Asian Journal of Applied Sciences (ISSN: 2321 – 0893)
Volume 02 – Issue 06, December 2014

Forecasting Stability of the Stock and Credit Markets of Ukraine

Kostyantyn Stryzhychenko
Ukrain
Email: strizh {at} bk.ru

ABSTRACT— ***In the current work we analyze the stability of the development of Ukrainian financial market segments. The stability theory and non-linear analysis are the mathematical tools of the investigation. In the article we used three types of stability. There are Lagrange stabiilty, Poisson stability and Lyapunov stability. The stability indexes show unstable trajectories for the trend of stock and credit segments by Lagrange. Poisson stability recognizes stable cyclic components in the dynamic of credit market. Ukrainian financial market was analyzed as a single system by the Lyapuniov stability that shows sustainable trajectories of both segments. We constructed attractors of each segments and forecasting stability in each attractor by investigation of the localization points.***

Keywords— stability, financial market, index, trajectory, dynamics, attractor.

---

1. INTRODUCTION

The financial market characterized by globalization and integration processes. These processes increase random effects that lead to the crisis on the market. Last financial crisis demonstrate weakest sides of the regulation of financial market. From one hand, neoclassical paradigm based on the conditions that are not relate with modern economical situation [1, 2, 4, 7, 8, 11]. Thus, developing markets (like Ukrainian financial market) have only strategic investors in majority cases and a lot of entrance barriers into the market. Free and immediately access information is the second condition of neoclassical paradigm in financial market. But, in modern economy high quality information is costly object of the company safety. Also, only a lot people could influence onto the tendency of financial market in the old paradigm. But, as we can see, there are odiously powerful persons in the World. Their words can greatly change of the world financial tendencies.

R.Deeg (1999) considers that the global crises are not possible in the neoclassical paradigm and the local crises could only be for certain financial institutions [5]. A. Greenspun (2008) [8] declared failure neoclassical paradigm in the summer of 2007 after the collapse of the «Lehman Brothers» company Thus, the core of neoclassical - stability and efficiency of markets haves allocated the wrong channel policies in the financial markets and led to the emergence of a global devastating crisis.

As noted by Stiglitz (2010) [15], a paradigm shift is not an easy process because the old paradigm invested a lot of effort. The main advantage in the formation of a new paradigm is no need to immediately specify all key components paradigm. Specification of concepts is in the process of adapting to the new paradigm of economic conditions. The main conditions for the formation of a new paradigm are the globalization and integration processes in the economy and society.

From the other hand, Schumpeter (1934), Grainer (1972) and others point to the inevitable evolution of financial, organizational and social structures [10, 14]. According to the Grainer's theory about evolution and revolution [10] the last phase of the evolution is relation with the crisis of bureaucracy and regulation. The last events in 2006-2010 years show lack of coordination and cooperation between structural elements in EU and USA.

Therefore, the stability of the financial market is the global aim in the regulation of the world economy. The main idea of this article is an investigation of stability of the development of Ukrainian financial market. This idea decomposes on the following task

i) Investigation tendencies of financial market segments;

ii) Components analysis of dynamics onto the financial market segments;

iii) Determination of financial market stability and its measurement

iv) Forecasting stability of the segments by the different components.

We constructed methodology to solve these tasks.

2. METHODOLOGY

The methodology of investigation includes four main units (fig. 1).

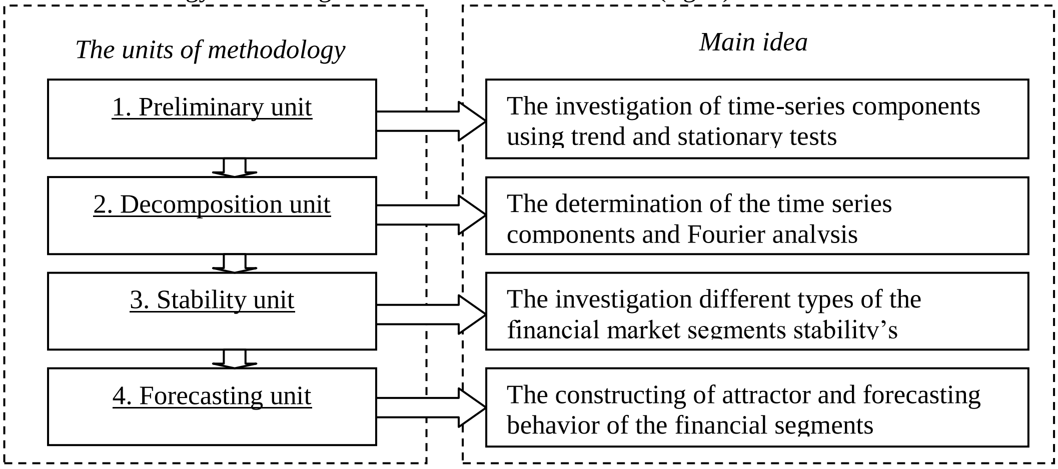


Figure 1. Methodology of stability's investigation of financial market segments

2.1. Preliminary unit.

The special tests for analysis of the stationarity are: Dickey-Fuller test (DF), Augmented Dickey-Fuller test (ADF) and Phillip-Peron test (PP). In this investigation we used the Augmented Dickey-Fuller test. The test is carried out by the estimation of the equation with y_{t-1} subtracted from both sides of this equation:

$$\Delta y_t = \mu + \gamma y_{t-1} + \varepsilon_t \tag{1}$$

where μ, γ are the parameters of the model ($\gamma = 1 - \rho$); ε_t is assumed to be white noise.

The null and alternative hypotheses are:

$$\begin{aligned} H_0 &: \gamma = 0 \\ H_1 &: \gamma < 0 \end{aligned} \tag{2}$$

While it may appear that the test can be carried out by performing a t-test on the estimated γ, the *t*-statistic under the null hypothesis of a unit root does not have the conventional distribution. Dickey and Fuller (1979) showed that the distribution under the null hypothesis is nonstandard, and simulated the critical values for selected sample size [6]. More recently, MacKinnon (1991) has implemented a much larger set of simulations than those tabulated by Dickey and Fuller [12]. The null hypothesis of a unit root is rejected against the one-sided alternative if the *t*-statistic less than a critical value

2.*2. Decomposition unit.*

After checking the stationarity of the initial time series by using the spectral analysis –the Fourier decomposition – we compose the cyclic component models. The algorithm for the search of these models is given in Fig.2.

In this case the cyclic component is the composition of different cycles, which can be presented as:

$$C(t) = \sum_k a_k \cos\left[\frac{2\pi}{T_k}(t-1)\right] + \sum_k b_k \sin\left[\frac{2\pi}{T_k}(t-1)\right] \tag{3}$$

Where a_k, b_k – Fourier coefficient; T_k – Period of *k* harmonic.

The quantity of harmonics is to be determined via the statistical significance of each harmonic. Thus the Fourier series involves the significant harmonics.

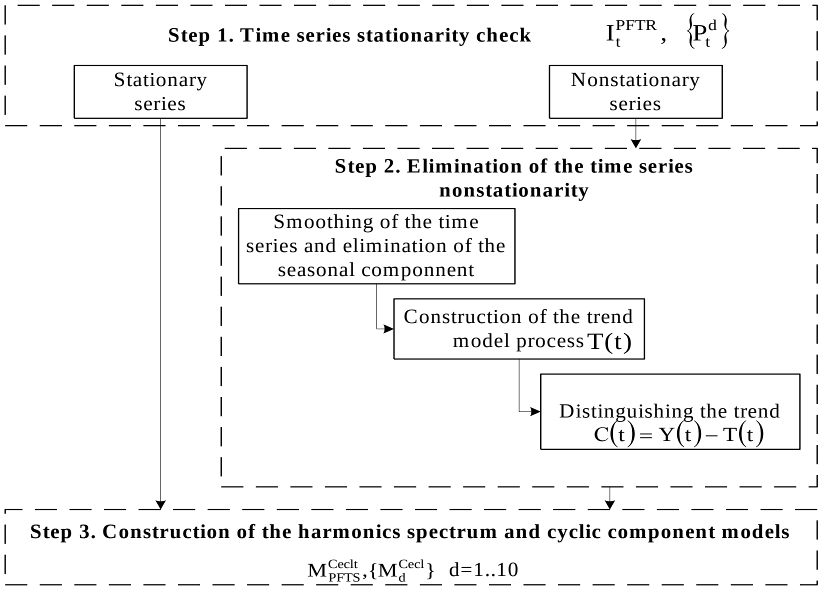


Figure 2. Algorithm for the composition the cyclic component models

2.3. Stability unit.

In this unit we used three main approaches for the stability: Lagrange stability, Poisson stability and Lyapunov stability.

Lagrange stability.

The trajectory $x(t)$ that goes from the initial state x_0 and for all time periods is to some closed area of phase space, which is characterized by constant R is called sustainable trajectory by Lagrange (fig. 3):

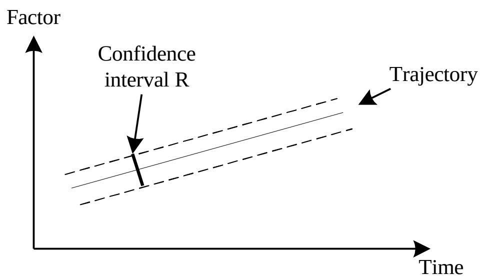


Figure 3. The sustainable Lagrange trajectory

$$\|x(t)\| < R, \ \|x(t)\| = \sqrt{x_1^2 + x_2^2 + \ldots x_N^2} \qquad (4)$$

where $x(t)$ - investigation trajectory; R - phase space characteristics $x_1, x_2, \ldots, x_N$ - points of the N-dimensional space of trajectory.

Financial market's segments (stock or credit segment) are sustainable by Lagrange in condition that the index of business activity has sustainable trajectory by Lagrange.

Poisson stability

The trajectory $x(t)$ that goes from the initial point x_0 is sustainable by Poisson if each point of the trajectory includes into the two sets: Ωx, $\mathrm{A}x$:

$$x(t) \in \{\Omega x \cap \mathrm{A}x\} \qquad (5)$$

where ω - limit points of phase trajectory $x(t)$ with following conditions $\lim x(t_k) \to y$ if $t_k \to \infty$; α - limit points of phase trajectory $x(t)$ with following conditions $\lim x(t_k) \to z$ if $t_k \to -\infty$

From other words, the trajectory $x(t)$ is sustainable by Poisson if it is recurring to the confidential area (ε) of a point G (Poincare recurrence [19]). The various types of Poisson stability depend from Poincare recurrence. There are periodically stability, quasi-periodical stability, chaotic stability (random stability) (fig. 4).

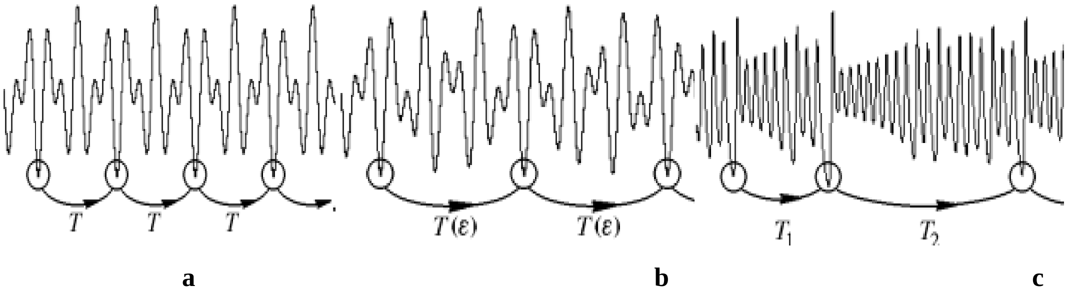


Figure 4. The three types of Poisson stability

The interrelation between recurrence and time determine the type of stability (fig. 5)

Lyapunov Stability.

The trajectory is sustainable by *Lyapunov* if there is another trajectory $y(t)$ that goes from y_0 and close to the trajectory $x(t)$ at any time (point y_0 is close to point x_0).

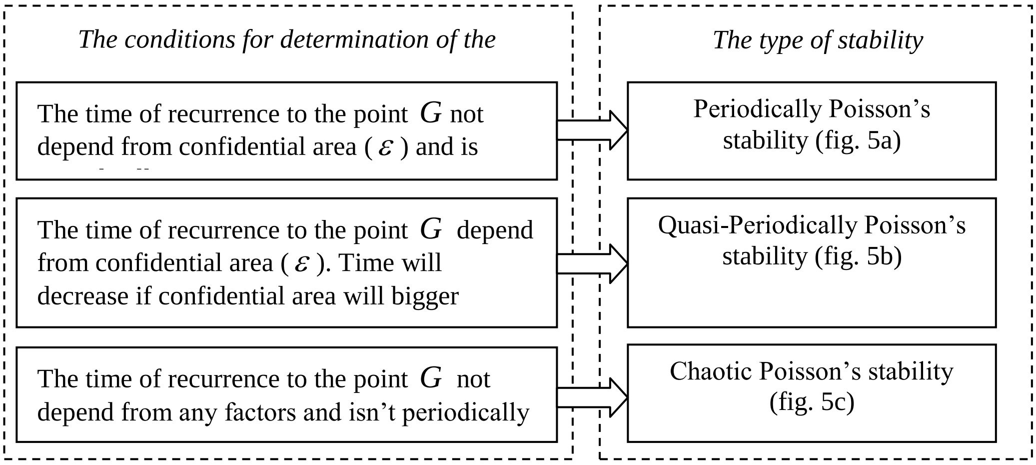


Figure 5. The determination of Poisson stability type

The stability has two main kinds; there are classical stability and asymptotical stability.

Classical stability for the trajectory determined following equation:

$$\|x(t) - y(t)\| < \varepsilon \text{, if } \|x_0 - y_0\| < \delta \tag{6}$$

Asymptotical stability is

$$\lim_{t \to \infty} \|x(t) - y(t)\| = 0 \text{, при } \|x_0 - y_0\| < \delta \tag{7}$$

The main idea of the Lyapunov stability in the financial market investigation is determine of stability of the interrelation between financial market's segments.

2.4 Forecasting unit.

Forecasting's unit solves following task:

1) Constructing of the attractor of financial segments for the determination of sustainable areas;

2) Computation of the correlation integral for the investigation of complexity of the behavior of the stock and credit segments

The unit has two blocks, there are choice of the lag time and attractor and investigation of the correlation integral

Choice of the lag time and attractor.

We used the autocorrelation function for the solve of this task in the paper that has following formula

$$B(\tau)=\frac{1}{m}\sum_{i=0}^{m-1}\left(x_{i,j}-\bar{x}\right)\left(x_{i,j+\tau}-\bar{x}\right) \tag{8}$$

The lag time has condition of minimum of the correlation between $x_{i,j}$, $x_{i,j+\tau}$ The disadvantage of this method is sensitive to noise. The simply attractor is constructed into the two dimension coordinate system $(x(t);\, x(t+\tau))$.

Investigation of the correlation integral

The correlation integral and dimension of the phase space are an important characteristics of the phase trajectory. The correlation integral is:

$$C(r)=\frac{1}{N^2}\sum\theta(x)\left(r-\rho(x_i,x_j)\right) \tag{9}$$

Where $\rho(x_i, x_j)$ – the distance between points; $\theta(x)$ – Heaviside function; r – limit value; N – observations.

3. RESULTS

3.1. Preliminary unit

We use two main indexes of the business activity of financial market segments – PFTS index for the stock market and KievPrime Index for the credit market. Their dynamics we can see on a fig. 6.

These date show us about trend and cyclic components in time series of indexes. ADF – test used for the diagnostic of the time series stationary. The results of ADF test is in table 1.

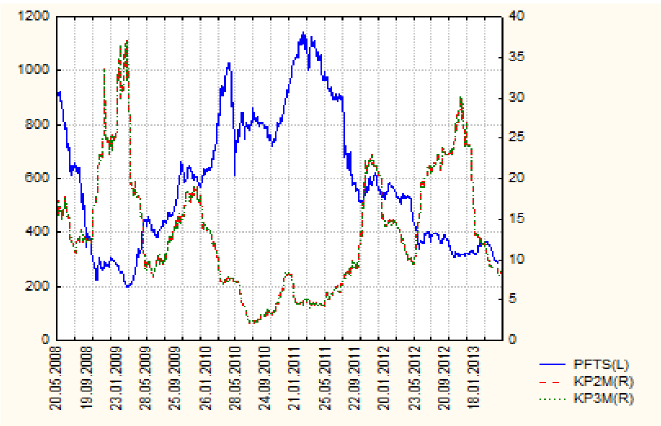


Figure 6. The dynamics of PFTS and KievPrime indexes

Table 1. Results of ADF test

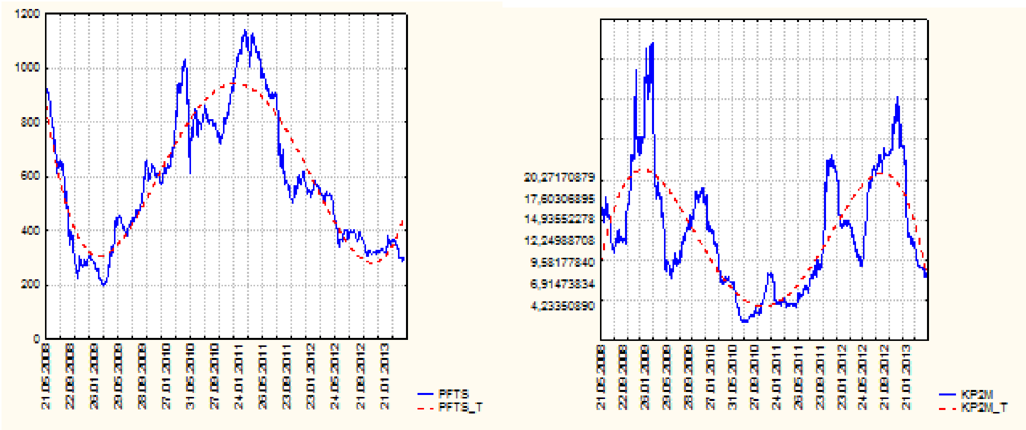
Time series (y_t)	Lag	Test equation					
		None		Intercept		Trend and intercept	
		y_t	Δy_t	y_t	Δy_t	y_t	Δy_t
PFTS	3	1.97	-4.40^{***}	1.10	-4.72^{***}	-0.99	-5.36^{***}
	4	0.81	-3.67^{***}	-0.49	-3.84^{***}	-3.16^{*}	-3.99^{**}
KP3M	3	0,98	-4.51^{***}	1,01	-4.52^{***}	1,05	-4.80^{***}
	4	0,99	-4.51^{***}	1,01	-4.52^{***}	1,05	-4.82^{***}

This test shows that all series is nonstationary, therefore need elimination trend from these series.

3.2. Decomposition unit

The decomposition of the time series of financial segments indexes starts from the elimination of trend component. We propose the hypothesis about polynomial trends by the analysis of indexes dynamics: $Y(t) = a_0 + a_1 \cdot t + a_2 \cdot t^2 + \ldots + a_n \cdot t^n$ ($a_0, a_1, a_2, \ldots, a_n$)– parameters of models

This trends show on fig. 7 and its parameters is in table 2.



a) PFTS index b) KievPrime2M index

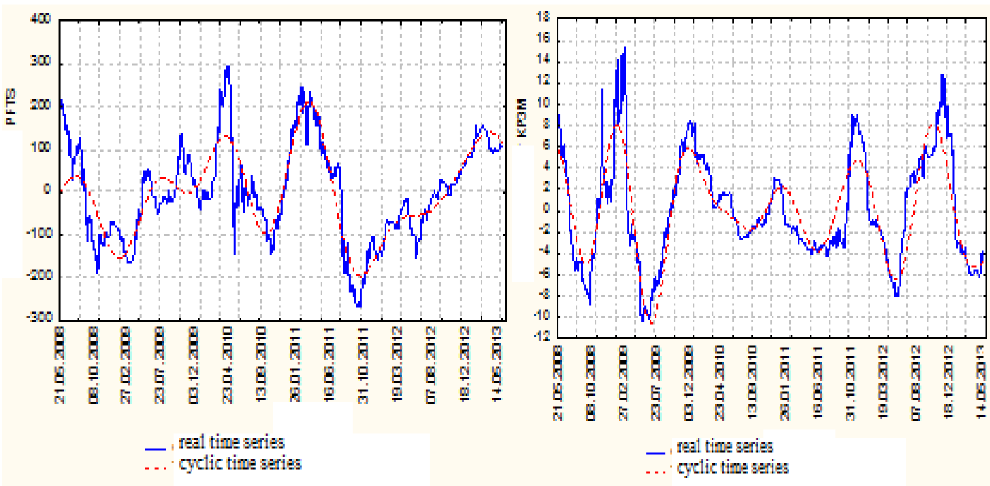
Figure 7. The trends onto the stock and credit segments

Table 2. Trend parameters

	a0	a1	a2	a3	a4	a5	Correlation coefficient
PFTS	742,55	-4,8789	0,0193075	-0,0000230385	0,00000000835	*	0,86
KP3M	6,64	0,251343	-0,001274	0,00000223946	-0,0000000016	0,00000000000041	0,77

The results of the trend parameters calculation show statistically significance of all parameters.

Next step of the decomposition is analysis of the cyclic component under the Fourier analysis. The compositions of these harmonics are showed on a fig. 8



a) PFTS index b) KievPrime2M index

Figure 8. Cyclic components of indexes

MAPE criteria uses for the analysis of adequacy of the cyclic models. Therefore, MAPE for PFTS index is 0.89, MAPE for KievPrime index is 0.94.

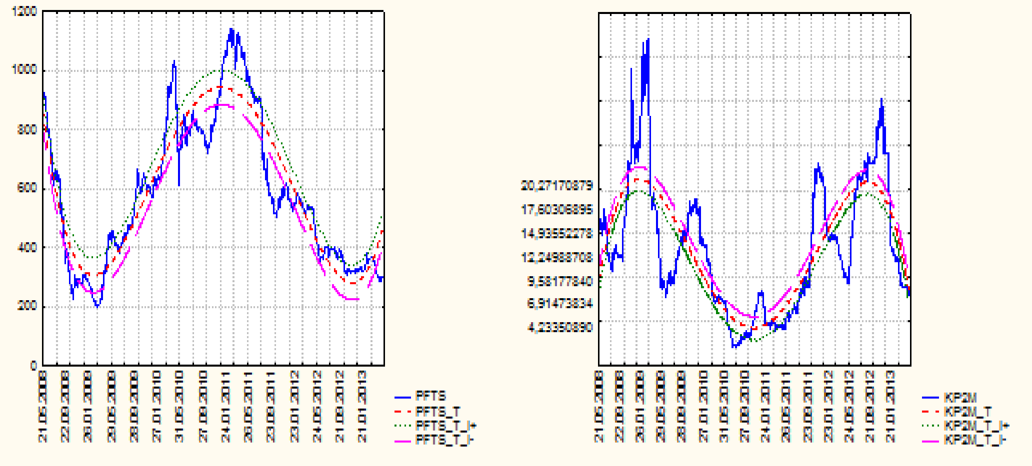
3.3. Stability unit.

The first step of the disquisition of Lagrange stability is determining constant R that shows confidence interval of trend variance. Usually, researchers use three confidence levels (1%, 5% and 10% significance levels). In this paper, we use verbal triangular space. In this case we determine three verbal levels of stability, there are high stability level ($R = 0{,}01 \cdot \bar{x}$), average stability level ($R = 0{,}05 \cdot \bar{x}$) and low stability level ($R = 0{,}1 \cdot \bar{x}$). Time series of PFTS and KievPrime Indexes have following confidence constant $R_{pfts} = 58{,}8$, $R_{kp2m} = 1{,}35$. The confidence intervals for these time series are showed on a fig. 9.

We use stability indicator for the investigation of stability level. This indicator is similar as correlation coefficient and shows the observations that relate to the confidence interval (table 3)

Table 3. Stability indicator and stability level

Financial segments	Stability indicator			Verbal stability
	High value	Average value	Low value	
Stock market	0,04	0,2	0,36	Unsustainable
Credit market	0,03	0,09	0,16	Unsustainable



a) PFTS index b) KievPrime2M index

Figure 9. The confidence intervals with trend

Therefore, credit market is more unsustainable then stock market by all stability indicators.

The analysis of Poisson stability requests time series without trend.

Each time series consist of trend, cyclic and irregular components. Therefore, cyclic component is main component for the analysis of Poisson stability. Each cyclic component could be decomposed on local harmonics (Fourier spectral analysis). Cyclic components will have Poisson stability if each harmonic will have Poisson stability.

By the rule of spectral analysis, optimal quantity of harmonics that compose into the cyclic components is seven. From the other hand, quality of composition must be more than 80%. If this quality is less than 80% then quantity of harmonics must be increase. The quality analysis shows that composition of seven harmonics give 72% quality for stock market and 87% for quality for credit market

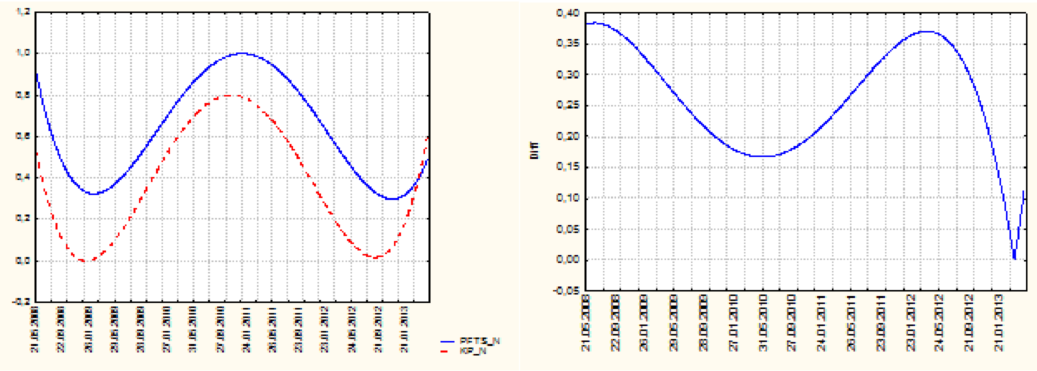
Therefore, we can make conclude that credit market is sustainable but stock market is unsustainable by Poisson stability.

Lyapunov stability analysis requests one scope (from 0 till 1) for the different trajectories. Normalized trajectories and module of them show on fig. 10

As we can see, module trajectory strives to 0, therefore the system of stock and credit segments is sustainable. Stability analysis results are in table 4.

Table 4. Stability analysis results

Segment	Stability		
	Lagrange	Poisson	Lyapunov
Stock market	Unsustainable	Unsustainable	Sustainable
Credit market	Unsustainable	Sustainable	



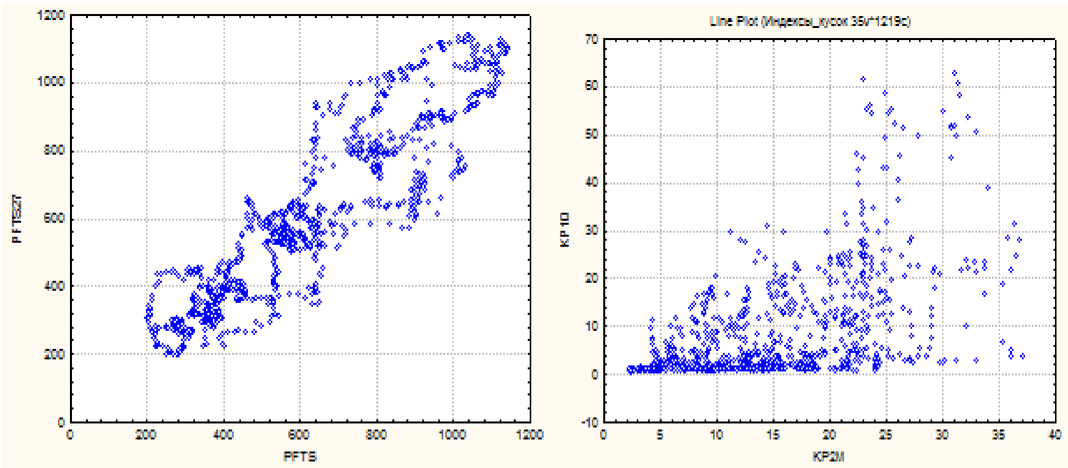
a) Normalized trajectories b) Module of differences

Figure 10. Lyapunov stability analysis

3.4. Forecasting unit.

Investigation of the lag time of the credit and stock segments shows that we have following lag times: $\tau_1 = 27$ $\tau_2 = 10$ (where "1" - stock segment; "2" - credit segment). These times related with following reasons: firstly, stock's time is determined by reports of enterprises, secondary, credit's time depends from credit deadline (usually credit deadline is 10th or 25th days of month)

The attractors of stock and credit markets into two dimension coordinate space $(x(t); x(t+\tau))$ are on fig. 11



a) PFTS index b) KievPrime2M index

Figure 11. The attractors of stock and credit markets

We have following results of the analysis:

i) Stock market attractor viewed like defined area. In this case, the investigation trajectory could reach the attractor and it is stable Lagrange trajectory;

ii) The attractor has three points of localization that indicate the three zones of attraction in phase space. This zone show three time series components.

iii) The credit market attractor characterized large crowded the points at zero of vertical axis and their expansion at increasing values on the horizontal axis. This indicates the presence of a large number of random noise and complexity to achieve the attractor.

The correlation integral shows how many factors influence onto the dynamic of the development of financial market segments (fig. 12).

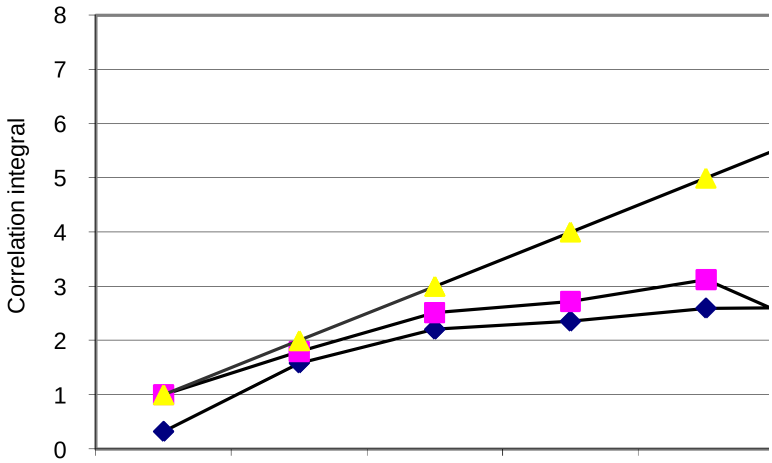


Figure 12. Correlation integral and phase trajectory

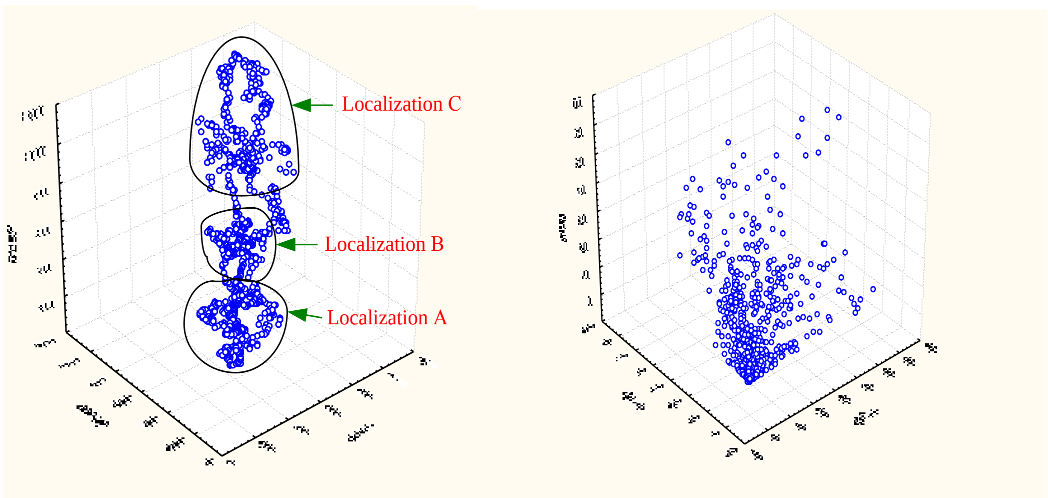
We have following results based on the analysis of the correlation integral

i) Correlation integral of PFTS index is more than correlation integral of KievPrime index. Therefore stock market has more complexity structure than credit market.

ii) Each segment has strong irregular processes because correlation integral increase with increasing of fractal dimension.

iii)) Fractal dimensions is equal to three. Therefore, we have one external factor that influences onto the dynamic. The factor could be the dynamic of the other segment of financial market.

We will construct attractors in three dimension coordinate space $(x(t); x(t+\tau); x(t+2\tau))$ based on the fractal dimension (fig. 13).



a) PFTS index b) KievPrime2M index

Figure 13. The attractors in the three dimension space

In the stock market we have three localizations (A, B, C).

i) Localization A characterizes average gatherings points and low values of the PFTS index. This localization suggests that low values of the trajectory have small cyclic or random fluctuations.

ii) Localization B has most crowded points and typical for the average values of the PFTS index. Therefore this trajectory is most stability trajectory if stock market.

iii) In localization C, we can look high values of the index which have more random effects.

Thus, localization of A and B as the most stable location and could use for the future investigation

5. CONCLUSION

Thus, we have following main results in this article:

1) We offered approach for the diagnostic of the three types of the financial market stability because that it is main purpose of the development of financial market. Each stability estimates different components of the time-series. So, Lagrange stability used for the trend stability analysis. Poisons stability investigates cyclic development of the financial market. Lyapunov stability helps for making decision about global financial market stability.

2) Analysis of the stability of the financial market and its segments in three main areas showed that each of the segments in the general form is unstable. But the trend in the stock market component close to stable. Also, cyclic component in the credit is stable by Poison stability.

3) The analysis of Ukrainian financial market as a single system by the Lyapuniov stability shows that both trajectories of the credit and stock segments are close to each other. Therefore, Ukrainian financial market is sustainable.

4) For the forecasting of stability of financial segments, we used non-linear analysis that recognizes two types of attractors. The attractor of stock market has three localizations. Two of them reflect the stability of the development of stock market when PFTS index has low and average values. The credit market attractor has random component that shows unstable situation on the credit market. The calculation of phase dimension indicating that the trajectory of every market is under influenced one main external factor. This factor is dynamics of one of the segments.

6. REFERENCES

1 Allen L. White. (2011) Economy Reset: Principles of a New Economy.
2 Black, W. (2010), “Neo-classical economic theories, methodology and praxis optimize criminogenic environments and produce recurrent, intensifying crises”, Creighton Law Review, May 13, 2010
3 Bernanke, B. (2002a), “Asset-price ‘bubbles’ and monetary policy”, speech delivered at the New York Chapter of the National Association for Business Economics, New York, October 15, 2002
4 Bezemer, D. (2009), “No one saw this coming: understanding financial crisis through accounting models”, Munich Personal RePEc Archive
5 Deeg, R. (1999), Finance Capitalism Unveiled: Banks and the German Political Economy, Michigan, University of Michigan
6 Dickey, D.A. and W.A. Fuller (1979) “Distribution of the Estimators for Autoregressive Time Series with a Unit Root,” Journal of the American Statistical Association, 74, 427–431
7 Fullbrook, E. (2010), “How to bring economics into the 3rd millennium by 2020”, Real- World Economic Review, Issue 54, pp. 89-102
8 Greenspan, A. (2008), Testimony of Dr Alan Greenspan to the Committee of Government Oversight and Reform, October 23, 2008
9 Greenspan, A. (2002), “Economic volatility”, speech delivered at a symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, August 30, 2002
10 Greiner L (1972). “Evolution and Revolution as Organizations Grow”, Harvard Business Review
11 Kresse J (2011). It’s Time For A New Economic Paradigm.
12 MacKinnon, J.G. (1991) “Critical Values for Cointegration Tests,” Chapter 13 in Long-run Economic Relationships: Readings in Cointegration, edited by R.F.Engle and C.W.J. Granger, Oxford University Press.
13 Rayevnyeva O., Stryzhychenko K. (2012) Investigation of the Wave Nature of the Ukrainian Stock Market", IJISA, vol.4, no.1, pp.1-10.
14 Schumpeter, J. (1934), The theory of economic development, 14th Printing, Transaction Publishers, New Brunswick
15 Stiglitz, J. (2010), “Needed: a new economic paradigm”, Financial Times, August 19, 2010
16 Schulman, L. S. (1978). "Note on the quantum recurrence theorem". *Phys. Rev.* **A 18** (5): 2379–2380
17 Stryzhychenko K (2009). Analysis of influence of Russian Stock Market into Ukrainian stock market/ Financial Market Principles of modeling, forecasting and Decision-Making. Lodz Unsversity Press, Lodz.