ON SO-CALLED "RANDOM WALK THEORY" AT THE GLOBAL FX MARKET

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Abstract. *This paper presents a numerical disproof for one of the well known "theories" of global financial markets such as "random walk theory". We had processed both tick and daily FX quotation records giving preference to number-theoretical approaches in opposite to the econometrical ones and, then, dealt with logarithmical modification of so-called binormalized randomness parameter S, the invariant of Russian academician V.I.Arnold, to estimate real "randomness" of both FX in general and some other assets of a special interest like precious metals (Au, Ag, Pt, Pd) and commodities (Brent Crude Oil, WTI). As known, that S tends to the two asymptotically for random configurations in question and to the one or infinity, otherwise. Once FX daily and intraday records since 1968 are processed, currencies' randomness rating is done with putting S into the order, one may conclude that "random walk theory" of the FX is false and must be declined. Strategically, it means that a floating rate ideology of 1968 is failed.*

Keywords: *financial markets; binormalized randomness parameter of Arnold; Kolmogorov theorem; Smirnov test; FX currencies' and precious metals' randomness rating.*

Introduction

Export of global risks and crises in recent years grows like an avalanche. The dark side effects of fatal volume of speculative transactions at the financial markets are almost impossible to be estimated in general. Forecasting of forthcoming financial turbulence, analysis of ongoing crisis, as well, is getting to be an essential geopolitical and social challenge. Solving such a problem, we have to identify and clarify all the mistakes done with local monetary authorities last decades, and no doubt then, to revise and decline some false economical theories as a primary source for such errors. This paper presents a recent result of unbiased test for one of such "theories" done by means of independent FX, global and local, and precious metals data series processing.

Data series

We have deal with official sources of the global and local financial markets OHLC data – global currencies as of 12:00 EST from FED, Central Bank of Russia (2014) official daily rates of RUB with respect to USD and EUR, London PM fixing rates of precious metals from LBMA (2014) and LPPM (2014). This collection consists of about 230000 records for daily FX and, approximately, of 100000 daily records for metals (gold, silver etc.) and commodities (Brent Crude) since 1968 by now. Also, we processed 51815 ticks of Russian ruble's devaluation show of 16 Dec'14 (FINAM, 2014) in attempt to get a real randomness.

Types of variables

In sufficient contrast with huge amount of econometrical methods and tools known for to confirm random walk theory of the asset rate dynamics at the global financial market, say as FX, we decided to apply here some another scheme either to prove or to disprove this hypothesis given. First, we have to introduce time series of variables to be analyzed.

Quotations as integers

Let us consider a subset of major currencies at global FX market quoting with unit step in bid-ask rates, and let time series p_t^k be the reference rates for asset k of trading date t (Federal Reserve, 2015). If we take only, say, 4 significant digits of these datasets, taking in mind our goal to test the randomness, we should expect a higher chance to get the real chaos in rate series which should follow a uniform distribution of p_t expected for distribution of integers at the circle of length 10^4. So, let $p_t^* = \{0000, 0001, \dots, 9999\} \in N$ be such modified time series of integer quotations and we consider now integer sequences with a set of corresponding arcs of different lengths at unit circle. In some special cases JPY, KRW, RUB we have two representations in points of price, i.e. USDRUB=57.6125 represents as both 6125 and 76125 depending of the sample volume with respect to 10^4, as well as USDJPY=365.57 transforms into 5570 or 6557, not into 5700, due to FX specifications.

General population of general populations

For every $k \in \{\text{USD}, \text{AUD}, \text{EUR}, \text{GBP}, \text{JPY}\}$ we put p_t^k into the order and, then, arrange general populations for assets of k with respect to each other and consider new variables

$r_k = 100\left(\frac{p_{t+1}^k}{p_t^k} - 1\right)$, if $k \in \{\text{USD}, \text{JPY}\}$ and

$r_k = 100\left(\frac{1/p_{t+1}^k}{1/p_t^k} - 1\right)$, if $k \in \{\text{AUD}, \text{EUR}, \text{GBP}\}$.

Merging general populations together, we arrange new joint population of the daily rates of return for assets of k and may apply necessary tools for the randomness estimation.

Quotations as logarithmical measure of FX

The third set of parameters is a set of the natural logarithms of the currencies (precious metals etc.) for official spot quotations which are ordered with respect to the US dollar, with USD itself included, namely *ln(USD), ln(Au), ln(JPY),..., ln(RUB).*

Notations *Au*=XAUUSD, *RUB*=USDRUB, *JPY*=USDJPY *etc.* follow FX codes for financial instruments. USD self-quotation in a form of distance in R^1 is as follows

$$d(USD,USD)=\ln(USD)-\ln(USD)=\ln 1=0.$$

We consider that origin as a service for putting assets into the order by their mutual distance in R^1. Cross-rate of GBPJPY, say, may be presented, thus, as usual sum in R^1

$$d(GBP,JPY)=\ln(JPY)-\ln(GBP)=[\ln(JPY)-\ln(USD)]+[\ln(USD)-\ln(GBP)]= d(GBP,USD)+d(USD,JPY).$$

With normalizing of an obvious equation for $x_i \in \{\text{USD}, \text{AUD}, \text{EUR}, \text{GBP}, \text{JPY}\}$

$$\sum_{\substack{i,j=1 \\ j \geq i}}^{N} d(x_i, x_j) = d(x_1, x_N),$$

we come to a set of new independent variables over the unit interval

$$d_{ij} = \frac{d(x_i, x_j)}{d(x_1, x_N)} \in [0,1].$$

With Figure 1–3 we have illustrated all the three of our transformations to be discussed.

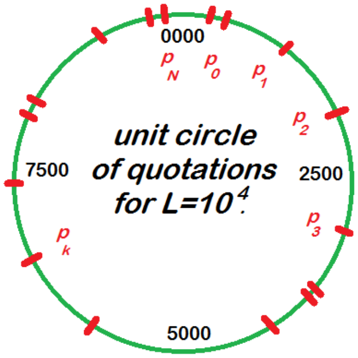

Figure 1. Unit circle of integers as the FX quotations $p_t^* = \{\mathbf{0000}, \mathbf{0001}, \dots, \mathbf{9999}\} \in N$

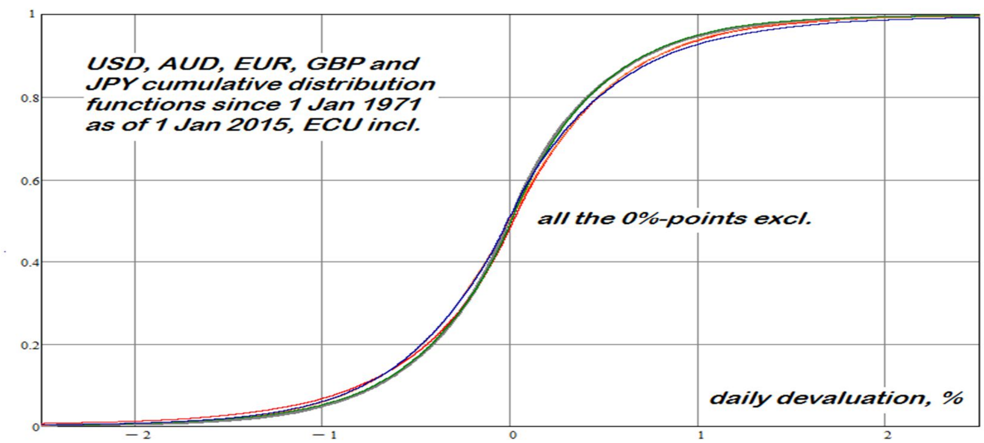

Figure 2. Cumulative distribution functions of r_k, $k \in \{USD, AUD, EUR, GBP, JPY\}$

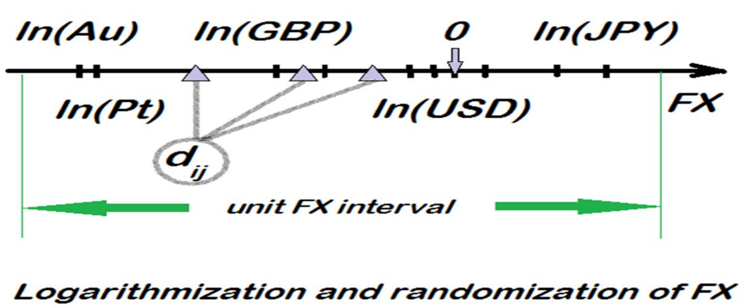

Figure 3. Scheme of putting into an order all the global currencies, commodities and precious metals.

Research tools

Theorem of V. I. Arnold

Academician V. I. Arnold presented the *binormalized randomness parameter* (Arnold, 2005, 2009)

$$s = T \sum_{i=1}^{T} \left(\frac{x_i}{L}\right)^2, L = \sum_{i=1}^{T} x_i$$

for studying random distribution of $x = \{x_1, x_2, \dots, x_n\}$ in the *(T-1)*-dimensional simplex

$$\sum_{i=1}^{T} x_i = 1, 0 \le x_i \le 1.$$

He proved that the mean of s is equal to $s_1 = \frac{2T}{T+1}$ as $T \to \infty$ [8]. Obviously, $1 \le s \le T$. So, if we substitute s with its logarithm, $s^* = \log_T s$, we get a measure of randomness at the unit interval, $0 \le s^* \le 1$. According to the theorem, the test for the FX randomness should be arranged as follows. Let $Data^{\langle k \rangle}$ be time series of *N* daily records since 1971 for asset *k* (Federal Reserve, 2015), modified as the abovementioned series of $p_t^* \in \{0000, 0001, \dots, 9999\}$, *t=1,…,N,* where *N* and *k* are listed in Table 1.

Table 1. Trading days since 1971 and arc length samples for FX

k, FX code	N, trading days	Arc lengths of the GBP		Arc lengths of INR (BRICS)	
AUD	11042	1	2453	1	0
EUR	8930	2	1043	5	6
NZD	11033	3	429	7	1
GBP	11049	4	119	10	2
BRL	5031	5	417	13	1
CAD	11055	6	17	20	22
CNY	8489	7	17	25	15
DKK	11048	8	17	30	19
HKD	8549	9	16	38	1
INR	10541	10	46	40	2
JPY	11043	11	1	45	1
KRW	8435	12	1	50	59
MYR	11027	13	1	60	1
MXN	5317	14	1	62	1
NOK	11048	15	14	70	6
SEK	11048	19	1	75	2
ZAR	8792	20	6	80	3
SGD	8548	22	1	100	45
LKR	10189	25	3		
CHF	11049	27	1		
TWD	7562	29	1		
THB	8468	30	1		
VEB	5024	35	2		

Let $x_i = Data_{i+1}^{\langle k \rangle} - Data_i^{\langle k \rangle}$ for *i=0…,N(k)-1.* For *L=10000=const,* we have finite set of arcs with different lengths $x_i^* \in \{0, 1, \dots, 9999\}$ for every k. The arc length histogram is that we have to verify for real randomness with parameter $s^* = \log_T s$ with respect to $L = \sum_{i=1}^{T(k)} x_i^*(k) h_i(k)$, where $h_i(k)$, *i=1,…,T(k)* – a discrete function of the histogram for individual currency of major FX basket.

In the case of testing FX basket of 23 currencies in general with the abovementioned logarithmic variables $d_{ij} \in [0,1]$ we apply this technique to the unit interval directly, and obtain $s_1(t) \in [0, \infty]$ as randomness sensitivity function of FX intraday evaluation.

Λ-parameter of A. N. Kolmogorov and method of N.V. Smirnov

Academician A.N. Kolmogorov (1992) presented well known statistic, which offers us to arrange test for randomness as follows. Let $D_n = \sup_x |F_n(x) - F_0(x)|, -\infty < x < +\infty$ be a distance between theoretical $F_0(x)$ and empirical cumulative distribution functions, where $F_n(x)$ is done for the variational series $x_1 \le x_2 \le \dots \le x_N$ of random variable x. It was proved, in the famous theorem of Kolmogorov, that

$$\lim_{n \to \infty} Prob \left\{ \sqrt{n} * \sup_{|x|<\infty} |F_n(x) - F_0(x)| < \lambda \right\} \to K(\lambda) = \sum_{k=-\infty}^{+\infty} (-1)^k e^{-2k^2\lambda^2}, \lambda > 0.$$

Here, $K(\lambda)$ and λ are known as Kolmogorov distribution function and λ-parameter respectively.

Distribution of D_n does not depend on $F_0(x)$. $K(\lambda)$ is tabulated. As soon as probabilities of getting $0.4 > \lambda > 1.8$ are both less than 1/3 per cent, it was proposed by Arnold (2005) to use λ as a measure of the real randomness for x. Other words, result of FX data processing, where λ is such that $\{\lambda < 0.4;\ \lambda > 1.8\}$, means a confirmation of non-randomness for variables in question. The creative idea on to exploit the Kolmogorov's theorem for measuring a degree of randomness provided and discussed in details by Arnold (2005). We apply this idea to major cumulative distribution functions for the variables r_k above.

To avoid difficulties with both getting and using of the theoretical distribution function $F_0(x)$, we apply the method of Smirnov which allow us to get the randomness test result for FX variables by using of additional set of mutual coefficients according (Smirnov, 1939a, 1939b). Table 2 contains the intervals for empirical counting functions $F_n(r_k)$ presented in Figure 2.

Table 2. Intervals for cumulative distribution functions $\mathbf{F_n(r_k)}$ as of 01 Jan 2015.

r_k	AUD	EUR	GBP	JPY	CHF	CAD	MXN	CNY
Min=x_1	-0.1766	-5.9617	-4.4848	-9.0670	-4.85	-4.945	-16.447	-2.400
Max=x_N	3.8803	4.8524	5.0916	6.4553	9.29	3.880	22.340	49.999

N.V. Smirnov (1939a, 1939b) strengthened the result and proved that we may replace unknown $F_0(x)$ with the pair of the different empirical cumulative distribution functions $F1_{n1}(x)$ and $F2_{n2}(x)$ for our goals. Smirnov statistic $D(n1, n2) = \sup_{|x|<\infty} |F1_{n1}(x) - F2_{n2}(x)|$ is very suitable for the randomness testing with $K(\lambda)$ for $F_n(r_k)$ which are taken from the same FX general population introduced above. In that case we should replace *D* with a slightly modified parameter, $D^* = D\sqrt{\frac{n1*n2}{n1+n2}}$, and apply the test as follows

$$\lim_{n1,n2\to\infty} Prob\left\{D^* = D\sqrt{\frac{n1*n2}{n1+n2}} < \lambda\right\} \to K(\lambda) = \sum_{k=-\infty}^{+\infty} (-1)^k e^{-2k^2\lambda^2}, \lambda > 0.$$

We have to underline here that our target is not the econometrical hypothesis testing but getting the mean value for λ-parameter, random itself, of different assets to estimate the randomness level of the FX in general. If one get $D^* \in [0.4; 1.8]$ we would confirm the random walk ideology instantly. Table 3 consists of the results for main currencies. We have especially separated into positive and negative parts the Smirnov distance to visualize its dynamics with Figure 4 below. Indexed constants mean the multipliers for the mutual distances of the USD={1}, AUD={2}, EUR={3}, GBP={4}, JPY={5}. We have got a very short list of EURJPY={53} and GBPUSD={41} (green, Figure 4) which might be declared as random in average. But λ-parameters of all mutual rates destroy this quasi-positive for a random walk theory result. Numbering {6} through {15} means "tournament table" for the five currencies listed.

Table 3. Smirnov statistic for $\mathbf{F_n(r_k)}$ and mean values for $\mathbf{D_n}$ as of 01 Jan 2015

Indicator	Value
Smirnov statistic	$\max(\lvert\min(Data^{\langle 6\rangle})\rvert, \lvert\max(Data^{\langle 6\rangle})\rvert)\cdot a51 = 4.02387$ $\max(\lvert\min(Data^{\langle 7\rangle})\rvert, \lvert\max(Data^{\langle 7\rangle})\rvert)\cdot a52 = 4.332227$ $\max(\lvert\min(Data^{\langle 8\rangle})\rvert, \lvert\max(Data^{\langle 8\rangle})\rvert)\cdot a53 = 2.352339$ $\max(\lvert\min(Data^{\langle 9\rangle})\rvert, \lvert\max(Data^{\langle 9\rangle})\rvert)\cdot a54 = 3.88335$ $\max(\lvert\min(Data^{\langle 10\rangle})\rvert, \lvert\max(Data^{\langle 10\rangle})\rvert)\cdot a41 = 2.584036$ $\max(\lvert\min(Data^{\langle 11\rangle})\rvert, \lvert\max(Data^{\langle 11\rangle})\rvert)\cdot a42 = 3.677186$ $\max(\lvert\min(Data^{\langle 12\rangle})\rvert, \lvert\max(Data^{\langle 12\rangle})\rvert)\cdot a43 = 4.250064$ $\max(\lvert\min(Data^{\langle 13\rangle})\rvert, \lvert\max(Data^{\langle 13\rangle})\rvert)\cdot a31 = 4.109176$ $\max(\lvert\min(Data^{\langle 14\rangle})\rvert, \lvert\max(Data^{\langle 14\rangle})\rvert)\cdot a32 = 4.246819$ $\max(\lvert\min(Data^{\langle 15\rangle})\rvert, \lvert\max(Data^{\langle 15\rangle})\rvert)\cdot a21 = 4.433258$

Mean value for D		$D(6)\cdot a51 = 2.465398$ $D(11)\cdot a42 = 1.844253$ $D(7)\cdot a52 = 2.031727$ $D(12)\cdot a43 = 2.370529$ $D(8)\cdot a53 = 0.739006$ $D(13)\cdot a31 = 2.485779$ $D(9)\cdot a54 = 2.495688$ $D(14)\cdot a32 = 1.446978$ $D(10)\cdot a41 = 0.642034$ $D(15)\cdot a21 = 2.378987$

Parameter of the market Efficiency

As for tick-by-tick analysis of the official intraday records, we considered recently (Prelov, 2012), without loss of generality, the daily trading period S_k, $k \in Z$ for the financial market with unit step in bid-ask rates and the variational series $p_i^k = p_0^k + i, i = 0 \ldots N_k, N_k \to \infty$ where we used a notation p_0^k and $p_{N_k}^k = p_0^k + N_k$ for interval bounds of the asset given. We denoted with D_k the total number of the anonymous transactions done with the FX asset during S_k. The FX non-randomness immediately follows our result for *E* (Prelov, 2012). Indeed, let tick $t_j = (p_{t_j}, V_{t_j}, T_{t_j}), j = 1 \ldots D_k$ be a standard vector record for every deal done for asset given, where $p_{t_j}, V_{t_j}, T_{t_j}$ – tick price, volume and turnover respectively. The cash and volume turnovers were introduced as $T^{S_k} = \sum_{t_j} T_{t_j}$, $V^{S_k} = \sum V_{t_j}^k$, and nominal rate of at-the-moment return as $R_k = N_k / p_0^k$. Then, at-the-moment rate of return is obviously equals to the value $r_k = T^{S_k} \Big/ \sum_{\le \mu_k} p_i^k V_i^k - 2$, where $V_i^k = \sum_{t_j} V_{t_j}^k \delta(p_i^k)$, $i = 0 \ldots N_k$, $\delta(*)$ - standard δ -function and μ_k - median of V_i^k distribution within a trading range. Finally, the Efficiency we defined with parameter *E*, $\overline{E} = \lim_{k \to \infty} \overline{\sum_k E_k}$, $E_k = r_k / R_k$. For this *E* the following theorem is valid (Prelov, 2012).

Theorem (the thermodynamic invariant of the global market)

$$\overline{E} = \int_0^1\int_0^1\int_0^1 \frac{[(\beta N - \ln\frac{e^{\beta N}+1}{2}) - e^{-\beta N} \ln\frac{e^{\beta N}+1}{2}]\cdot d\ln N \cdot dp^2 \cdot d\beta}{(\beta(p-N) + \ln\frac{e^{\beta N}+1}{2}+1) - e^{-\beta N}(\beta(p+N) - \ln\frac{e^{\beta N}+1}{2}+1)} \approx 0.37816720$$ where

$\beta \in [0;1]$ – parameter of the Boltzmann distribution.

Proof

To get *r* we have to obtain V_i distribution of the maximal probability, i.e. we meet a standard problem to minimize $\sum_i V_i \ln V_i$ under conditions $\sum_i p_i V_i = T$, $\sum_i V_i = V$ with well known Boltzmann's result $V_i = \alpha e^{-\beta p_i}$, *i=0…N*, where α, β – const, $\beta \in [0;1]$. Let micro-state of the market be fixed now. To get median μ we have to solve an equation (our discrete market replaced with continuous one for a moment)

$$\int_{p_0}^{p_\mu} e^{-\beta x} dx = \frac{1}{2} \int_{p_0}^{p_N} e^{-\beta x} dx$$

and, then, to get the intermediate parameter

$$\mu = N - \frac{1}{\beta} \ln \frac{e^{\beta N} + 1}{2}.$$

After substitution μ in *r* and routine transforms we obtain the integrand of Theorem. To get $\overline{E}$, we permit *T* and *V* to be floating in the first quadrant, i.e. we consider the floating right-hand sides of the Boltzman's conditions $T = T(S_k), V = V(S_k), k \to \infty$. Taking into account an evident fact that *card* S = *card* β we have, trivially,

$$E_k = \frac{\sum_{\geq \mu_k} p_i^k V_i^k \Big/ \sum_{\leq \mu_k} p_i^k V_i^k - 1}{N_k / p_0^k}.$$

Just after normalization in (p, N, β)-axes and the unit cube averaging we get an explicit expression for our constant *E*. We have to note that the result does not depend on asset or market in question. If the FX asset were really random, we should expect any other result for such a parameter but not the invariant proved. This supports once more the non-randomness hypothesis of global markets behavior from the thermodynamic point of view.

Results

Theorem (the non-randomness of the global market)

Data processing for major FX currencies done with three different special mathematical tools adapted for the randomness testing has rejected the "random walk" hypothesis for both single asset and market as pool of assets, for three types of independent variables.

Proof

The visualization of theorem presented at Figure 5-7, and Figure 4 accompanied with Table 3. So, it becomes clear from Figure 4 that neither USD itself nor set of other major currencies fit the randomness assumption for the variables of Type II. Direct calculations done for all λ and Smirnov test for cumulative distribution functions of r_k show that the distances of our interest are much higher than 2 and, as well, there are no chances to get it inside the [+/-0.4; +/-1.8] intervals marked with yellow belts at Figure 4. Randomness hypothesis failed for all $D(n1, n2) = \sup_{|r_k| < \infty} |F1_{n1}(r_k) - F2_{n2}(r_k)|$, $k \in \{\text{USD}, \text{AUD}, \text{EUR}, \text{GBP}, \text{JPY}\}$.

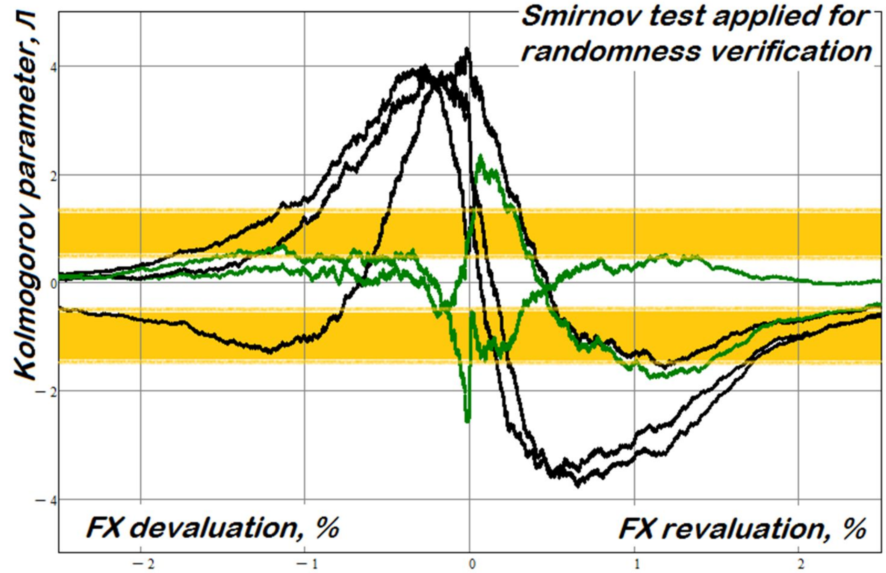

Figure 4. Verification of the FX randomness by the Kolmogorov parameter λ and Smirnov test

Figure 5 presents our result in a form of the rating for global currencies, Russian ruble and precious metals done for variables of Type I based on the Arnold theorem and values of $\log_T s$ for currencies listed in Table 1. We follow the slang of (Arnold, 2005, 2009) and name the parts of the "non-randomnesses" as "attraction" and "repulsion" in corresponding with a type of the non-randomness. Intermediate positions we would call as "bifurcation zone" (1/3 of unit interval) and "quasi-randomness zone" (the last 1/3). It is easy to see that "real randomness", +/-1/33 of $s^*(k), k \in \{\text{FX, commodities, precious metals etc.}\}$, we met just once in intraday tick-by-tick data of 16.Dec.14 while turbulence at "Russian forex". The only asset which has been detected as random one with no doubt is XAGUSD spot. Divergence between the theoretical and practical values of $s^*(Ag5D)$ is only 0.0390 %.

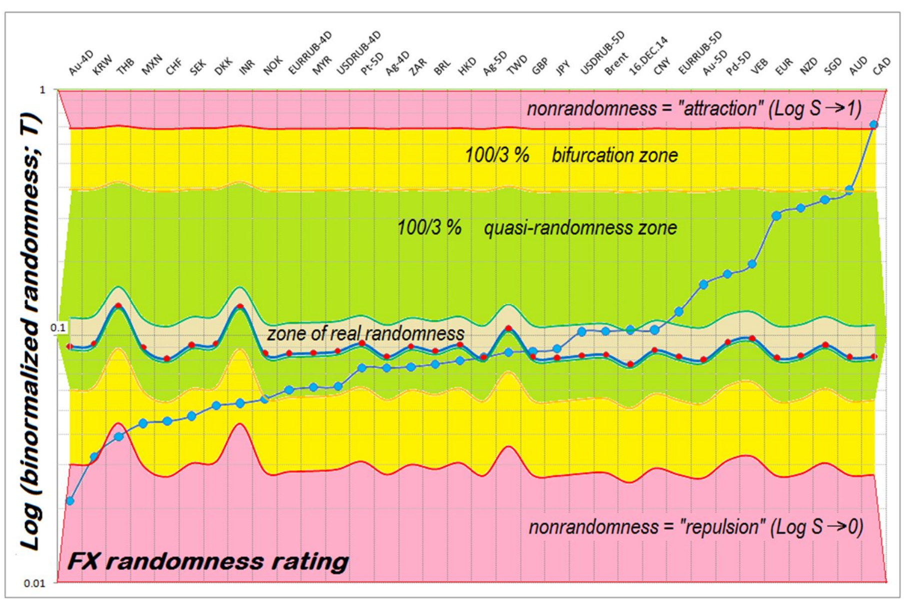

Figure 5. Result of the randomness rating for global currencies, Russian ruble and precious metals

We see, through the rating presented, that there are no chances to accept the randomness hypothesis for all single assets. If the randomness were valid in reality we might expect some about the constant as rating line. So, the second attempt to get fair randomness at the global FX is failed. As well as an attempt to get it through the Smirnov test at Figure 6.

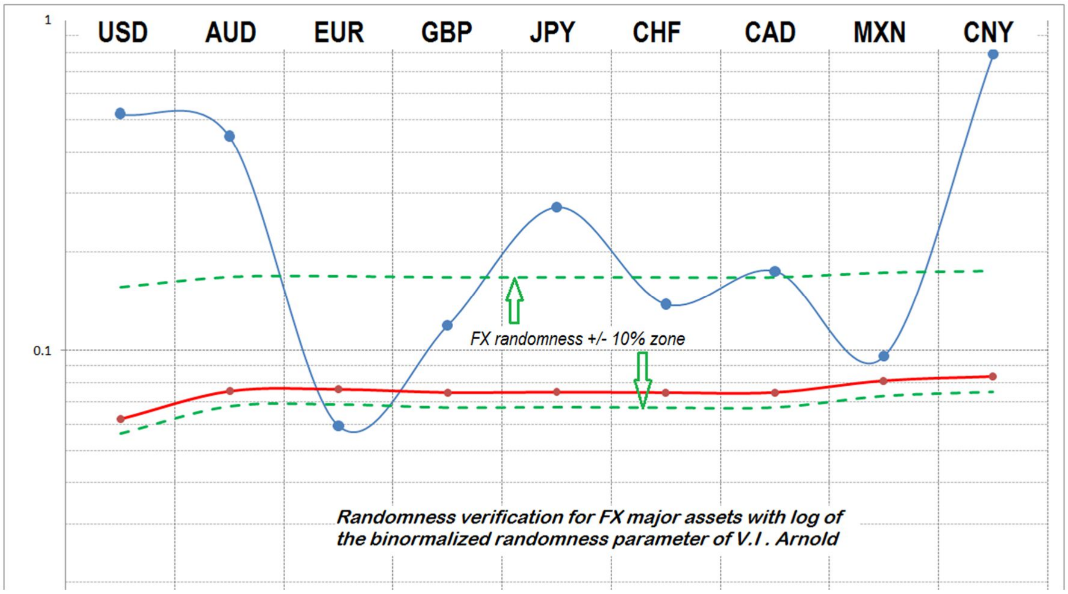

Figure 6. Result of the randomness verification for general populations of the major FX currencies.

Finally, the result for testing the FX as a basket of assets is shown with Figure 7. We have tested the FX with logarithmical variables of Type III, $d_{ij} = \frac{d(x_i, x_j)}{d(x_1, x_N)} \in [0,1]$. As of Jun 2014, FX has reached just once the value of 2.615, 30% higher than 2, in 2001, thus, the final attempt to confirm the "random walk hypothesis" for markets in general is failed.

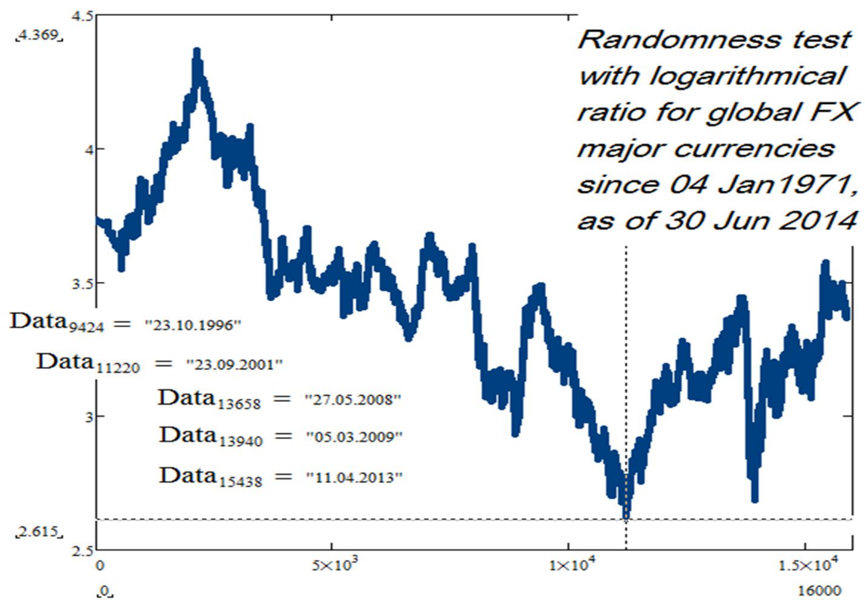

Figure 7. Result of the randomness verification for major FX currencies with logarithmical ratio

The numerical disproof of randomness is completed.

Remarks:

• The behavior of financial markets is not random and might be predictable in the terms of estimating the check points. But the adequacy of tools and time of the FX regulators' decisions (CBRF in Dec'14 or SNB in Jan'15) became the main challenge in this point.

• As financial markets are not random, so the problems to foresee financial crises and to predict the financial market dynamics seem equivalent, i.e. the analysis of the financial markets behavior hidden details looks like a key for giving forecasts of both geopolitical and macroeconomic turbulence.
• Of the particular scientific interest is the problem of classification of individual trading instruments and their baskets with the degree of randomness. We found that a currency basket of BRICS countries, on a 20-year horizon since 1995, gives us the value of the above parameter S equals to 1-1.5, i.e. S is very close to unity, thereby, disproving once more the theory of "random walk" in dealings for the high-frequency trading at markets.

Discussion

One could pay attention that theorems both pure practical and mathematical one had deals with datasets collected of tick-by-tick records with different vendors. In a context of the global markets, the distribution of information is asymmetrical and not equally available to all the participants. Economical development in such conditions becomes unstable, and the markets themselves are the goal and object for manipulations by the FX gamblers with the most complete information. This means, by the way, the reason to accept "non-randomness" as an intrinsic attribute of all financial markets at the globe. Nevertheless, understanding the "non-randomness" of global financial markets in spirit of the both theorems above as well as the essential role of the FX as a modern "risk & crisis export" media makes it necessary to design some high-scientific tools to foresee the timetable and magnitudes of the forthcoming economical problems. In such a case, prediction of financial disasters means finding a tool to solve two sub-problems, such as:

- analysis of both goals and timetables of financial manipulation with dealers interested in, and risks associated;
- scenario analysis and verification of forecasting methods to prevent such manipulations.

We have to note that the main risks and threats in this regard are represented with a set of risks associated with using the modern arsenal of so-called "psi-weapons", such as

- "currencies' wars" accompanied with "related analytical materials" and some other advanced NLP technology;
- "wars of the ratings" for to obtain significant preferences during the global financial turbulence and volatility;
- development, promotion and implementation of pseudo-scientific theories (e.g., "rational expectations" and "efficient market hypothesis") over the world;
- implementation of the false tools & targets (e.g., so-called "inflation targeting");
- "the inflation contagion" by dealing with a long list of pseudo-assets (e.g., futures/options/ADR etc.)

.

On the sovereign level, therefore, what seems extremely urgent is that pivotal problem of scenario modeling and calculation of real-time algorithms for efficient management of foreign reserves to neutralize all the possible on-line actions of the outside dealers. Thanks to modern powerful supercomputers, this problem does not seem hopeless.

We present within the table below some of basic tasks and tools clarifying a scheme of further scientific researches in crisis forecasting methodology in application to markets.

Table 4. Tasks proposed and achieved

List of targets and tasks	The methods to get the results	The results expected
Acquisition and processing of all available tick-by-tick information. Analysis of the reliability and quality of the datasets.	Synchronization of the foreign exchange records, frequency analysis of the information and news flows, marking all the misinformation and synergistic effects. Verification of all the known methods of the technical analysis of the financial markets.	Development of the generalized repository of the tick-by-tick databases for the total combinatorial etc. studying of extra-long time and data series.
Getting the characteristics of the	Searching the anomalies within time	Verification of partial models

individual events. Analysis of characteristics. The integral results of the analysis of the similarities.	series corresponding to the single event. Identification of resonance features in the action of various precursors. Searching the properties both general and singular events. Application of the number theory, information theory, theory of catastrophes.	of precursors, hypothesis about the genome properties of the crisis precursors.
Design of Proto-System for identification the syndrome of crisis or other external event. Analysis of the anticipated goals of the outside FX participants.	Applying the methods of the synchronized targets and of the parametrical resonances for the normalized parameter of the efficiency for a collection of tick-by-tick transactions. Using the theory of direct and reflected waves of efficiency, geometric probabilities and their dynamics in the system of entropy indices.	Giving forecasts for the crisis events have already taken place, i.e. fine-tuning of the proto-system on-line.
Presenting both the numerical and theoretical disproof for the false economic concepts and theories.	Retro analysis of the financial markets and a comparison of all the practical and theoretical results on the available time horizon. Total combinatorial analysis with supercomputers.	Development of the real-time system to identify the timetable and magnitude of the forthcoming crises.

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