

ASSESSMENT OF ALGERIAN INTERBANK INTEREST RATE THROUGH EXTREME VALUE THEORY

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ABSTRACT

This article tries to examine the evolution of interest rates of the Algerian interbank money market which focus on the behavior of extreme. Empirical results illustrate that data are not distributed normally, exhibit that their distribution are fat tails. Applying the GEV method on the maxima shows that the distribution law of the maxima changes over time due to the non-stationary data. Subsequent investigations suggest two subsample periods. The first period characterized by A deterioration of the liquidity of Algerian banks following the collapse of oil price (1997-2000), the distribution law obtained is the law of Fréchet, but during the period characterized by an excess liquidity of the banks resulting from the increase in oil prices (2002-2013), the distribution law found is that of Weibull which is right bounded.

KEYWORDS: The Algerian interbank market, the day to day rate, Normal law, Extreme value theory, Algeria.

JEL CLASSIFICATION: C1, C13, C16, E4.

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LE TAUX D'INTÉRÊT INTERBANCAIRE EN ALGÉRIE : UNE APPROCHE EMPIRIQUE À TRAVERS LA THÉORIE DES VALEURS EXTRÊMES.

RÉSUMÉ

Cet article examine l'évolution du taux d'intérêt du marché interbancaire algérien en s'appuyant sur l'analyse de comportement des extrêmes de ce dernier. Les résultats empiriques montrent que les données ne sont pas distribuées normalement, leur distribution est des queues grasses. L'application de la méthode GEV sur les maxima montre que la loi de distribution des maxima évolue dans le temps en raison des données non stationnaires. Des enquêtes ultérieures suggèrent deux périodes de sous-échantillon. La première période est caractérisée par une baisse de liquidité des banques algériennes suite à l'effondrement des prix du pétrole (1997-2000), la loi de répartition obtenue est la loi de Fréchet. Concernant la seconde période qui est caractérisée par un excès de liquidité des banques, dû à la hausse des prix du pétrole (2002-2013), la loi de distribution trouvée est celle de Weibull qui est bornée à droite.

MOTS CLÉS : le marché interbancaire algérien, le taux au jour le jour, la loi normale, la théorie des valeurs extrêmes, Algérie.

سعر الفائدة في السوق النقدية في الجزائر : مقارنة من خلال نظرية القيم القصوى.

ملخص

تهدف هذه الدراسة الى فهم تطور ديناميكية اسعار الفائدة في السوق ما بين البنوك في الجزائر. الدراسة تعتمد اساسا على التحليل السلوكي للقيم القصوى لأسعار الفائدة. تظهر النتائج ان البيانات لا تتبع توزيع طبيعي. تطبيق طريقة تحليل "جاف" على الحد الاقصى يوضح ان هذا الاخير يتغير بمرور الزمن بسبب ان البيانات غير مستقرة في

فترة الدراسة قسمت الى فترتين. تميزت الفترة الاولى بانخفاض سيولة البنوك الجزائرية بعد انهيار اسعار النفط 1997-2000 وقانون التوزيع الذي تم الحصول عليه هو قانون فريشيه. فيما يتعلق بالفترة الثانية والتي تتميز بفائض السيولة لدى البنوك نتيجة ارتفاع اسعار النفط 2002-2013 فان قانون التوزيع هو قانون ويبل المحدد على اليمين. التوزيع قانون, اليومية الفائدة, الجزائرية البنوك بين ما الفائدة كلمات المفتاحية: سوق الجزائر القصبوى، القيم نظرية، الطبيعي.

INTRODUCTION

The short-term interest rate is a key variable in economics and finance in particular. Currently, with large liberalization of economies and the deregulation of money markets, the monetary authorities adopt indirect instruments to control money supply. The short-term interest rate has become the main channel for the transmission of monetary policies. Indeed, the short-term interest rate is also a fundamental input in securities and derivatives yields valuation. It is considered, as factor and a state variable in term structure models of interest rates. Therefore, its variation induces the discrepancy of the whole structure by term. Its effect on the expectations of market rates and the cost of loans leaves it a reference for better management of the portfolios of investors and companies and for an efficient allocation of the banks' resources.

Nautz and Scheithauer (2011) indicate that the day to day rate is an objective of monetary policy, and its policy rate gap impacts the effectiveness and implementation of monetary policy. The day-to-day rate plays a crucial role given that it informs us about the level of overall interest rates and the position of monetary policy.

Several studies have focused on modeling and estimation of short-term interest rate processes, most empirical studies address this issue assuming that changes in interest rates are normally distributed.

However, since the pioneering work of (Mandelbrot 1963¹ and Fama 1965), which challenged the normality hypothesis, several subsequent works corroborate that the distribution of high-frequency data (usually the financial time series) deviates from the normal law and contains extreme movements. An extreme movement in interest rates is defined as the maximum or minimum level observed over a given period. These movements can have far-reaching consequences on the direction of monetary policy, on financial equilibrium and therefore on economic equilibrium in general.

Some works (Boulier, Dalaud and Longuin (1998), BALI (2007), Gençay and Selçuk (2006)) have shown that the extreme movements of short-term interest rate are underestimated by the Gaussian approach. However, extreme value theory is considered the most relevant for this kind of movement. This theory, contrary to classical statistical theory, which is concerned with the mean of the sample, is a statistical theory which analyzes rare events (Embrechts, Kluppelberg and Mikosch, 1997), it indicates the asymptotic law of the maximum and minimum terms of a random process" (LONGIN, 1995, page 77). It deals with the extreme values of the random variables by looking at the behavior of the tails of a distribution, necessary for the detection of potential risks and therefore their management. Benito et al. (2007) analyze the daily time series of the euro overnight interest rate (EONIA) and conclude that jumps are an essential component of EONIA's modeling.

At the end of the 1980s, Algeria adopted several economic reforms. The aim of these reforms is to perform the transition from a planned economy to a market economy. The reforms focused on the liberalization and rehabilitation of the money-finance sector. Indeed, as part of planning, according to Naas (2003), interest rates were systematically determined by the finance ministry; while the main reform introduced by the law on money and credit, Law 10-90, clearly

¹ MANDELBROT (1963), points out that commodity price changes are not well described by the normal distribution. To this end, he presented a new model for testing price behavior in speculative markets (stable distributions with infinite variance as an alternative to finite variance models).

aims at a dual objective: regulation by the market and therefore a rehabilitation of interest rates in their role as an economic category which will play their role in the mechanisms of economic adjustment and regulation. However, these reforms aimed at this transition to a market economy have been in effect for more than twenty years, while the mode of determining this interest rate is not clearly highlighted. From this arises a central issue that we propose to study in this article. In fact, the problem is declined in the following central question:

Is the short-term interest rate in Algeria, in particular, the day to day rate, actually determined by the market?

In other words, does the market mechanism involved in confrontation liquidity supply and demand on the interbank market operate efficiently? To answer this question we analyse the interest rate dynamic through their stochastic behavior. We assume that the evolution of interest rate in a competitive market should follow the normal law and the imperfections in the market manifest as an extreme behavior of interest rate. In this work , we also study the law of distribution of the short-run interbank interest rate.

In Algeria, empirical studies dedicated to the analysis of extreme changes in short-term interest rates are rare. In this article , an attempt will be made to examine the behavior of extreme interest rates on the interbank money market from 1997 to 2013. The choice of this rate is due to the fact that, as of 2001, the refinancing of banks with the Bank of Algeria has become almost zero, due to the excess liquidity on the interbank market. In this context, the monetary policy instruments used to regulate liquidity are exclusively reserve requirements and market instruments. The monetary authority must look at the interbank rate, in particular, the day to day rate. Therefore, the study of the day to day rate behavior is crucial for detecting the potential existence of extreme movements and for informing the monetary authority about the interbank market situation in order to properly manage its monetary policy and maintain the day to day rate close to the monetary policy rate.

The article is organized as follows: the first section presents the work carried out in this direction, the second section summarizes the

foundations of the extreme value theory, and the third describes the data, the methodology and the descriptive statistics. In the fourth, the estimation results obtained from the GEV method are presented. The last section reports the results of the POT method and concludes with a conclusion.

1- MAIN LITERATURE CONSIDERATION

In general, works on implementations of extreme value theory in finance shows that the distribution of high-frequency financial data (the exchange rates and other financial assets prices) diverge from the normal distribution and have thick tails. For example, Boothe and Glassman (1987), Koedijk, Schafgans and de Vries (1990), Dacorogna, Muller, Pictet and de Vries (1995), Hols and de Vries (1991) ... etc, have applied the theory of extreme values to the exchange rate, but, Jansen and de Vries (1991), Loretan and Phillips (1994), Francois Longin (1995), Longin (1996), E. Jondeau and M. Rockinger (1999), Gencay, R, and Selcuk. (2004), Eric Jondeau and Rockinger (2003), John Cotter (2004), Christian Robert (2002), Boulier, Dalaud and Longin (1998), Lux (2001), Quintos, Fan and Phillips (2001)...etc, have used the extreme value theory to study the behavior of queues of returns on financial markets.

In general, there is little research on the behavior of extreme interest rates. By way of example:

Boulier, Dalaud and Longin (1998), using the extreme value theory and by the maximum likelihood method and the nonparametric method developed by Hill (1975), estimate the asymptotic distribution of extreme values of short-term interest rate on the French market over the period from January 1981 to August 1996. The asymptotic law found is of the Fréchet type.

Bali and Neftci (2001) studied the extreme movements of federal fund market interest rates in the US from July 1, 1954 to December 29, 2000. They showed that the estimated form parameter for the maximums is larger than the minimums, meaning that the distribution of maximum changes has thicker tails than the distribution of minimum changes.

Gençay and Selçuk (2006), examined the dynamics of the extreme values of the overnight borrowing rates of Turkey's interbank money market from 2 January 1990 to 23 February 2001. They showed that interest rates are far to be distributed normally and that the generalized distribution of Pareto adapts well to the distribution of extreme values of the interest rate. They also found that the post-crisis interest rate distribution has a thicker tail than that before the crisis. In order to compare Turkey's interest rates with US interest rates, they repeated the analysis with the daily US federal funds rate over the period July 1, 1954 to December 31, 2000. GPD estimates indicate that the daily maximum US federal fund rates have a tied support, this is a Weibull distribution with a form parameter of -0.40 , in contrast to the maximum interest rates in Turkey, which converge towards a distribution that shows an infinite variance. They postulate that the difference between the United States and Turkey comes from the fact that the two countries have a different degree of development from the financial market and financial institutions. The Turkish financial markets are very shallow and the financial structure is very weak.

Turan G. Bali (2007) used the extreme value approach to study the asymptotic behavior of extreme changes in interest rates of US treasury securities from 1982 to 2001. Using the maximum Likelihood, the tail index for the minima of the treasury yields is higher than that of the maxima, which means that, the minimum changes have thicker tails (are more volatile) than the maximum changes. What is also found is that, extreme changes in the short-term interest rate have thicker tails compared to extreme changes in long-term rates. Finally, it has shown that the GEV model for evaluating the options provides more accurate forecasts of option interest rate estimation than the normal log distribution and generalized error-adipose distribution (GED) during periods of extreme volatility.

2- EXTREME VALUES THEORY

«Extreme value theory emerged as one of the most important statistical disciplines for applied sciences." (COLES, 2001, page 1). This theory appeared between 1920 and 1940, and among its founders

were M. Fréchet (1927), R. A. Fisher and L. H. C. Tippett (1928), E. J. Gumbel (1935) and B. V. Gnedenko (1943). Initially, this theory concerned flood heights and civil engineering (Klajnmic, 2005, page30), but in recent years its scope has been extended to numerous and varied fields. The main theoretical results of the extreme value theory are available in the book of Embrechts, Klüppelberg and Mikosch (1997), and in the books of Coles (2001) and Reiss and Tomas (2001), which offer practical examples.

For the modeling of extreme movements, there are two approaches: the Generalized Extreme Value Theory (GEV) and the Excess over Threshold (POT) approach, two theorems are essential to the understanding of these two approaches: Fisher-Tippet's theorem (1928) and the Balkema-de Haan-Pickands theorem.

2.1- Generalized extreme values theory (gev)

This approach focuses on the distribution of maximum and minimum realizations. The core of this approach is Fisher Tippet theorem (1928), which specifies the form of the limit distribution of the maximum correctly normalized. Indeed, this theorem was subsequently proposed by Gnedenko (1943), which gives the form of boundary laws. The theorem is the following (BENLAGHA,REHOMME and VASECHKO, 2009, page 51):

Consider a sequence X_1, \dots, X_n , of n real independent and identically distributed random variables (iid), and $M_n = \max(X_1, \dots, X_n)$. If there exist two real sequences $(a_n)_{n \geq 1}$ and $(b_n)_{n \geq 1}$ with $b_n > 0$, and a non-degenerate distribution function G such that:

$$\frac{M_n - a_n}{b_n} \xrightarrow{d} G,$$

When n tends to infinity, then G is necessarily one of the following three types: (Type I, Type II or Type III)

Type I: Gumbel

$$G_0(x) = \exp(-\exp(x)) \quad -\infty < x < +\infty$$

Type II: Fréchet

$$G_{1,\alpha}(x) = \begin{cases} 0 & x < 0 \\ \exp(-x^{-\alpha}) & x \geq 0, \alpha > 0 \end{cases}$$

Type III: Weibull

$$G_{2,\alpha}(x) = \begin{cases} \exp(-(-x)^{-\alpha}) & x < 0, \alpha < 0 \\ 1 & x \geq 0 \end{cases}$$

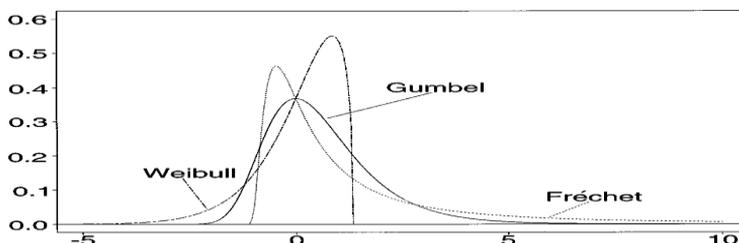
Von Mises (1954) and Jenkinson (1955) gave a general formula that combines the three types of laws, known as the Generalized Extreme Value Distribution (GEV), which corresponds to:

$$G_{u,\sigma,\varepsilon}(x) = \exp \left\{ - \left[1 + \varepsilon \left(\frac{x-u}{\sigma} \right) \right]^{-1/\varepsilon} \right\}$$

Where U is a parameter of localization (which plays the role of the mean), σ is a dispersion parameter (which plays the role of a variance) and ε is a shape parameter, also known as an index of values Extreme or tail index. The higher this index is in absolute value, the greater the weight of the extremes in the distribution. The sign of the parameter ε , identifies the maximum domain of attraction (MDA) to which the distribution belongs. Three cases are possible (RAGGAD, 2009, page37):

1. $\varepsilon > 0$, $G_{u,\sigma,\varepsilon}$, follows the Frechet law, which is an unbounded law, it has an infinite support to right and characterizes extreme dangerous situations. This law gathers the majority of large-tailed distributions such as Cauchy or Pareto's law and Student's.
2. $\varepsilon < 0$, $G_{u,\sigma,\varepsilon}$, follows the Weibull law, which is a right-bounded law, combines the majority of the tailless distributions, such as the uniform law or beta.
3. $\varepsilon \rightarrow 0$, $G_{u,\sigma,\varepsilon}$, follows Gumbel's law, which combines the majority of finite-valued distributions, such as the exponential, Gamma, normal and Log-normal distributions.

Figure 1 Representation of the density of the three types of laws: Gumbel($\varepsilon = 0$), Fréchet ($\varepsilon = 3/4$), and Weibull($\varepsilon = -3/4$).



Source: Paul Embrechts, Resnick Sidney I., and Samorodnitsky Gennady, « Extreme value theory: Potential and limitations as an integrated risk management Tool. North American Actuarial Journal, Volume 3, Number 2, April 1999, page33.

Since the GEV approach concerns only the laws of maximum values, a second method of the extreme value theory has been introduced, the latter not only concerns maxima, but also analyzes the asymptotic behavior of observations called excess, which Exceed a sufficiently high threshold (Gencay and Selcuk, 2006, page551). This method is known as the method of excesses over threshold.

2.2- Excess over threshold

The Peaks Over Threshold method (POT) models observations that exceed a certain threshold. For a given high threshold U , the distribution function of excess values of x over the threshold u is defined by

$$F_u(y) = \frac{\Pr\{X - U \leq y, X > U\}}{\Pr\{X > U\}} = \frac{F(y + u) - F(U)}{1 - F(u)}$$

Which represents the probability that the value of X exceeds the threshold u by at most a quantity y .(Gencay and Selcuk, 2004, page 291).

The objective of the POT method is to determine by which law of probability one can approach this conditional distribution. This is ensured by the theorem of Balkema and de Haan (1974) and Pickands (1975), by which these authors have shown that for a sufficiently high threshold U , the distribution function of the excess can be

approximated by the generalized Pareto distribution, that is to say, when the threshold becomes large, the distribution $F_u(y)$ converges towards the GPD.

$G_{\epsilon, \beta}$ is the distribution function of the generalized Pareto distribution (GPD) of parameters ϵ and B defined by (Gencay, Selcuk, 2006, page 551):

$$G_{\epsilon, \beta}(x) = \begin{cases} 1 - (1 + \epsilon \frac{x}{\beta})^{-\frac{1}{\epsilon}} & \text{if } \epsilon \neq 0 \\ 1 - e^{-x/\beta} & \text{if } \epsilon = 0 \end{cases}$$

The parameter ϵ is the shape parameter and B is a scale parameter. Three cases are known (Gencay, Selcuk and Ulugulyagcı , 2001, page 216):

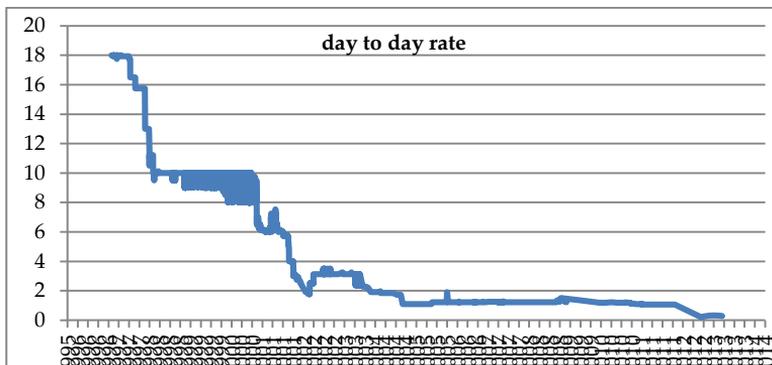
1. When $\xi > 0$, the distribution takes the form of the ordinary Pareto distribution. This particular case is the most relevant for the analysis of the financial series since it is a heavy tail.
2. When $\xi = 0$, the GPD corresponds to the exponential distribution, and it is known as a Pareto distribution of type II for $\xi < 0$.

Before applying the extreme value theory methodology, we will first compute a number of descriptive statistics on our data.

3- DATA DESCRIPTION AND STATISTICS EMPIRICAL ASSESMENT

All data are obtained from the database of the central bank of Algeria and consists of the intraday data of the day to day rate of Algerian interbank market. This interbank interest rate is the price at which banks refinance each other by performing 24-hours transactions on the Algerian interbank market. The data are for the period December 1996 to April 2013, representing a sample of 12271 observations.

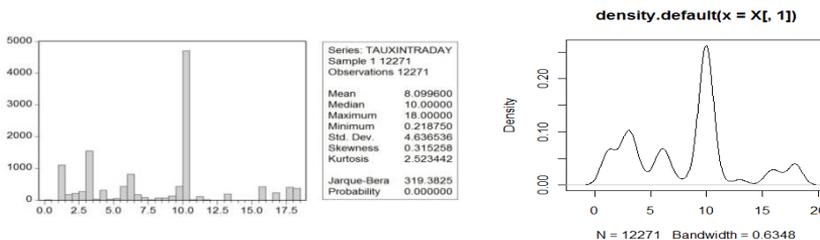
Figure 2. Changes in the day to day rate over the period (December 1996 - April 2013)



Source: Realized by ourselves using the data of the bank of Algeria

The visual observation of the graph indicates that the day to day rate has a downward trend throughout the study period, from a high level (18) in December 1996 to a very low level (0.28) in April 2013.

Figure 3. Density, histogram and descriptive statistics of the day to day rate over the period (December 1996 - April 2013)



Source: Histogram obtained by software Eviews1.4, the density is obtained by software R 2.10.

Indeed, the histogram and density graph are simple and explanatory methods to get an idea about the type of behavior of the tail. (Embrechts Kluppelberg and Mikosch, 1997), emphasizes the importance of such graphic analysis.

- The histogram and the density graph obtained differ from the histogram and the density graph representing the normal distribution.

- The asymmetry coefficient (Skewness) (moment of order 3) measures the asymmetry of the behavior of the rates around their empirical mean, equal to 0.315258, it is different from 0 (which is a characteristic of the normal distribution), and it is positive, so there is a right asymmetry.
- The kurtosis coefficient, which is a measure of the behavior of the tails of distribution, is equal to 2.523442, it is different from 3 (which is also a characteristic of the normal distribution), so the tail of this distribution is different of the normal distribution.
- JarqueBera statistic (319, 38) reveals that the probability of interest rates being normal is zero.

These results show that the interest rates are not distributed normally, to confirm this result, the Kolmogorov-Smirnov test is carried out, the test and the result of which are as follows

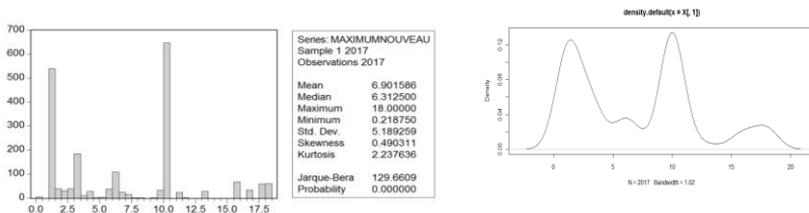
H_0 : the series follows the normal law

H_1 : the series does not follow the normal law

$D = 0.2016$, the tabulated statistic for $n=12271$ and $\alpha=5\%$ is $d = 0.0138$. $D = 0.2016 > d$ tabulated $= 0.0138$, therefore the null hypothesis of normality is rejected.

Since this series does not follow a normal law, so there is a probability of having extremes. After selecting the maximums, the descriptive statistics of the maxima are calculated.

Figure 4. Density, histogram and descriptive statistics of the day to day rate maxima over the period (December 1996 - April 2013)



Source: the histogram is obtained by software Eviews, the density is obtained by software R.

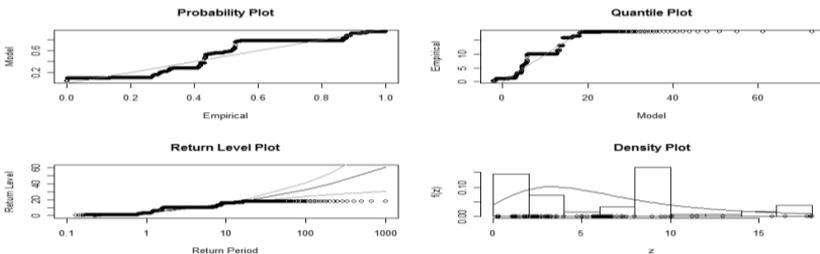
- The histogram and the density graph show that the distribution is thick-tailed.
- Skewness = 0.490311, it is different from 0, which means that the series has an asymmetric distribution compared to the normal, it is positive, so there is a right asymmetry.
- Kurtosis = 2.237636, it is different from 3, so the tail of this distribution is different from that of the normal distribution.
- Jarque Bera statistic (129.66) ($p = 0.0000$). The normality hypothesis is rejected for the series.
- the Kolmogorov-Smirnov test confirms that interest rate maxima are not distributed normally, since $D = 0.1796 > d_{\text{tabulated}} = 0.0138$ for $n=2017$ and $\alpha=5\%$.

After confirming that the maxima do not follow the normal law, we use the function GEV. FIT of the package **extreme** of software **R**, for graphical presentations and GEV model estimates, to determine the distribution of maxima.

4- APPLICATION OF THE GEV METHOD TO MAXIMA OF DAY TO DAY RATE ON THE PERIOD (DECEMBER 1996-APRIL 2013)

The application of the GEV method on our data allows us to obtain the following graph:

Figure 5. Application of the GEV method to the maxima of day to day rate over the period (December 1996 - April 2013)



Source: Realized by ourselves using software R 2.10.

Indeed, the likelihood ratio test (at a 5% level) does not accept the Gumbel hypothesis, since the likelihood ratio statistic is **(13.79733)** which is greater than the Chi-Square critical **(3.8414591)**.

4.1- Estimation of GEV parameters

Table 1. Estimation of GEV parameters by the L-moments method and the maximum likelihood method

The estimated parameters	By the L-moments method	By the maximum likelihood method
Location parameter	4.673962	3.99952
Scale parameter (Dispersion parameter)	4.383411	3.71640
Shape parameter	-0.07594239	0.20631

Source: Results obtained by software R2.10.

The results obtained by the maximum likelihood method are different from those obtained by the L moment method. The shape parameter is found negative by L moments method (Weibull distribution), and positive (Fréchet distribution) by the maximum likelihood method.

The plot QQ plot is used to determine the exact law.

4.2- Quantile-Quantile plot (the QQ-plot)

A QQ-plot graph is a visual tool suitable to examine if a sample comes from a specific distribution (Gencay and Selcuk, 2006, page552). The interest of this graph is to allow us to obtain the shape of the tail of the distribution. It is a graph that gives the quantiles of the empirical distribution as a function of the quantiles of the theoretical distribution envisaged. In the case of the extreme value theory, the QQ plot is typically the representation of the quantiles of the empirical distribution on the X axis against the quantiles of the Gumbel distribution on the y-axis. Three cases are possible: (Gencay and Selcuk, 2006, page 552)

1. If the data follow the Gumbel law, the QQ plot is linear.
2. If the data follow a fat-tailed distribution, the QQ-plot graph is concave.
3. If the data follow a right bound distribution, the QQ-plot graph has a convex shape.

In our case, observation of QQ plot shows a representation that changes over time, sometimes a concave form (Frechet's law) and sometimes a convex form (Weibull's law), which indicates that the data series are not stationary over the entire period (the behavior of the interest rate changes over time). To obtain more details and to determine the exact law, we subdivide our sample into two sub-samples corresponding to two distinct periods:

4.3- The first period (January 1997 to December 2000)

Since 1990 (the date of the reforms of the Algerian monetary system in the context of the transition to the market economy) to 2000, the banks are characterized by a net deterioration in their liquidity situation. According to Ilmane (2006), the banking system was characterized by structural illiquidity which made it entirely dependent on the refinancing of the central bank.

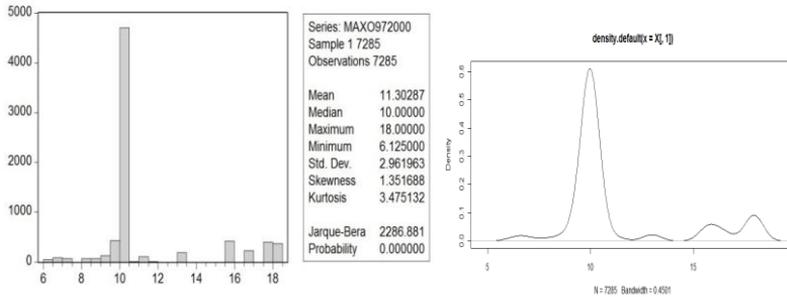
4.5- The second period (January 2002-April 2013)

During this period, Algerian banks are characterized by structural excess liquidity resulting from the increase in net foreign assets mainly as a result of the increase in resources from export earnings of hydrocarbons and treasury spending for the benefit of public banks, for their recapitalization and partial deleveraging towards her. As a result, the banking system has become outside the central bank and only the interbank money market remains functional.

5- STUDY OF THE BEHAVIOR OF THE DAY TO DAY RATE MAXIMA DURING TWO PERIODS

5.1- Period (december 1996- december 2000)

Figure 6. density, histogram and descriptive statistics of the day to day rate over the period (December 1996-December 2000)

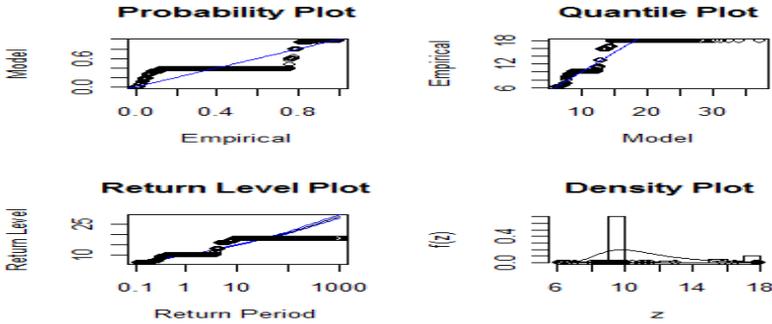


Source: the histogram is obtained by software Eviews1.4, the density is obtained by software R2.10.

- The asymmetry coefficient (Skewness) = 1.351688 . It is different from 0 and it is positive so there is a right asymmetry.
- The coefficient of flattening (Kurtosis) = 3.475132. It is greater than 3, so the representation of the rates during this period is leptokurtic.
- The JarqueBera statistic (2286.88) ($p = 0.0000$). The hypothesis of normality is rejected for the series of rates.
- The Kolmogorov-Smirnov test rejects the null hypothesis of normality, since $D = 0.4353 > d_{tabulated} = 0.0138$ for $n = 7285$ and $\alpha = 5\%$.

Since this series does not follow a normal law, so there are extremes. After having drawn the maxima, the GEV method is applied to the maxima.

Figure 7. The GEV representation of the day to day rate maxima during the sub-period (December 1996-December 2000)



Source: Obtained from R2.10 software.

- -The histogram and density graph have the appearance of a Fréchet distribution (the right tail is longer);
- -The observation of QQ plot, shows a concave form which corresponds to the law of Fréchet;
- The likelihood ratio test (at a 5% level) does not accept the Gumbel hypothesis, since the likelihood ratio statistic is (301.7982) which is greater than the Chi-Square critical (3.8414591).

5.2- Estimation of GEV parameters

Table 2. Estimation of the parameters of the GEV by the L-moments method and the maximum likelihood method

The estimated parameters	By the L-moments method	By the maximum likelihood method
Location parameter	9.943738	9.97207
Scaleparameter (Dispersion parameter)	1.131510	1.87989
Shape parameter	0.3914316	0.10311

Source: Results obtained by software R2.10

The results either obtained by the L-moments method or by the maximum likelihood method indicate that it is the Fréchet law, since by both methods the shape parameter is positive. To confirm that the shape parameter is positive, we observe the Hill plot.

5.3- The Hill plot

The Hill-plot graph is a tool that allows estimation of the tail index of the distribution and the threshold determination. The Hill estimator was proposed by Hill (1975), and is described as nonparametric estimators, along with the Pickands estimator (1975) and the Dekkers-Einmahl-De Haan estimator (1989). Is defined as follows: (Gencay, Selcuk and Ulugulyagci, 2001, page 217)

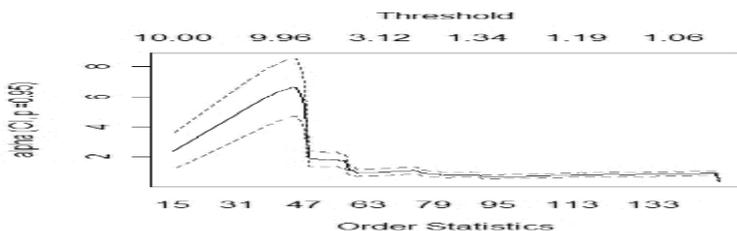
$$\hat{\xi} = \frac{1}{k-1} \sum_{i=1}^{k-1} (\ln x_{i,n} - \ln x_{k,n}) , \quad k \geq 2$$

With k , the highest statistical order, n is the sample size and $\alpha = 1 / \xi$ is the tail index of the distribution.

The Hill-plot graph allows us to have estimates of the parameter ξ as a function of the highest statistical order, and the good estimate is that which corresponds to the stability zone on the graph. The Hill estimator can only be used for the Fréchet distributions for which it provides a more efficient tail index estimate than the Pickands estimator (Gauthier et Pistre, page8). Mason (1982), also showed that the Hill estimator is efficient (Longin, 1996, page 390).

The Hill graph obtained for this period is as follows:

Figure 8. Hill plot

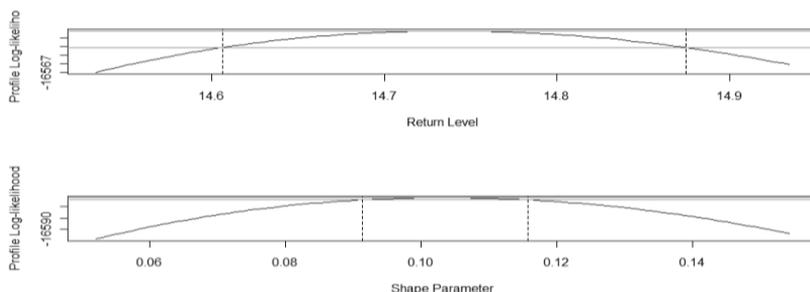


Source: Realized by us by software R2.10.

The result confirms that the value of the shape parameter is positive, since the graph stabilizes at a value below 1 but greater than 0. This result confirms that the distribution is of the Fréchet type.

- **The maximum likelihood estimate of the GEV confidence interval over 10 years gives the following results:**

Figure 9. The confidence interval of the shape parameter and the return level.

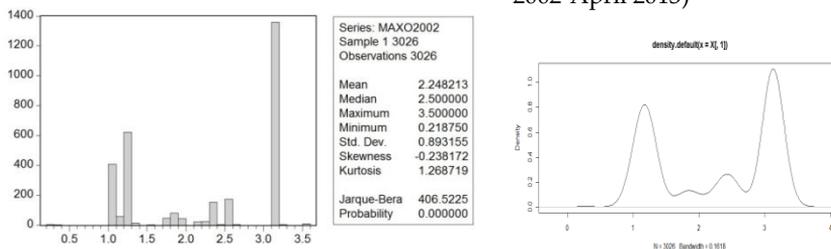


Source: Obtained by software R2.10.

- The estimated return level is equal to 14.7336.
- The confidence interval of the return level at 10 years at 95% is approximately: [14.60596, 14.87492]
- The confidence interval at the 95% of shape parameter is approximately: [0.09137, 0.11572]

5.2- Period (january 2002 - april 2013)

Figure 10. Histogram, density and descriptive statistics of the day to day rate on the sub-period (January 2002-April 2013)



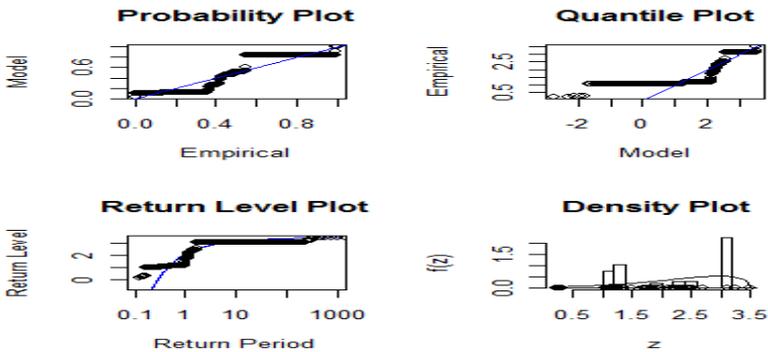
Source: The histogram is obtained by software Eviews1.4, the density is obtained by software R2.10.

- The asymmetry coefficient (Skewness) = -0.238172. It different from 0 and it is negative, so there is a left asymmetry.
- The coefficient of flattening (Kurtosis) = 1.268719, it is less than 3, so the representation of the rates during this period is platykurtic.

- The Jarque Bera statistic (406.52) ($p = 0.0000$). The hypothesis of normality is rejected for the series of rates.
- The Kolmogorov-Smirnov test confirms that the null hypothesis of normality is rejected ($D = 0.2896 > d_{\text{tabulated}} = 0.0138$ for $n = 3026$ and $\alpha = 5\%$).

Since this series did not follow a normal distribution, the GEV method is applied to the maxima.

Figure 11. The GEV representation of the day to day rate maxima during the sub-period (January 2002-April 2013)



Source: Obtained by software R2.10

- The histograms and the density graph have the appearance of a Weibull distribution (the tail on the left is longer);
- The observation of QQ plot shows a convex form, which corresponds to the Weibull law.
- The likelihood ratio test (at a 5% level) does not accept the Gumbel hypothesis, since the likelihood ratio statistic is **(1160.756)** which is greater than the Chi-Square critical **(3.841459)**.

5.3- Estimation of GEV parameters

Table 3. Estimation of GEV parameters by the L-moments method and the maximum likelihood method

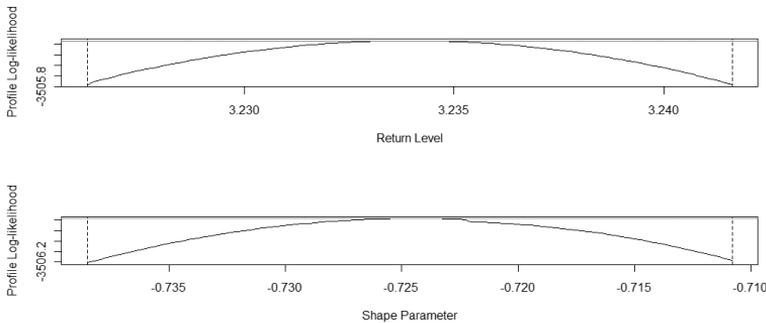
The estimated parameters	By the L-moments method	By the maximum likelihood method
Location parameter	2.040593	2.12698
Scale parameter (Dispersion parameter)	0.9273656	0.99745
Shape parameter	-0.5073738	-0.72466

Source: Results obtained by software R2.10.

From the results obtained, either by the L-moments method or by the maximum likelihood method, the law found is a Weibull distribution (the shape parameter is negative).

5.4- The maximum likelihood estimate of the GEV confidence interval over 10 years gives the following results:

Figure 12: the confidence interval of the shape parameter and the return level.



Source: Obtained by software R2.10.

- The estimated return level is 3.2339
- The confidence interval of the return level at 10 years and at 95% is approximately: [3.22624, 3.24164]
- The confidence interval at the 95% of shape parameter is approximately: [-0.73852, -0.7108]

6- APPLICATION OF THE POT METHOD TO THE DAY TO DAY RATEFOR THE PERIOD (DECEMBER 1996-APRIL 2013)

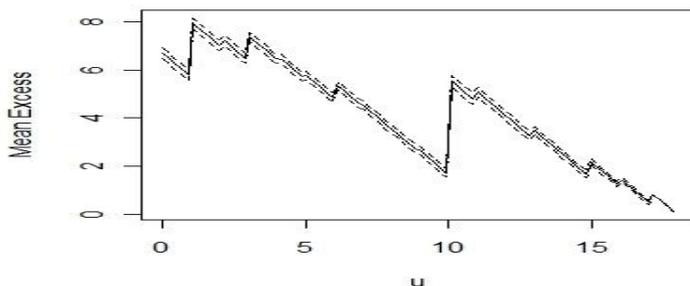
Before looking at which distribution converges the data beyond a particular threshold, one first seeks to determine this threshold, which is a crucial step in the POT approach. Indeed, there are several methods for determining the threshold: the record plot method, Hill plot, and the most widely used graph, the Mean Excess Function Graph (MEF) will use in this study. The latter is a more widely used graphical tool for discrimination in tails and estimation of the asymptotic distribution of maximum. The mean function of the excesses $e(u)$ is defined as: $e(u)=E[X-u/X>u]$ (Embrechts, Kluppelberg and Mikosch,1997, page 294). The latter represents the sum of the excesses above the threshold u divided by the number of observations that exceed this threshold. Indeed, this graph makes it possible to determine the threshold to be retained, by choosing the one for which MEF is approximately linear. Three cases can be obtained (Gencay, Selcuk and Ulugulyagcı , 2001, page217):

1. If the mean function of the empirical excesses is marked by a positive slope, then the data follow a generalized Pareto distribution with a positive parameter.
2. If the average function of the empirical excesses is horizontal, the data follow a Gumbel distribution.
3. If the empirical EMF is marked by a negative slope, we have a bounded distribution on the right.

In our case, the MEF graph is as follows:

Figure 13. Graph of the function of the mean of the excess of day to day rate over the period (December 1996-April 2013)

Residual Life Plot: taux au jour le jour1996-



Source: Obtained by software R2.10

The observation of the graph shows that the graph is more linear when the threshold is equal to 10, so the threshold to be retained is $u = 10$, the maximum likelihood estimate of the shape parameter corresponding to this threshold is equal to -3.11 , it is negative, indicating that the distribution of data over the threshold converge to a generalized Pareto law of type 2.

CONCLUSION

The results of this study show that the distribution of interest rates (the day to day rate) on the Algerian interbank market diverges from the normal law. The behavior of interbank interest rates changes over time, reflecting the non-stationary of interbank interest rates. Also, the behavior of the day to day rate changes as the price of oil changes:

- During the period characterized by a net deterioration in the liquidity situation of the banks as a result of the low level of the oil price (1997-2000), the distribution law obtained for the short-term interest rate maxima is the law of Fréchet, which is logical because, as a result of the shortage of liquidity, banks are increasing their demand on the interbank market, which has led to an increase in interest rates negotiated on this market as a result of the shortage of liquidity offers, therefore, the banks resort to refinancing with the central bank of Algeria.

- Within the period characterized by excessive liquidity of banks caused by the excessive increase in oil prices (2002-2013), the distribution law found is that of Weibull, which is also reasonable, because, with the over-liquidity of banks, The latter reduce their demand and increase their supply of liquidity on the interbank market, which should lead to the excessive fall in the day to day rate and the fall in the volume of transactions in the day to day compartment of the interbank market. But to remedy this problem, the Bank of Algeria continues to absorb excess liquidity in the market by taking over liquidity in order to avoid the severe fall in the interbank interest rate.

This result informs us that the day to day rate is not determined in an absolute way by the market mechanism. The distribution of the rates diverges strictly from the normal distribution. We notice the existence of extremes behavior of interbank interest rate which reflects situations of monopoly and imperfection in the market. The reason of this dynamic is that Algerian banks have the same standard structure, they all operate in the same sphere of activity, all banks activities depend on hydrocarbons sector. If they intervene on the market, it is all the banks which intervene as suppliers or as applicants, so there is no compensation between supply and demand. That creates situations of imbalance and monopoly in the market.

Therefore Algerian's transition to the economy market is not achieved. The market regulation is marginal on the monetary policy. The determination of interest rate in Algerian interbank market is characterized by competition imperfections and the intervention of non-market powers which makes their functioning inefficient.

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