.i.d)*. Generalization, in the case of an autoregressive process of order p, leads to the test of Augmented Dickey and Fuller (ADF).

In the models of simple Dickey and Fuller [1979], process ε_t is, by hypothesis, a white noise. Now, there is no reason so that, *a priori*, error is not correlated. The tests of Augmented Dickey and Fuller [1981] take into account the degree of the realism of this hypothesis. So, to pass in tests, procedure ADF is based, under the alternative hypothesis $|\phi_1| < 1$, on the estimation by the ordinary least squares of three models :

[1] A process AR is always inversible. It is stationary when the roots of $\phi_p(B)$ are outside of the circle unity of the complex plan. For more details, to see Bourbonnais R. and Terraza M, O*p. cit.* P. 89.

Model (1") $$\Delta x_t = \rho x_{t-1} - \sum_{j=2}^{p} \Phi_j \Delta x_{t-j+1} + \varepsilon_t$$

Model (2") $$\Delta x_t = \rho x_{t-1} - \sum_{j=2}^{p} \Phi_j \Delta x_{t-j+1} + c + \varepsilon_t$$

Model (3") $$\Delta x_t = \rho x_{t-1} - \sum_{j=2}^{p} \Phi_j \Delta x_{t-j+1} + c + bt + \varepsilon_t$$

With, as in the case of models (1, 2 and 3), ε_t are independent and distributed identically *(i.i.d)* of null average and of finished variance σ_ε^2. It is advisable from then on to choose the number of lag of p in three models above in order to "to be cleared" the residuals of the regression. There is no " universal rule " for the determination of p and we have to proceed case by case, *i.e.*, series by series by taking Dickey and Pantula's [1987] strategy. The application of the tests of Augmented Dickey and Fuller (ADF) in a stock exchange series leads to results presented in the following table :

	Series in level (in logarithms)			**Returns**		
Series	**Model**	**Lags**	**Stat. *ADF***	**Model**	**Lags**	**Stat. *ADF***
BCM	1	7	-1,0593	1	0	-39,8542
BMCE	1	0	-1,0089	1	4	-17,3995
CMA	1	0	0,5452	1	0	-38,4295
HOLCIM	1	0	0,4105	1	0	-37,4979
MANAGEM	1	3	-1,5691	1	4	-11,7244
ONA	1	2	-0,4125	1	4	-16,6383
SNI	1	5	-0,3014	1	4	-17,7756
SONASID	1	5	0,1324	1	4	-17,5400
WAFAA	1	0	-1,1798	1	0	-33,7407
WAFABANK	1	0	-0,6304	1	0	-35,7111

Table 3 : *Tests of* Augmented *Dickey and Fuller. Model 1 : model without constant or trend.. Model 2 : model with constant and without determinist tendency. Model 3 : model with constant and determinist tendency. The choice of model makes by comparing the value of empirical t-statistic corresponding to the tendency in the model 3 ; if this value is lower than the critical value of Dickey and Fuller who is from 2,79 to the critical threshold of 5 %, model 3 is rejected. For the model 2, refusal is pronounced if the value of empirical t-statistic corresponding to the constant is lower than 2,54 at the threshold of 5 %. The column "lags" indicates the number p of lags retained after having studied partial autocorrelations; The method of choice of p corresponds to the last partial autocorrelation significantly different from zero combined in the procedure suggested by Campbell and Perron [1991] of which objective is to study the significance of regressions for every lag by beginning by the most high. ADF Statistic is the value of the statistic t of Dickey and Fuller to compare with the critical value - 1,95 for the model 1 with 5 %. This critical value can be read either on the table feigned by Dickey and Fuller [1979], or directly from exits TSP-Eviews.*

To test the order of integration of series, test ADF was implemented on series in first difference (returns) following Dickey and Pantula's [1987] strategy. One notices then, towards the table above, that all the series are stationary in first difference. On the other side, these test ADF stands out the presence of an unit root in all the series in level. We notice according to the results of the various tests that *T-statistic* is widely superior, in every case and without exception, Relatively to critical values indicated directly by Eviews ; we accept so H_0 hypothesis about is the threshold from 1 to 10%. The series of the most active main values of the quotation are consequently not still stationary. The application of tests ADF appears that model 1 is the most adequate model to describe the behavior of studied series. Also, lag 0 was selected 10 times on 20. This proves, following the example of the majority of financial series, that all the values of our sample describe a process of random walk at without tendency[1].

Because of the importance of the validity of the hypothesis of stationarity for our different tests, a second type of unit root test was applied to verify the results of the test of Dickey and Fuller : the test of Phillips and Perron. This test is particularly adequate for our study on stock exchange data. It is, besides , sturdier in the Heteroskedasticity.

2.2.2. Test of Phillips and Perron (PP)

The test of Dickey and Fuller knew numerous extensions. Among these, we can quote the test of Phillips and Perron [1988], which is a non parametric approach.

Hypotheses envisaged within the framework of this test are much less restrictive than those formulated by Dickey and Fuller. Essential idea introduced by Phillips Perron is that recent errors can be dependent, while more and more distant errors the one with regard to the other one are independent. In more learned terms, to eliminate the parameters of nuisance, associated to the existence of correlations in the stochastic component of the generative process of returns, which disrupt the results of ADF tests, Phillips and Perron [1988] suggest to add to the statistic of Student a factor of correction based on convergent estimators of the parameters of nuisance, which eliminates this asymptotic dependence.

Let us the following three models :

[1] This is confirmed by calculating the correlogram of the series filtered by the first differences which has to obey a white noise. As a rule, all the series filtered by first differences are characteristic of a white noise because *Q*-statistic has a critical probability (for $k = 15$) widely superior to 0,05 ; we accept H 0 hypothesis of the nullity of the coefficients of the correlogram. Studied series are so many processes DS without tendency.

Model (1) : $x_t = \rho^* x_{t-1} + \varepsilon_t^*$

Model (2) : $x_t = \hat{\rho} x_{t-1} + \hat{\mu} + \hat{\varepsilon}_t$

Model (3) : $x_t = \tilde{\rho} x_{t-1} \tilde{\beta}(t - \frac{1}{2}T) + \tilde{\mu} + \tilde{\varepsilon}_t$

Where,

$$\rho^* = 1$$

$$\hat{\rho} = 1,\ \hat{\mu} = 0$$

$$\tilde{\rho} = 1,\ \tilde{\mu} = 0,\ T = 1,...,n$$

Phillips and Perron [1988] retain a set of hypotheses about the errors which expresses the measure of the temporal dependence in term of " *mixing-coefficient* α_m ". This coefficient itself is defined in the following way :

$$\alpha_m = \sup_m \sup_{j>n+m} \alpha(F_1^n, F_{n+m}^j) \qquad (19)$$

Where,

$$\alpha(F,G) = \sup_{f \in F, g \in G} \left| P(fg) - P(f)P(g) \right|$$

And F_a^b indicate the value of σ, algebra engendered by $\{\varepsilon_a, \varepsilon_{a+1}, ..., \varepsilon_b\}$ for everything $a \le b$. One says that series is " $\alpha - mixing$ " or " $strong - mixing$ " if α_m aims towards zero when m aims towards the infinity. This shows asymptotic independence of the serie $\{\varepsilon_t\}_{t=1}^{\infty}$. The quantity α_m estimates so dependence existing between distant errors from m periods. Practically, as in the case of tests ADF, test PP retains the same hypothesis according to which $\rho = 1$ and the estimation of the equations of three models makes by the method of Ordinary Least Squares. Also, *T-statistic* of the coefficient is corrected by serial correlation in t. A the opposite of tests ADF, the models tested by Phillips and Perron do not contain differenciated lag terms[1]. Indeed, the test of PP suggests widening tests ADF to the cases where errors have no "maids" statistical properties (absence of autocorrelation, homoskedasticity, …). This is particularly interesting within the framework of financial series

[1] For more technical details concerning this subject, to refer in Hamilton J. *D., Time series analysis*, Princeton University Press, on 1994.

because one knows that these last ones show frequently an effect of type ARCH[1]. Correction none parametric brought by Phillips and Perron allows so to take into account at the same moment an autocorrelation and a possible Heteroskedasticity. Hypotheses made on the residuals ε_t are from then on sharply less restrictive : errors can be weakly dependent temporarily and distributed in a heterogeneous way (*i.e.* not *i.i.d*) but asymptotically independents. A particularly interesting characteristic of statistics transformed by *PP* (with a none parametric correction) is to note that their asymptotic distribution is identical to that diverted by Dickey and Fuller. This implies that the procedure of test of Phillips and Perron can be used by referring to critical asymptotic values of Dickey and Fuller even though it allows to specify in a more general way studied chronological series.

The implemented of the Phillips and Perron test is identical to that of the Dickey and Fuller test. As in the case of the ADF test, one begins by testing null hypothesis according to which series filtered in difference is not still against the alternative hypothesis of stationnarity. The application of the test of Phillips and Perron requires to choose first the parameter of truncation *l* occurring in the calculation of the variance of long term of the residuals. So the value of the lag usually used is $l = T^{1/4}$ where T is the number of observations of the series. We retain within the framework of our test the value suggested by Newey and West [1987][2] and who is :

$$l = \text{int}\left[4\left(\frac{T}{100}\right)^{2/9}\right]$$

The results of the test of Phillips and Perron are presented in the table below.

	Series in logarithms			Series in differences		
Series	**Model**	**Delays**	**Stat. PP**	**Model**	**Delays**	**Stat. PP**
BCM	1	7	-0,992937	1	7	-40,98537
BMCE	1	7	-1,121285	1	7	-37,27306
CMA	1	7	0,588264	1	7	-38,48480
HOLCIM	1	7	0.445989	1	7	-37.58625
MANAGEM	1	6	-1,388989	1	6	-23,52383
ONA	1	7	-0,386304	1	7	-28,72778
SNI	1	7	-0,292021	1	7	-36,08530
SONASID	1	7	0,153411	1	7	-36,09413
WAFAA	1	6	-1,230153	1	6	-33,75589
WAFABANK	1	7	-0,640906	1	7	-35,68437

Table 4 : Results of test of Phillips and Perron.

[1] ARCH process (AutoRegressive Conditional Heteroskedasticity) allows to realize the conditional variability of the volatility of series.
[2] Let us note that results are almost identical for the value of *l*.

The results of test of Phillips and Perron confirm those obtained by means of test of Dickey and Fuller and remain stable with regard to the reserved number of lags : presence of an unit root in series in level, stationarity for series in first difference.

2.3. Descriptive statistics

Descriptive statistics give an radioscopic picture on the Heteroskedasticity of series. Their analysis allows to characterize the distribution of the returns of the most active values of the market stock exchange of Casablanca. The table below gives main descriptive statistics (number of observations, average, standard deviation, skewness and kurtosis) with log-differentiated series, as well as the value of the normality statistic of the test of Jarque and Bera. Let us remind that for a normal law, the value of skwness (S) is null and that of kurtosis (K) is worth 3. This law being characterized by its symmetry with regard to the average as well as by the weak probability of the extreme points. The statistic of Jarque and Bera (JB) is based on the definition of the coefficients of flattening and asymmetry. The formulae which allow their calculation are the following ones :

$$S = \frac{\left[\frac{1}{T}\sum_{t=1}^{T}(x_t - \bar{x})^3\right]^2}{\left[\frac{1}{T}\sum_{t=1}^{T}(x_t - \bar{x})^2\right]^3} = \frac{\mu_3^2}{\mu_2^3} = \beta_1 \qquad (20)$$

$$K = \frac{\frac{1}{T}\sum_{t=1}^{T}(x_t - \bar{x})^4}{\left[\frac{1}{T}\sum_{t=1}^{T}(x_t - \bar{x})^2\right]^2} = \frac{\mu_4}{\mu_2^2} = \beta_2 \qquad (21)$$

Where $\bar{x}$ is the average of the serie x_t, $t = 1,...,T$ and μ_i are them moments centred by order i.

For a normal law, we have :

$$\begin{cases} \mu_4 = 3\mu_2^2 \\ \mu_3 = 0 \end{cases}$$

The test of Jarque and Bera consists in testing null hypothesis of following normality:

$$H_0 : \sqrt{\beta_1} = \beta_2 - 3 = 0$$

And the statistic of Jarque and Bera (JB) is given by :

$$JB = \frac{T-k}{6}\left[S^2 + \frac{1}{4}(K-3)^2\right] \qquad (22)$$

Where T is the number of observations, k is the number of estimated parameters (in the case of a test is implemented on the residuals, otherwise $k = 0$). Under the null hypothesis of normality, statistic JB follows a law of *chi-deux* in two degrees of freedom.

Series	**T**	**Mean**	**Standard Deviation**	**Skewness**	**Kurtosis**	**J.B.**
BCM	1390	-0,000240	0,011605	0,108633	9,902663	2760,288
BMCE	1391	-0,000274	0,010246	-1,447829	32,42035	50615,78
CMA	1389	-0,000235	0,014642	-0,588386	19,35059	15541,36
HOLCIM	1392	-0,001760	0,014230	-0,080223	14,00516	7021,030
MNAGEM	676	-0,000896	0,017219	0,360067	8,166959	765,4518
ONA	1391	-0,000125	0,011185	0,233244	9,151638	2204,323
SNI	1391	0,000077	0,012545	0,015123	9,516061	2459,140
SONASID	1392	0,000075	0,014942	-0,099879	12,77969	5545,584
WAFAA	1147	-0,000780	0,021597	1,493239	19,44077	13332,66
WAFABANK	1390	-0,000232	0,014115	0,060639	8,361114	1748,543

Table 5 : The main descriptive statistics of studied series. T is the number of log-differentiated observations and J.B. is Jarque and Bera's normality statistic.

One notices that null hypothesis of normality is rejected for all the studied series. The statistic of Jarque and Bera, which is sharply raised with regard to the critical value of the table of chi-deux (5,99) confirms it at the threshold of 5 %. One will note indeed, strongly leptokurtic character of the distribution of returns because the kurtosis is widely superior to that of the normal law (which is worth 3). It is besides asymmetric. The coefficients of skwness always not null indicate that the distribution of series is displayed towards the left in case they are negative and towards the right-hand side in case they are positive. This asymmetry reflects the existence of an abnormal phenomenon in the process of evolution of returns. It is the sign of the presence of none linearity in this process. We know that gaussian linear models can not generate that a symmetric behavior of the series and phenomena of asymmetry linked generally to the volatility can not indeed realize and correlatively in the ARCH effect frequently met in financial series.

3. TESTS AND ESTIMATION OF ARCH AND GARCH MODELS

Main property econometric financial series is their heteroskedasticity : the none normal character of their distribution (demonstrated above) proved by the net size of the statistic of Jarque and Bera leads to the rejection of all the classic tests of the efficiency. Considered of this heteroskedasticity, called conditional, we are going to make two tests : the first is that of homoskedasticity of White and the second is *ARCH-LM* test, of whom interest is to test existence or not of an ARCH effect in the behavior of returns. The results of two tests are carried in the table below :

Series	Nature of process (B-J)	White Test	ARCH-LM Test
BCM	ARMA(1,1)	42,69385*	65,95509*
BMCE	MA(4)	84,49184*	30,48612*
CMA	ARMA(2,2)	27,20966*	49,12105*
HOLCIM	ARMA(1,1)	37,94376*	31,11721*
MANAGEM	AR(1)	72,55818*	75,88718*
ONA	AR(1)	117,7334*	107,1687*
SNI	ARMA(1,1)	68,82038*	94,60237*
SONASID	ARMA(2,2)	37,13583*	30,04472*
WAFAA	ARMA(1,1)	2,379882	229,7372*
WAFABANK	ARMA(2,2)	58,71512*	55,59759*

Table 6 : Test ARCH-LM. The statistic of the test ARCH-LM is compared with the value of chi-deux in 5 degrees of freedom $(\chi^2_{0,05}(1) = 3{,}84)$; *1 is the order of lag retained in the test. The asterisk (*) expresses the refusal of the null hypothesis of homoskedasticity at the threshold of 5 % B-J : Box and Jenkins.*

According to found results, null hypothesis of homoskedasticity is rejected in favor of the alternative hypothesis of conditional heteroskedasticity. The existence of an ARCH effect in the behavior of the securities of the continuous market of Casablanca is so verified. This result allows us to pass in the estimation by ARCH and its extensions of securities retained in this study. Indeed, our strategy aims at two essential objectives :

- To find the modeling among the ARCH classes which describes in best the volatility of the prices of the most active shares of Casablanca stock exchange ;
- Try to know if the modeling of the volatility by a process of type ARCH is exploitable to realize abnormal earnings.

For that purpose, the rest of this work is going to be dedicated to these two objectives by emphasizing the notion of volatility modeling by *ARCH* and its extensions on the basis of the data of the stock exchange of Casablanca. So, by basing itself on the statistics of selection of models, we shall show what of the models of ARCH type is capable of better explaining the volatility of the market of Casablanca stock exchange. The second sub paragraph as for him, will be dedicated to the evolution of the volatility of the stock exchange of Casablanca from June 1998, dates the implemented of the automatic system.

3.1. ARCH Modeling of returns and its extensions

We consider in this study various classes of *ARCH* and *GARCH* for various values of p and q : *ARCH(P)*, *GARCH*(p,q), *EGARCH*(p,q), *TGARCH*(p,q) and *ARCH-M*. Four types of statistics go allow us to select the best model, that naturally which answers the best following criteria :

- *T* of Student : the value informs us about the significance of the parameter for which it makes reference. If the absolute value is lower than 1,96 for the only one of parameters, we can eliminate at once the model ;
- $\overline{R}^2$: his adjusted value informs us about the significance of the regression of the tested model ;
- The criteria of entropy (*AIC*[1] and Schwartz[2] criterion) : the best model is the one the values of these criteria of which are the weakest ;
- The descriptive statistics of the standardized residuals : the best model is the one of which the skewness, the kortosis and Jarque and Bera is the most close to those of the normal law ;
- Statistics referring to the method of estimation (SSR and Log likelihood) : the best model is the one of that sum of her squares residuals is minimized and the logarithm of likelihood of which is maximized.

On the basis of these criteria, we are going to proceed to the estimation of several models and we shall retain among them, those that are valid. Models to be estimated are :

[1] Criterion AIC (Akaike Information Criterion) realizes the quality of the conditional information introduced into the explanation of the model.

[2] This criterion has the same function as the criterion AIC but sturdier than the first one.

$$
\begin{cases}
ARCH\ (P):\ h_t = a_0 + a_1\varepsilon_{t-1}^2 + a_2\varepsilon_{t-2}^2 + ... + a_p\varepsilon_{t-p}^2 \\
GARCH\ (1\ ,\ 1):\ h_t^2 = a_0 + a_1\varepsilon_{t-1}^2 + b_1 h_{t-1} \\
ARCH\text{-}M:\ h_t = c + a_1\varepsilon_{t-1}^2\ r_t = c' + m_1 h_t,\ (23) \\
EGARCH:\ \ln h_t^2 = a_0 + a_1\left|\dfrac{\varepsilon_{t-1}}{h_{t-1}}\right| + \gamma\left|\dfrac{\varepsilon_{t-1}}{h_{t-1}}\right| + b_1 \ln h_{t-1}^2 \\
TGARCH:\ h_t^2 = a_0 + (a_1^{+}\varepsilon_{t-1}^{+} - a_1^{-}\varepsilon_{t-1}^{-})^2 + b_1 h_{t-1}^2
\end{cases}
$$

With r_t is the return of the value considered at the moment t and signs + and – take into account thresholds of the model. The results of this estimation are regrouped in the table below :

		ARCH(1)	ARCH(2)	ARCH(3)	GARCH(1,1)	EGARCH(1,1)	TGARCH(1,1)
	R2			**0.008694**	0,005343	0,001290	**0,008443**
	LL			4312.101	4344,086	4352,583	**4386,169**
	AIC			**-8,915674**	-8,913017	-8,908233	**-8,915421**
	SIC			**-8.889270**	-8,890384	-8,881929	-8,889017
BCM	SSR			**0.184493**	0,185251	0,185871	**0,184540**
	S			0,198409	0,285999	0,393738	**-0,024778**
	K			12,62564	13,68710	14,68177	**12,61556**
	J-B			5367,531	6624,304	7928,021	**5347,358**
	R2	**0,001084**			-0,000188	-0,001125	-0,000844
	LL	4605,769			4605,769	**4612,446**	**4606,150**
	AIC	**-9,159932**			-9,157942	-9,156289	-9,156570
	SIC	**-9,144861**			-9,139104	-9,133683	-9,133964
BMCE	SSR	**0,145347**			0,145428	0,145459	**0,145418**
	S	**0,673466**			0,758407	0,713823	0,761654
	K	**13,68593**			14,94952	14,54812	14,96788
	J-B	**6718,524**			8403,231	7841,760	8429,231
	R2			-0,011827	**-0,003452**	-0,014984	**-0,005777**
	LL			3981,917	**3984,487**	**3985,828**	**3982,131**
	AIC			-8,429545	**-8,438575**	-8,426429	**-8,435542**
	SIC			-8,403110	**-8,415916**	-8,399994	**-8,409106**
CMA	SSR			0,299552	**0,297288**	0,300486	**0,297761**
	S			**-1,269082**	-1,473478	1,473478	**-1,343267**
	K			**20,29668**	23,80107	23,80107	23,28912
	J-B			**17649,41**	25489,07	25489,07	24227,46
	R2			-0,005377	**-0,003900**	-0,005751	
	LL			**4043,588**	4037,178	4027,027	
	AIC			-8,493649	**-8,495835**	-8,493277	
	SIC			-8,467275	**-8,473229**	-8,466904	
HOL	SSR			0,281771	**0,281560**	0,281875	
	S			-1,018358	**0,953582**	-1,088719	
	K			19,10870	**18,54725**	20,00093	
	J-B			15269,07	**14210,10**	17014,35	
	R2	**0.004719**			0.001421	-0.003385	-0.000250
	LL	1853.829			1861.824	**1866.226**	**1863.865**
	AIC	**-8.138398**			-8.133616	-8.127343	**-8.130472**
	SIC	**-8.111613**			**-8.100135**	-8.087166	-8.090295
MNG	SSR	**0.194556**			0.194909	0.195554	**0.194943**
	S	**0,052142**			0,177522	0,316389	**0,224306**
	K	**6,116460**			6,426833	6,991181	**6,454551**
	J-B	**273,0599**			333,3278	**458,5989**	**340,7962**
	R2			**0,049187**	0,048834	0,046920	0,047618
	LL			4470,289	**4483,182**	**4492,067**	**4487,056**
	AIC			-9,032209	**-9,032556**	-9,029829	-9,030561
	SIC			-9,009590	**-9,013706**	-9,007209	-9,007942
ONA	SSR			**0,164555**	0,164735	0,164947	0,164827
	S			0,498997	**0,458680**	0,722015	0,544649
	K			**12,52418**	13,00194	14,05850	12,93088
	J-B			**5307,479**	5838,450	7198,239	5776,442
	R2			0,000298	**0.000969**		
	LL			4282,132	**4292.560**		
	AIC			-8,751427	**-8.752814**		
	SIC			-8,725037	**-8.730195**		
SMI	SSR			**0,217585**	**0.217596**		
	S			**-0,448603**	-0,614452		
	K			**9,790069**	10,42086		
	J-B			**2714,915**	3274,532		

	R2		-0,008304		**-0,002893**		
	LL		3987,663		**3995,163**		
	AIC		-8,393357		**-8,398738**		
	SIC		-8,370738		**-8,376119**		
SID	SSR		0,015013		0,310045		
	S		**-0,628473**		-0,744824		
	K		**17,47760**		19,24745		
	J-B		**12222,09**		15406,26		
	R2			-0.007757	**0.034041**		-0.015566
	LL			2940.709	2978.017		**2981.898**
	AIC			-7.655693	**-7.698922**		-7.647973
	SIC			-7.624861	**-7.672495**		-7.617142
WAA	SSR			0.535390	**0.513635**		0.539539
	S			0,350889	**0,012997**		**0,007196**
	K			7,779064	**6,650355**		**6,462234**
	J-B			1113,128	**635,7500**		**571,8928**
	R2			-0.000682	**0.000220**	-0.000553	**0.000103**
	LL			4039.032	4042.955	4072.118	**4085.346**
	AIC			-8.514194	**-8.515813**	-8.514323	**-8.514979**
	SIC			-8.487774	**-8.493168**	-8.487903	**-8.488559**
WAB	SSR			0.275439	0.275390	0.275403	**0.275223**
	S			0,855342	0,889848	0,968740	**0,642144**
	K			12,73849	13,10740	13,81861	**10,99932**
	J-B			5649,978	6087,017	6981,015	**3793,359**

Table 7 : Results of the Estimation of Various GARCH Models.

According to our estimation, they are the models GARCH which model describe better the volatility of the most active shares of the stock exchange of Casablanca. At first sight, it is *GARCH(1,1)* who seems to be the best model for the estimation of the volatility of the most liquid shares of the stock exchange of Casablanca. Nevertheless the superiority of the model TGARCH(1,1) takes it on that of *the GARCH (1,1).* This choice confirms as far as the value of the maximum of log-likelihood is superior for *TGARCH(1,1)* compared with those of the other models. This conclusion confirms the superiority of models GARCH and in particular the models GARCH taking into account asymmetric phenomena with short memory in the behavior of returns.

This says, we wonder about the repercussion which can engender the introduction of the electronic quotation on the volatility. That is why, we are examine, at present, to be the object of it in the following paragraph.

3.2. Electronic quotation and evolution of the volatility of the stock exchange of Casablanca

Leptokurtic character stock-exchange series is an indisputable fact. Our study concerning the volatility of the most liquid values showed it very clearly. Rest to be known now the origin of this volatility.

In the theory, temporal consolidation and aggregation of orders, within the framework of electronic *fixing*, should as a rule reduce volatility. Also, the increase of the degree of transparency will reduce volatility by the factor of realism of the investors, because these last ones observe the state of offer and demand, before the *fixing*. On the contrary, quotation in continuous increases the volatility of prices in case listed securities are not enough liquid, by of the memory effect. Now, we notice a contradiction : after the introduction of the electronic quotation, liquidity and volatility increased amply. For the most liquid shares, it is quotation in continuous, by means of a strong demand, which engendered such an increase. Introduction, very recently, of close fixing for shares quoted in continuous can reduce this volatility.

4. CONCLUSION

Towards found results, the volatility of the most active shares of the stock exchange of Casablanca was revealing by the asymmetric GARCH modeling. This one takes into account the short memory effect in the generative process of returns. This type of model describes better the situation of fluctuations in the prices of the most active shares of the stock market of Casablanca as far as the change of price observed since the introduction of the electronic system of quotation in 1998 made in a rough way by the ascendancy of the exchanges of blocks.

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