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# An overall view of Albanian currency exchange rates during crisis of 1997 using q-analysis

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**Abstract**
We use herein q-deformed algebra and functions in the study of Albanian currency exchange rate series considering it as particular and specific. The assumption of the near to discrete scale invariance (DSI) behavior estimated by the fit of the q-log-periodic function is alternated with the correlation of the states in the hypothesis of a q-difference simulation of the trend. In this case, a possible dynamic series containing more points that the real one is analyzed using non-stable distribution of the returns. The technique is applied for the rate itself and the Bid-Ask dynamics too. We hope that improvement of this view will provide better knowledge for this specific systems.
***Keywords:*** *q-calculus, q-functions, financial series.*

## 1. Introduction

The study of exchange rates series for Albanian currency (ALL) toward USD or Euro has been considered in different point of views, as it happens routinely in similar consideration. The complexity methodology introduced in our previous works has been based on the combination of discrete scale of invariance approaches introduced in [1] with distribution of returns in similarity with [2], making use of Tsallis' statistics introduced in [3],[4]. The system considered in the following consist on time series of a specific financial environment related to a non-active real financial market, and only one single value per day (as provided by Bank of Albania) is administered. Following the idea of extension use of q-functions and q-operation like in [5] and [12] we propose to analyze the behavior of the exchange rates on the crises of 1997 that culminate in a full economic collapse and socio-political breakdown. Restricting on the major effect concerning herding behavior on a regular opinion lattice, a specific price formation model has been developed in the framework of self-organization with discrete scale invariance (DSI) [1], whereof a log-periodic function is obtained adequate to describe the complex dynamics therein. We reconsider the DSI approach for exchange rates dynamic of our currency using q-functions proposed in [5]. Making use of mathematical arguments for q-transforms in [6] and assembled documentation in q-calculus [7], we proposed in [11] to extend the computation tools using q-algebra and q-functions in an attempt to capture specific behavior in the cases where some scaling properties or correlation are mixed with other complexity behavior. In the analysis of the distributions we make use of our arguments used in [12] and [13]

## 2. Alternative interpolation of scarce series of exchange rates all/usd

The exchange rates ALL/USD has been strongly correlated to the economical breakdown of 1997 and culminated on 23 May. Under the assumption of classical bubble like behavior where the DSI self-organization is expected to underline the dynamics, the log-periodicity has been observed in the trend and further analyzed [5]. Specific dynamics are expected to occur around this period and in those terms we will refer periods preceding the bubble, and the other succeeding it. By the first assumption that discrete scale of invariance could be always present even not dominant, a q-log periodic approach has been discussed in [5]. Generally speaking, we can consider the processes that govern the behavior as non-equilibrated, and following the techniques proposed in [2] and [3], and in the spirit of a general view for complex

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behavior as in [3] [10], we try to analyses the q-distribution fitted with generalized returns of the forms $z = \frac{y_{t+1} - y_t}{y_t}$ where y could be exchange rates, the Bid-Ask values etc. We refer the exchange rate of Albanian Lek toward major world-wide used currencies EURO and US Dollars, as they can physically have considered as thermal bath and therefore many assumptions usually hidden or unspecified in the treatment, are considered to be in accordance with general theories. Generally

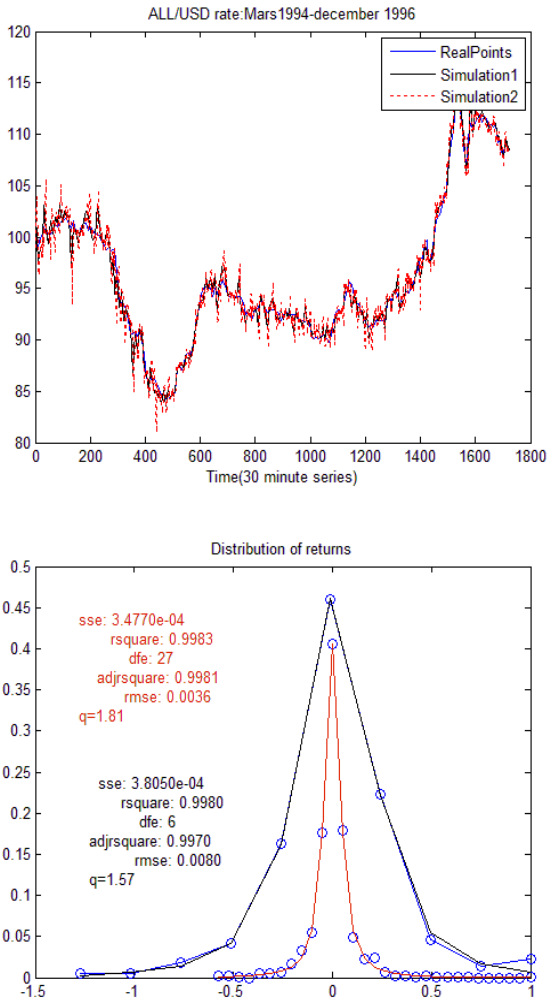


Fig. 1 The simulation (above) and the distribution for non-log-periodic behavior of the rates ALL/USD 1994-1996 (below).

speaking, financial time series shows nonlinear variability [3],[5], so nonlinear models have been proposed and tested in the specific cases of option pricing dynamics of the indexes and so on. As explained above, our exchange market is quite incomplete in the sense of trade theories, and hence classical models are expected to be less descriptive. Particularly, the Bid-Ask series are expected to be even more complicated and therefore modeling them becomes a more difficult task. Based on those arguments the idea elaborated in [2], we can qualitatively estimate the

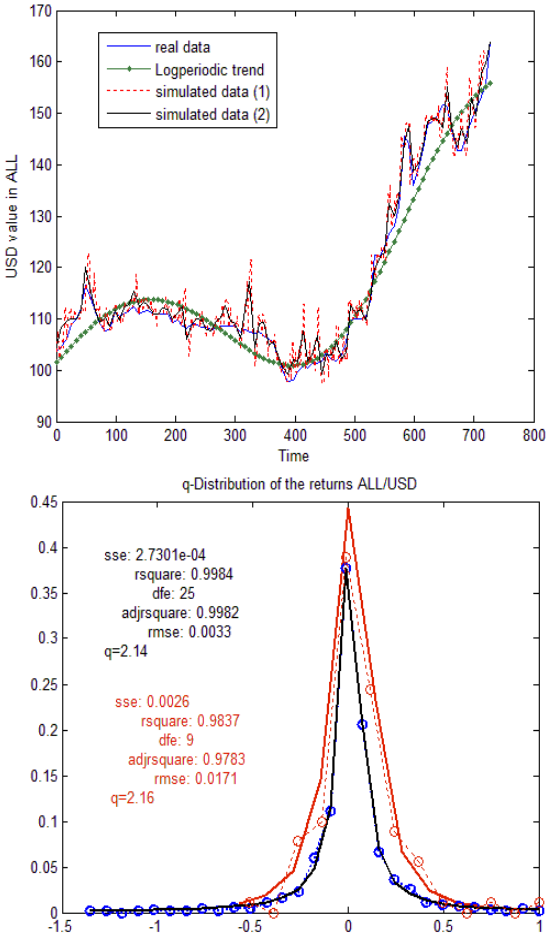


Fig. 2 The simulation (above) and the distribution for log-periodic behavior of the rates ALL/USD 1996-1997 (below).

equilibrium and its issue for our system. Here we limit the analysis in the use of q-calculus motivated by scaling properties, correlation of the states, high irregularity and heterogeneities presence. It could be the case of figuring DSI behavior $O(x) = \mu(\lambda)O(\lambda x)$, but assumed to not be as fundamental, is proposed recently in [5[ and [11], to be captured by the form

$$P(t) = a + bx^m + cx^m \cos(\omega \ln_q(x) + \phi) + dx^m \cos(2\omega \ln_q(x) + \phi),$$

where $x = t - t_c$ is the time distance from the critical time $t_c$ and $\ln_q x = \frac{x^{1-q} - 1}{1-q}$ is the q-logarithm defined in [3],[10].

To count for possible effects of the factors affecting our very specifics financial system, we empirically suggested

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in [12] q-sum or q-differences $x(t+\Delta t) \cong x(t) \oplus Dx$ for the

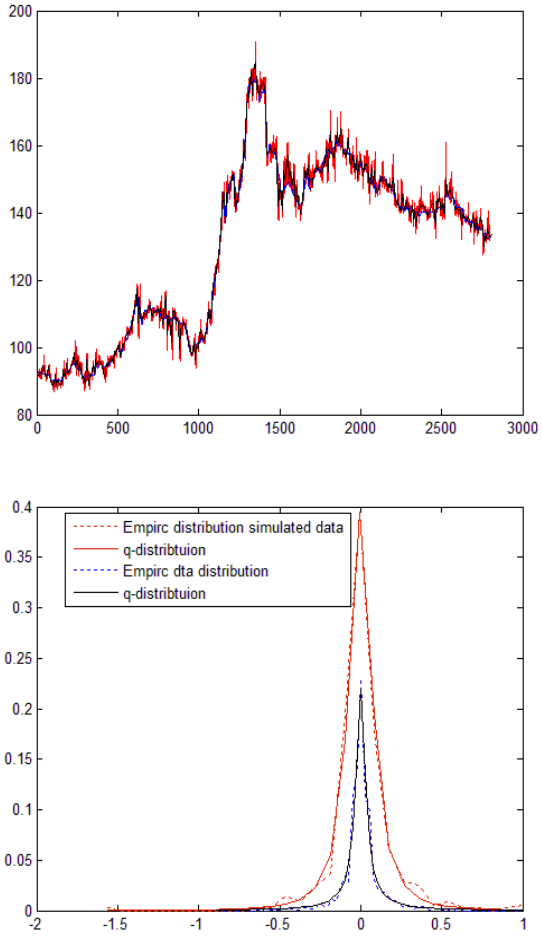


Fig. 3 Simulation of the exchange rate and its return distribution. Period 1995-2000.

some sense, the q-derivative based calculation gives less acceptable pattern. When applying q-formula we minimize the difference of generated values from the q-log-periodic envelope points computed previously. We compute $\Delta x = r * p$ and use $r = (p_{t+1} - p_t)/p_t$ as drawn from the q-distribution again evaluated beforehand. Simulations are performed for typically not tinny intervals (30 and 60-minute interval). In the series studied, we evidenced that in the case where log-periodicity is significant in the trend as read form the q-values of the $\ln_q$ that is found near to 1. The simulation using q-derivative produces a series that has more stable volatility compared to the original one (Fig2). If the distribution of the simulated-daily averaged return is less stable than the old one, we do not accept it as correct, and therefore, the assumed dynamics based on q-operation is rejected. This is based on the idea that having more data in a series the sum of q-distribution of the q-independent variable we expect that the q-Gaussian should be more stable. The provisions of q-CLT detailed in [10] calculation of the possible values around each real point. Here *Dx* is the simple derivative or Jackson derivative defined for example in [6], [7]. The calculation has been performed for series coming from the pure ore fuzzy DSI behavior and for different grade of stability. The first is estimated by the q-value found in the q-log-periodic approach, after a log-periodicity has been verified. We consider this verification by the ability to reproduce the critical time $t_c$ is such moment does exist in the empire evidence. The discussion of the log-periodic fit using residual analysis is very difficult as it includes many process and we restrict this observation in empiric arguments. Hence, in the period 1994-1995 this behavior is not apparent, whereas in the series starting from January 1996 to May 1997 a pure bubble behavior has been identified and a log-periodic approach reproduce correctly the critical time. Following discussion [3] ,[10] in general case, we estimated the distance from the best log-periodic trend identified using q-logarithm in the standard form, and by this estimation the value found at q~1.02 justified the near to pure log-periodic regime. In this case the simulation of the missing hourly value gives a series of exchange arte that have the returns more stabilized which is read form the q-Gaussian fitted. In this case we obtained q=2.14 whereas for the daily return for such period we obtain q=2.16. We obtained that if the system seems to be more stabilized in acknowledged q-Gaussian as the attractor of the distributions in this case, so, having more data means that direction in the stability language. In a previous analysis of a dynamics of the exchange rates in a financial crisis as it happened in 1997 in Albania, we observed that the best approach could be a q-log-periodic form, as proposed above and firstly introduced in [6]. We observe that the critical time, and cyclic frequency and other parameters will be known with better accuracy is we replace classical log-periodic form

$$P(t) = a + bx^m + cx^m \cos(\omega \ln(x) + \phi) + dx^m \cos(2\omega \ln(x) + \phi)$$

with our version of q-log-periodic when the logarithm is replaced with q-logarithm defined in [5]. The simulated series based on q-sum have produced more stable hourly exchange rates, as read from the respective $q_{stationary}$ parameters. We've considered a larger interval where a bubble and anti-bubble are likely to be present representing different regimes and therefore a strong change in the dynamics. We aim to test in this case the robustness features of such simulation for common series where many processes are present. This has the specific property of involving different regimes therefore consist in a third type series. In this case we observe that the simulation produced a less stable series of returns as read form the q-Gaussian fitted. We have q=2.14 for the simulated series whereas q=1.6 for original series (Fig. 3). Hence for such case we obtain a less stable return series,

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therefore the simulation is questionable or even not applicable. The tools of a based reject/acceptance of the simulation in this case have to be elaborated further on.

## 3. Conclusions

The use of q-derivative and q-functions could be a good alternative in the discussion of the dynamics for some specific time series. In the case of financial time series with very rare data point, it seems that the method could result in acceptable outcome for the periods where a log-periodic trend is characteristic. The q-simulation could be a good alternative in the situation where vary rare data are administrated a self-organization dynamics are present.

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