STATISTICAL ANALYSIS OF MONETARY POLICY INDICATORS VARIABILITY

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ABSTRACT: *This paper attempts to characterize through statistical indicators of statistical data that we have available. The purpose of this paper is to present statistical indicators, primary and secondary, simple and synthetic, which is frequently used for statistical characterization of statistical series. We can thus analyze central tendency, and data variability, form and concentration distributions package data using analytical tools in Microsoft Excel that enables automatic calculation of descriptive statistics using Data Analysis option from the Tools menu. We will also study the links which exist between statistical variables can be studied using two techniques, correlation and regression. From the analysis of monetary policy in the period 2003 - 2014 and information provided by the website of the National Bank of Romania (BNR) seems to be a certain tendency towards eccentricity and asymmetry of financial data series.*

KEY WORDS: *descriptive statistics, asymmetry, eccentricity, normal distribution, correlation, regression, Data Analysis.*

JEL CLASSIFICATIONS: *C10, C40, E52.*

1. INTRODUCTION

Starting from concepts and data describing trends in the evolution of monetary policy in Romania and permanent facilities were made some statistical conclusions on them. After identifying a heterogeneous set of variables selected were evaluated by descriptive statistics homogeneity asymmetry (skewness), vaulting (kurtosis) and normal distribution of data over the last 12 years.

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In this study we used three series of data on indicators of monetary policy, namely interest on monetary policy (IMP), interest lending facility (ILC) and the interest deposit facility (IDF).

Standing facilities (refinancing mechanism):

- Lending facility: a credit with a maturity afford a day at a predetermined interest rate. The central bank acts as lender of last resort;
- Deposit facility: Allows placement of an amount with a maturity of one day at a predetermined interest rate.

Interest rates on standing facilities granted by the BNR (deposit facility and credit facility) falls, since 1 April 2015 in a symmetrical corridor of ± 1.75 percentage points from the monetary policy rate.

Monetary policy rate is the interest rate used for the main central bank's money market operations.

2. DESCRIPTIVE STATISTICS

Most often, the information we are presented as numerical values stringing whose meaning is at first glance, encoded. For example, we find on the Internet, the site's central bank, central bank interest rates - monthly series over a period of several years. The sequencing of numbers in the first phase gives us information about the unit observed (point in time). If we want but overall information, the period of time or people observed sequencing data remains less conclusive. In this case, the question of extracting information from the data stream, which can be done through different ways of processing the data.

Data Representation graphs is done in order to transmit the same information already contained in the data stream in a more synthetic, with a stronger impression, allowing the overall emphasis of certain features.

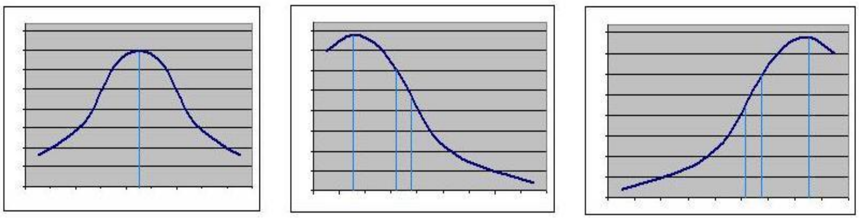
Digital processing of data comes with some additional information, revealing certain features of the phenomenon (e.g., media), which were not available directly from the data stream. Processing consists of calculating parameters which define summarizes overall data set, such as mean, median, modal, standard deviation, asymmetry, excess etc. (Craiu, 1998).

A more complete picture is obtained when the series calculate various parameters that describe a whole series of data.

We mention three groups of parameters i.e. parameters that describe the phenomenon of central tendency (mean, median, modal), or variation of parameters describing the values of the population deviation from the mean value (amplitude variation or dispersion, standard deviation) and parameters describing Statistical data distribution form (asymmetry, excess).

Asymmetry and eccentricity through their analytical indicators easily transpose the comparison between the position of core values, and typical central or confrontation between the distribution of a series of financial data and normal distribution capacity assessments expression mean to be a representative of the overall population analyzed statistical data.

The asymmetry (skewness) is intended to indicate to a number or extension data distribution asymmetry (deviation from symmetrical) and asymmetry direction (positive or negative) (Figure 1).



$\overline{x} = x_m = x_M$ Symmetrical distribution | $\overline{x} > x_m > x_M$ Positively-skew distribution | $\overline{x} < x_m < x_M$ Negatively-skew distribution

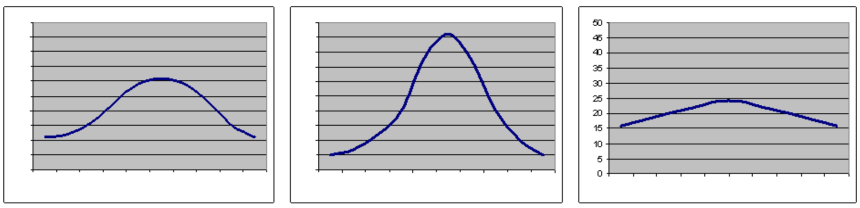
Figure 1. Distribution division and eccentricity symmetric positive, negative

Asymmetry either a positive or negative show how a series of unimodal frequency distribution is more (pronounced sense) or less (meaning moderate) oblique in relation to normal distribution of frequency Gauss - Laplace (visual assimilable a bell-shaped curve). Asymmetry indicator system comprises a variety of indicators of absolute asymmetry in the density distribution of a variety of frequencies and asymmetry coefficients (Pearson, Yule and Kendal, Bowley, Fisher etc.).

Asymmetry coefficients proposed by Carl Pearson resolve from absolute asymmetry, the problem of comparing the degree of skew in relation to normal distribution of frequency distributions expressed in different units of measure.

Kurtosis, in the language of statistics, it is a departure from the normal distribution, with respect to which there is a greater flattening (platykurtic distribution) or a higher elongation (leptokurtic distribution).

Eccentricity is manifested as platykurtic (flat) or as leptokurtic (sky) that shows the distribution of values is thinner or thicker (concentrate) around the central tendency than the normal distribution (Figure 2).



Mezokurtic Series | Leptokurtic Series | Platykurtic Series

Figure 2. Developments on the state of symmetry and asymmetry of specific data series

Frequently, in scientific research, occurring phenomena in which dominant partition law is normal distribution (Popescu, 2016; http://www.mec.upt.ro/). Support for this law is central limit theorem of probability theory. By virtue of this theorem amount a sufficiently large number of independent random variables

$$S_n = X_1 + X_2 + ... + X_n \quad (1)$$

tends to the limit by normal distribution, with media $m_k = E(X_k)$ and finished variations $V(X_k) = \sigma_k^2,\ k \in N^*$.

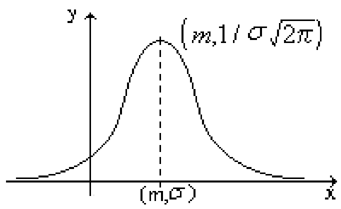


Figure 3. The density of the normal distribution curve

A continuous random variable follows a normal distribution (Figure 3) if it has the following probability density function (p.d.f.):

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-m)^2}{2\sigma^2}},\ x \in \mathrm{R},\ m \in \mathrm{R},\ \sigma > 0 \quad (2)$$

The probability density function (the cumulative distribution function) is given by:

$$P(x, m, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} \int_{x_1}^{x_2} e^{-\frac{(x-m)^2}{2\sigma^2}} dx = \int_{x_1}^{x_2} f(x)dx \quad (3)$$

The properties of normal distribution curves may be formulated:
- allow a maximum point $x = m$:

$$f(m) = \frac{1}{\sigma\sqrt{2\pi}} \quad (4)$$

and decreases asymptotically toward the *x*-axis to the left and to the right.

- are symmetrical to the corresponding ordered mean ($x = f(m)$ - the axis of symmetry);
- the bell-shaped with the convexity facing upward, in the area of the maximum point; curve has two inflection points located at $x = \pm\sigma$ a distance from the mean;
- ordered function is all the greater as the mean square deviation σ is less; if σ increase curves "flatten it" increasingly more to flattening (curves leptycurtiks).

The probability that the random variable continues to take values within the range $(-\infty,+\infty)$ is:

$$P(x<+\infty)=\frac{1}{\sigma\sqrt{2\pi}}\int_{-\infty}^{+\infty}e^{-\frac{(x-m)^2}{2\sigma^2}}dx=1 \tag{5}$$

i.e. $\forall\ x \in \mathrm{R},\ \exists\, P(x) \leq 1$.

The probability density $f(x)$ is continuous, non-negative and satisfies the condition:

$$\int_{-\infty}^{+\infty} f(x)dx=1=P(x) \tag{6}$$

To simplify the calculation function $P(x,m,\sigma)$ operation is performed to change the variable

$$z=\frac{x-m}{\sigma} \tag{7}$$

a normal random variable, of course.

With this notation, the normal distribution $N(m,\sigma)$ becomes $N(0,1)$. Normal probability density variable rules, in this case it can write:

$$f(z)=f(z,0,1)=\frac{1}{\sqrt{2\pi}}e^{-\frac{z^2}{2}} \tag{8}$$

and distribution function takes the form:

$$P\left(z<z_p\right)=\frac{1}{\sqrt{2\pi}}\int_{-¥}^{z_p}e^{-\frac{z^2}{2}}dz \tag{9}$$

The correlation coefficient resulting from the comparison between the IDC's column with column IMP is equal to approximately 0.96 . The correlation coefficient is close to 1, it follows that between the data of the two columns there is a significant correlation, i.e. they are more linearly relative to each other.

From the comparison between IDF column to IMP column and IDF column with the IDC column it is found that the correlation coefficients are statistically moderate (0.74, respectively 0.66). The most effective way to display the relationship between two quantitative variables, is a scatterplot. In a scatterplot the values of one variable appear on the horizontal axis, and the values of the other variable appear on the vertical axis. Each “case” - ordered pair of numbers - in the data appears as the point in the plot whose coordinates are the values of the variables for that “case”.

The correlation coefficient, *r*, shows the extent to which the variations of a variable are correlated with the variations of another variable. Simple linear correlation coefficient can take values between-1 and 1. Between -1 and 0, the connection between the two variables is of the opposite direction and is even more intense, as it draws to a close. Between 0 and 1, the connection between the two variables is direct and is more intense, the more it approaches 1.

The coefficient of determination, r^2, measures the proportion of the variance (fluctuation) of one variable that is predictable from the other variable. The coefficient of determination represents the percent of the data that is the closest to the line of best fit. The coefficient of determination is a measure of how well the regression line represents the data. If the regression line passes exactly through every point on the scatter plot, it would be able to explain all of the variation. The further the line is away from the points, the less it is able to explain.

Presentation of the link between two linear variables, when it exists, is called the method of linear regression (linear regression) (Anghelache & Anghel, 2015).

For this purpose it is considered one of the independent variable or variables as a predictor variable and the other variable as the dependent variable or variable response (outcome).

Linear link between the two variables is described by an equation linear regression equation (regression equation) which corresponds geometrically right regression (the regression line).

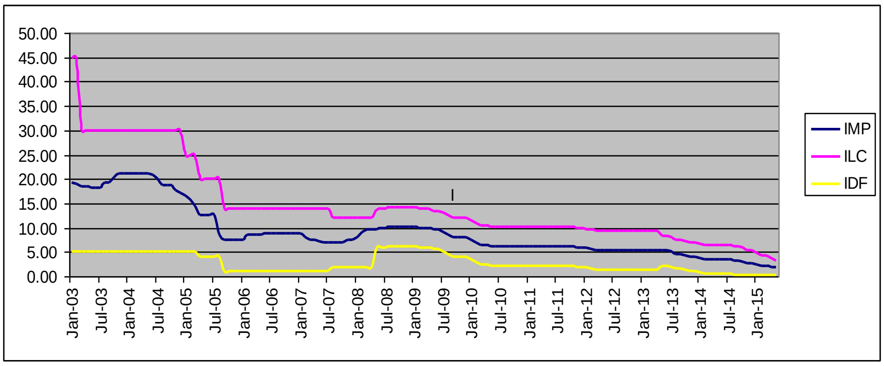
Regression,

$$y = a + bx \tag{10}$$

where a is called interceptor and b regression coefficient.

3. RESULTS

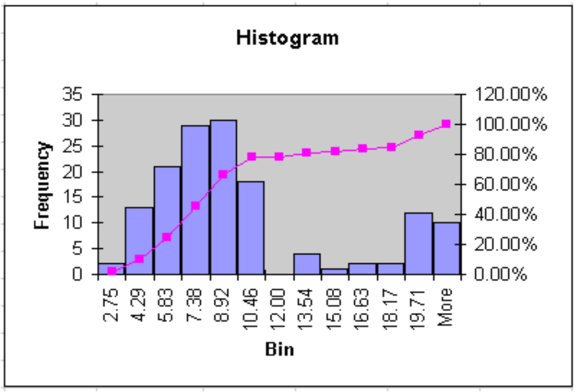
As an example of the specificity of financial data series was selected a range of data from the National Bank of Romania (BNR) and the specialized website BNR (http://www.bnr.ro/), between January 2003 and December 2014 (Figure 4).



Source: http://www.bnr.ro/Indicatori-de-politica-monetara-1744.aspx

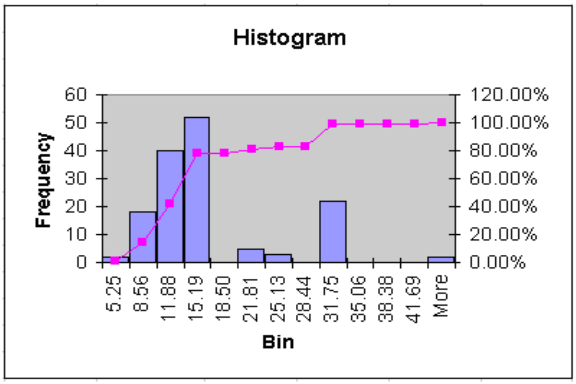
Figure 4. The evolution of monetary policy indicators in Romania between 2003-2014

Microsoft Excel enables automatic plotting of the histogram using the Data Analysis option from the Tools meniu (Figure 5).



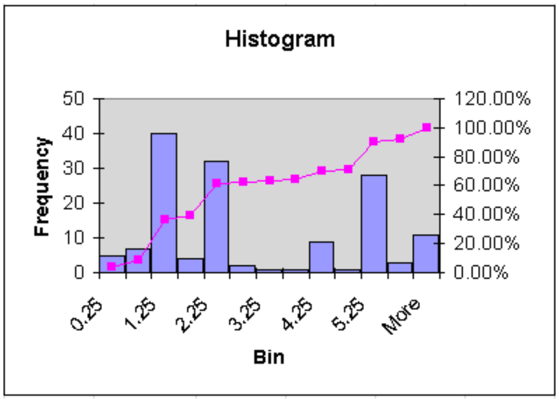
Bin	*Frequency*	*Cumulative %*
2.75	2	1.39%
4.29	13	10.42%
5.83	21	25.00%
7.38	29	45.14%
8.92	30	65.97%
10.46	18	78.47%
12.00	0	78.47%
13.54	4	81.25%
15.08	1	81.94%
16.63	2	83.33%
18.17	2	84.72%
19.71	12	93.06%
More	10	100.00%

Interest on monetary policy



Bin	*Frequency*	*Cumulative %*
5.25	2	1.39%
8.56	18	13.89%
11.88	40	41.67%
15.19	52	77.78%
18.50	0	77.78%
21.81	5	81.25%
25.13	3	83.33%
28.44	0	83.33%
31.75	22	98.61%
35.06	0	98.61%
38.38	0	98.61%
41.69	0	98.61%
More	2	100.00%

Interest lending facility



Bin	*Frequency*	*Cumulative %*
0.25	5	3.47%
0.75	7	8.33%
1.25	40	36.11%
1.75	4	38.89%
2.25	32	61.11%
2.75	2	62.50%
3.25	1	63.19%
3.75	1	63.89%
4.25	9	70.14%
4.75	1	70.83%
5.25	28	90.28%
5.75	3	92.36%
More	11	100.00%

Interest deposit facility

Figure 5. Histograms and descriptive statistics successive monetary policy indicators

It can be seen in the histograms (Figure 5) that the three indicators of monetary policy not have a normal distribution.

Microsoft Excel allows the automatic calculation of descriptive statistics using Data Analysis option from the Tools meniu (Popescu, 2016; Săvoiu, 2013).

Obtained automatically arithmetic mean, mode, median, variance etc. for the three sets of data submitted for analysis, monetary policy interest rate, interest rate lending facility and the deposit facility (Table 1).

Table 1. Descriptive statistics of monetary policy indicators (2003 2014)

Sample 2003 2014	IMP	ILC	IDF
Mean	9.27256944	14.97743056	2.779513889
Standard Error	0.43468411	0.688322481	0.156339747
Median	7.5	12	2.25
Mode	6.25	14	5
Standard Deviation	5.21620937	8.259869769	1.87607697
Sample Variance	27.2088402	68.2254486	3.519664797
Kurtosis	0.14828335	1.486997956	-1.276154746
Skewness	1.15532112	1.449151174	0.474363673
Range	18.5	39.75	6
Minimum	2.75	5.25	0.25
Maximum	21.25	45	6.25
Sum	1335.25	2156.75	400.25
Count	144	144	144
Largest(1)	21.25	45	6.25
Smallest(1)	2.75	5.25	0.25
Confidence Level(99.0%)	1.13480676	1.796966994	0.408147887

Software used MS Excel

From the table we conclude that the coefficient of vaulting / flattening both monetary policy and positive lending facility (series leptokurtic) and for deposit facility is negative (series platikurtic).

The coefficient of the asymmetry is positive and greater than one for the interest monetary policy and interest credit facility, which shows that series are significantly asymmetrical to the right and there is a distribution of the data to the left, and for the interest of the deposit facility of the asymmetry coefficient is also positive and close to zero, which shows that is moderately asymmetric series to the right, within the series predominantly lower values (mean> median).

In financial series time generates greater financial econometric modelling uncertainty because it enhances or degrades significantly correlations of data series in financial markets, as reflected in the correlation matrix applied to the data series of central bank interest rates (Table 2).

The dependence of both the ILC and the IMP and the IMP of the IDF and is positive: an increase in the growth of the IMP involves standing facilities, the ILC and the IDF. Regression lines have an uptrend, and dispersion diagrams indicate an increasing trend (Figure 6).

Table 2. Correlation matrix applied to the data series of central bank interest rates (1.01.2003-31.12.2014)

	IMP	ILC	IDF
IMP	1		
ILC	0.960957	1	
IDF	0.738284	0.662457	1

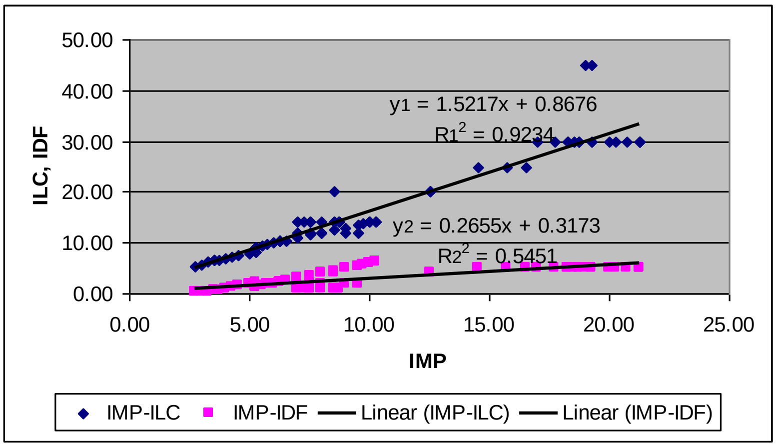


Figure 6. Correlation between IMP - ILC and IMP - IDF

The interpretation of coefficients of determination:
- r_1^2 = 0.9234 which means that 92% of the total variation in ILC, can be explained by the linear relationship between IMP and ILC (as described by the regression equation). The other 18% of the total variation in ILC remains unexplained.
- r_2^2 = 0.5451 which means that 55% of the total variation in IDF, can be explained by the linear relationship between IMP and IDF.

The coefficient of the variable *x* in the regression equation is interpreted as follows: y_1 for every increase in IMP (*x*) with a unit of measure (% p.a.), ILC (*y*) grow by 1.52 percentage points, while free-coefficient if the ILC would be equal to 0, the IMP would be equal to 0.87 percentage points.

The coefficient of the variable *x* in the regression equation y_2 is understood as follows: for every increase in IMP (*x*) with a unit of measure (% p.a.), IDF (*y*) increased by 0.27 percentage points, while free-coefficient if the IDF would be equal to 0, the IMP would be equal to 0.32 percentage points.

Assuming normal distributions of the three strings, each string individually, around the average $m_{DPM} = 9.27$ and dispersion $\sigma^2_{DPM} = 27.21$ for the interest of monetary policy, around the average $m_{DFC} = 14.98$ and the dispersion $\sigma^2_{DFC} = 68.23$ for the interest lending facility, around the average $m_{DFD} = 2.78$ and the dispersion $\sigma^2_{DFD} = 3.52$ for the interest rate deposit facility can calculated for each element in each row, the value density function of normal distribution, with the relation (8) applied to determine the point values:

$$f(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} \tag{11}$$

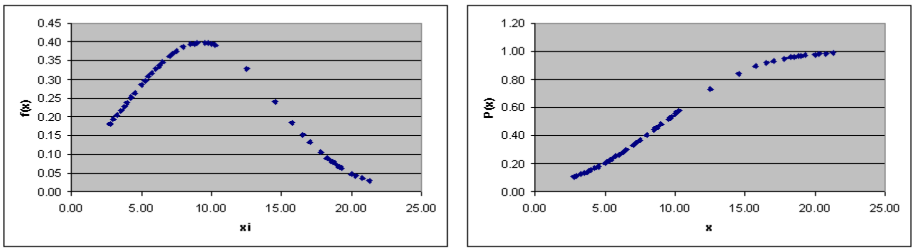
Figure 7 also shows the use of expression (11) and values fixed m and σ^2 and the function of the distribution of probability, calculated as a function of cumulative frequencies, $P(x)$.

The density of the distribution is calculated by writing function =1/SQRT(2 * PI()) * EXP(- ((x-mean) ^ 2/2/variance)), and the function of the distribution by applying instruction = NORMDIST(x, mean, variance, cumulative).

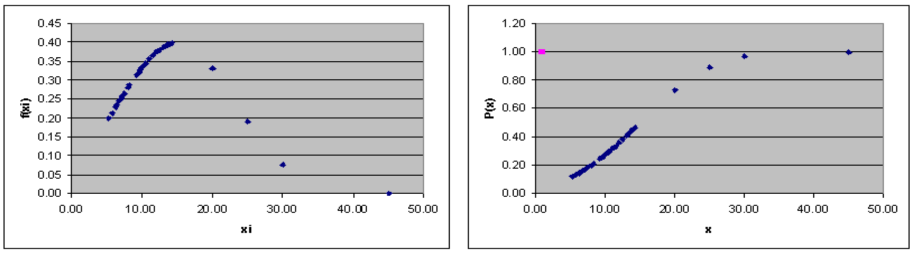
				f(x)	P(x)
Dec. 2014	2.75			0.18	0.11
Nov. 2014	2.75	*x*		0.18	0.11
Oct. 2014	3.00			0.19	0.11
Sep. 2014	3.25	Mean	9.27	0.20	0.12
Aug. 2014	3.25	Standard Error	0.43	0.20	0.12
Jul. 2014	3.50	Median	7.50	0.22	0.13
Jun. 2014	3.50	Mode	6.25	0.22	0.13
May. 2014	3.50	Standard Deviation	5.22	0.22	0.13
Apr. 2014	3.50	Sample Variance	27.21	0.22	0.13
Mar. 2014	3.50	Kurtosis	0.15	0.22	0.13
Feb. 2014	3.50	Skewness	1.16	0.22	0.13
Jan. 2014	3.75	Range	18.50	0.23	0.14
Dec. 2013	4.00	Minimum	2.75	0.24	0.16
Nov. 2013	4.00	Maximum	21.25	0.24	0.16
Oct. 2013	4.25	Sum	1335.25	0.25	0.17
Sep. 2013	4.50	Count	144.00	0.26	0.18
Aug. 2013	4.50	Largest(1)	21.25	0.26	0.18
Jul. 2013	5.00	Smallest(1)	2.75	0.29	0.21
Jun. 2013	5.25	Confidence Level(99.0%)	1.13	0.30	0.22

Figure 7. Sequence data sheet of the program with input and automated statistical analysis results

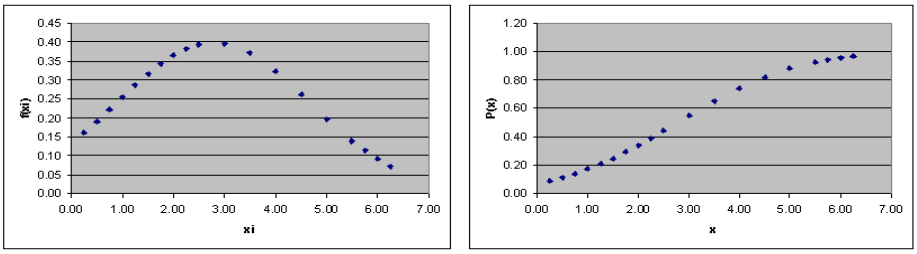
Using the data in columns $f(x)$ and $P(x)$ plot graphs of density distribution and the probability distribution function (Figure 8).



Interest on monetary policy



Interest lending facility



Interest deposit facility

Figure 8. Graphs density function of the distribution and of the function of the distribution of the probability

It can be seen in Figure 8, that both monetary policy, as well as the facility of credit follows a leptokurtic distribution, sharp, which shows that the data are very grouped together and close to the average (9.27, respectively 14.98), the batch database having a high degree of homogeneity of the values, and the deposit facility follows a platikurtic distribution, flat, which indicates a distribution in which the results are very scattered from the average (2.78) and indicates a high degree of heterogeneity of values.

4. CONCLUSIONS

The investigation descriptive statistics on the three series of financial data stresses that the asymmetry coefficients of interest rates on standing facilities granted by the central bank (BNR) (the deposit facility and credit facility) are almost symmetrical analyzed period January 2003 - December 2014, compared to asymmetry coefficient of monetary policy rates and credit facility is more arched than the deposit facility (owns a greater degree of eccentricity specific financial phenomena dominated by risks and uncertainty).

In leptokurtic distribution, the probability of an event is extremely high probability of occurrence of a normal distribution (and vice versa, in a leptokurtic distribution, the probability of an event is extremely lower probability of occurrence of a normal distribution). As a result, valuation models stock prices and yields can cause errors if we assume that their distribution is normal.

The correlation between the credit facility and the deposit will have a positive value if, on average, increase the value of the credit facility of the average it will cause increasing the amount of the deposit facility from its own medium, and subtracting the value of the credit facility from the average will determine, most of the times, subtracting the value of the deposit facility from her own medium. We say about these standing facilities that are correlated positive.

When the monetary authority down to the base rate, it stimulates interest for refinancing banks or requesting more loans. They are used for crediting the national economy and increasing money supply causes. In the opposite case, the increase in the base rate, the central bank "more expensive" credit, refinancing and reducing discouraging the practice of banks to lend economy potential.

In general empirical data series are slightly or moderately asymmetrical as proof that on certain days in the financial market has been no quotations for example higher or even very large or smaller, and very low in comparison with previous day (defining moderate or pronounced asymmetries positive and negative).

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