CURRENCY AND STOCK EXCHANGES: ON THE EFFICIENCY SHOALS

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The purpose of this article is to define the preliminary results of investigation of decision-making management in currency and stock exchanges. The object of the research is decision-making management in currency and capital markets. A particular aim of the research has been creation and practical utilization of a currency and stock trading system which relies upon historical data and provides for trading strategies with a guarantee ensuring positive trading results. The conceptual aim of the paper is to show (according to specially elaborated simple portfolio trading strategies) that today's currency exchange rate and capital markets offer real possibilities to get a bigger than average trading profit, i.e. to show that in these markets there are some "shoals" of effectiveness, which can be realized as inefficiency features of these markets.

The purpose of the paper. In the paper, tentative results of research in decision-making in exchange and capital markets are described. The object of the research was decision-making management in exchange and capital markets (DMMECM). Here management of decision-making is recognized as formulation of particular goals, generation, selection and accumulation of information for reaching these goals, creation of measures for attaining them, selection of aim-reaching criteria, preparation and realization of aim-reaching strategies. A particular aim of the research was creation and utilization of a system of trading in currency exchange rates and stocks, which relies only on historical trading data and allows creating the trading strategies that assure positive trading results with a desirable level of guarantee. A particular object was historical trading data in the global market of exchange rates (FOREX) and several capital markets, among them New York Stock Exchange (NYSE), Milan Exchange, etc. *Pragmatical aim of the research.* On the basis of analytical conclusions it is shown that the proposed DMMECM system is efficient in those markets and has a theoretical background and practical approval. Altogether, it is necessary to bear in mind that the advantages of the proposed system offer opportunities for effectively using the naïve stra-

tegies, called maximas here. For digital system solution the so-called imitation technologies are used, which allow to solve analytically quite complex systems of mathematical models with stochastical variables, limitations and criteria. Also, it should be mentioned that the proposed variant of the system of strategies is only initial and has a high potential of development.

Historical data, which are the object of practical research, are obtained from official information sources and are used directly without correction or adaptation.

Scientific intention of the paper. The conceptual aim of the paper is to show (according to specially created simple portfolio trading strategies) that in today's currency exchange rate and capital markets there are real possibilities to get a higher than average trading profit, i.e. to show that in these markets some "shoals" of effectiveness exist, which can be understood as inefficiency markers of these markets.

Key words and expressions: market efficiency, guarantee of possibility, portfolio adequate for investment profit stochasticity assessment, isoguarantee as a portfolio decision-making instrument, decision-making management in currency exchange and capital markets (DMMECM).

The logical structure of the paper. The integral decision managing effect is usually attained by forming and managing investment or trading portfolios in capital or exchange markets. The final goal of the proposed decision managing system is portfolio decisions made in exchange and capital markets. The preparation and use of the managing system can be assumed to consist of three stages:

> determination of the system's main parameters for portfolio decisions in exchange rate and stock markets;
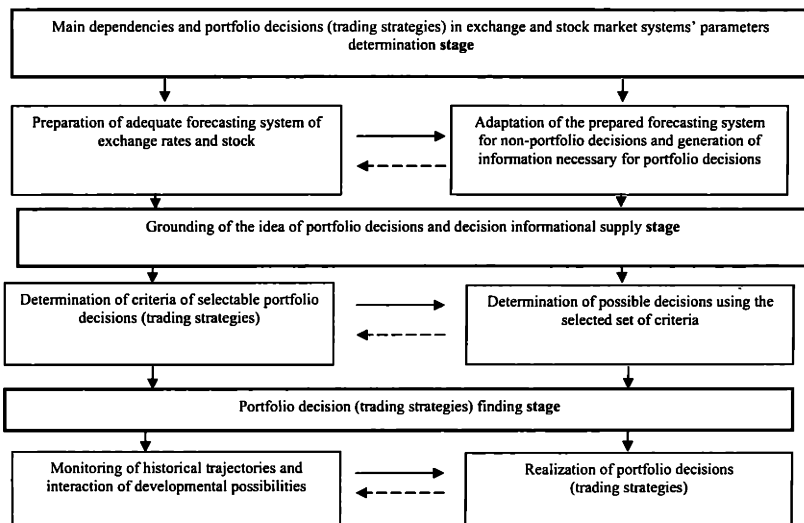
portfolio decision system information supply;
portfolio decision finding.

We also want to note that the advantages of the proposed currency system of forecasting exchange rates and stock prices offer opportunities for an effective use of naïve strategies, named maximas here.

1. Introduction

As is mentioned above, the aim of the paper is to present the management system of decisions made in currency and capital markets. The layout scheme is as follows (Pic. 1):

> forecasting principles and models of exchange rates and stock prices will be presented, with a discussion of the advantages, disadvantages and real possibilities of technical analysis for implementation of the forecast. Particular forecasts created according to our methods will be presented, their utilization and realization for the formation of naïve trading strategies will be illustrated;
> analysis of portfolio decision possibilities in exchange rates and capital markets will be carried out, discussing the necessity of developing traditional standard deviation – average or VAR – principles and suggesting an adequate portfolio stochastical nature. Particular possibilities of an adequate portfolio utilization in decision-making in exchange rates and capital market will be presented;
> the possibilities of portfolio utilization in global exchange and various capital markets will be examined;
> utilization of imitational technologies in searching for portfolio solutions and the conception of DMMECM monitoring will be presented.

Main dependencies and portfolio decisions (trading strategies) in exchange and stock market systems' parameters determination **stage**

| Preparation of adequate forecasting system of exchange rates and stock | → ⇠ | Adaptation of the prepared forecasting system for non-portfolio decisions and generation of information necessary for portfolio decisions |

Grounding of the idea of portfolio decisions and decision informational supply **stage**

| Determination of criteria of selectable portfolio decisions (trading strategies) | → ⇠ | Determination of possible decisions using the selected set of criteria |

Portfolio decision (trading strategies) finding **stage**

| Monitoring of historical trajectories and interaction of developmental possibilities | → ⇠ | Realization of portfolio decisions (trading strategies) |

Picture: 1. Search stages and actions of portfolio solutions (trading strategies)

Although the DMMECM system is intended for the management of portfolio decisions, the non-portfolio decision making management subsystem and the suggested forecasting system for exchange rates and stock prices have a self-sufficient value.

2. General scheme of the research and the subsystem of simple decision making management in exchange rates and capital markets

2.1 Conditional denomination of partial historical data with forecasting information.

As is mentioned before, the particular object of our research is historical data on exchanges rates and stock prices. Picture 1 shows a fragment of the analyzed data. For the purpose of

research, historical data were differentiated into "truly" historical and "seemingly" perspective. We will explain the reasons for such differentiation below. At the time of research, part of data (1–t data of days) were accepted as historical; the corresponding assessments were made and information for decision making was selected. t–200-day data were treated as future data; decisions made with their help were tested. As our strategies were oriented to one step, the solution made on the background of t-day data was tested by data of t + 1 days, and the real data of this day for the next step were accepted as historical. The process would continue until the 200th day.

It should be noted that the research decisions were differentiated into simple decisions and portfolio decisions. The purpose of such differentiation will be revealed in the further text of the paper. However, we also will note

Historical data Days	Currency exchange rates					Stock prices								
	FOREX-e					NYSE-e								
	EUR/USD	EUR/GBP	EUR/CHF	EUR/JPY	EUR/CAD	WMT Wal-Mart Stores	GM – General ral Motors	F- Ford Motor	C – Citi-group	GE - General Electric	T - ATand T	VZ – Veri-zon Comm.	IBM	JPM - JP Mor-gan Chase
1*	1.1491	0.6834	1.5651	12.982	1.5197	56.9	36.04	10.58	45.45	27.41	19.82	35.67	81.85	34.94
2	1.1435	0.6837	1.5658	12.871	1.5144	56.5	36.2	10.59	45.64	27.42	19.53	35.33	82.3	34.86
3	1.1409	0.6823	1.5718	12.846	1.5247	55.63	36.27	10.68	44.87	27.44	20	34.69	81.51	34.58
⋮														
190	1.2005	0.6631	1.5212	13.31	1.6786	58.35	48.27	14.94	49.14	30.7	18.59	37.69	91.26	37.68
191	1.2042	0.657	1.5085	13.207	1.6616	58.6	48.84	15.77	49.66	30.85	18.03	37.76	90.74	38.38
192	1.2138	0.6562	1.5105	13.189	1.6531	58.97	49.18	15.7	49.18	30.69	18.34	37.54	91.28	38.3
193	1.2142	0.6599	1.5098	13.208	1.6354	58.14	49.33	15.69	48.99	30.75	18.31	37.74	90.43	38.55
194	1.211	0.661	1.5094	13.193	1.6466	58.6	49.5	16.03	48.96	30.55	18.14	37.5	91.11	38.62
195	1.2114	0.6649	1.5132	13.212	1.6431	57.98	48.5	15.5	48.43	30.02	17.85	37.66	90.41	37.93
196	1.209	0.6653	1.5154	13.116	1.6593	57.57	47.62	15.37	48.17	30.05	17.49	37.79	89.08	37.65
197	1.2178	0.667	1.5146	13.044	1.6588	57	47.42	15.36	48.09	29.95	17.15	37.74	88.17	37.6
198	1.2154	0.6657	1.5187	13.085	1.6654	56.54	48.29	15.27	48.56	30.3	17.09	37.69	88.02	37.86
199	1.2195	0.6663	1.5212	13.156	1.6632	56	47.94	15.41	48.84	30.44	17.09	37.89	89	38.31
200	1.2155	0.6711	1.5242	13.233	1.6607	55.86	47.56	15.12	48.63	30.49	17.3	37.83	88.96	38.05

*Here we have 200 trading day exchange rates and stock trading closedown prices. For exchange rates, the 200 trading day period coincides with the period 01.11.2003 – 01.07.2004 and for stocks with the period 22.07.2003 – 05.05.2004.

that the role of future data for portfolio decisions fell only on data of days 190–200.

Before starting the analysis of the forecasting and decision making systems, we will shortly study analysis methods for exchange rate and capital markets. Because in this paper we will study the decision (trading strategies) search system in exchange rates and capital markets based only on historical data, attention will be focused on the realization and development of methods for technical analysis and forecasting. Therefore, first of all let us study the stage of analysis in the hierarchy of management actions as a necessary presumption for adequate forecasting.

2.2 Adequate forecasting system of exchange rates and stock prices

Knowing the abundance and versatility of the set of technical analysis forecasting models, it would be negligent to generalize these properties of this set. Therefore, even though most forecasting methods in technical analysis theoretically are suitable for forecasting exchange rates and stock prices and have a long-time experience not only in this area, we have to admit that they do not satisfy the main attributes indispensable for forecasting methods:

the method of forecasting exchange rates and stock prices must be adaptive, i.e. helpful in considering the fact that in each point of variation of exchange rates or stock prices, changes also the sum total of factors, their role, the functional dependence of exchange rates and stock prices on the factors that determine them, as well as the interrelation among these factors themselves;

methods of forecasting currency rates and stock prices must be flexible, i.e. their utilization should be possible in every forecasting system, be it a complex system of mathematical models or subjective expert decisions;

the forecasting method should be consistent, i.e. factors and their consequences should be strictly differentiated. This is very important when determining and using analytical interrelations between a factor and its consequence and interrelations among the factors;

utilization of one or another method should allow a quantitative assessment of the reliability of the obtained results; methods of forecasting must be constructive, i.e. allowing a selection of the most probable values of the variables or processes.

Main principles of adequate forecasting system. Below we will illustrate the main one-step exchange rate and stock price utilization principles of the forecasting system. The core of the forecasting system is the regressive dependence of the value of the forecast index at the $(t+1)$ moment on the values of this analyzed index at the t-th and previous moments:

$$\overline{y}^{t+1} = f\left(\overline{x}_1^t, \overline{x}_2^t, ..., \overline{x}_n^t; \Theta(0, t)\right) \qquad (1)$$

where

$\overline{y}^{t+1}$ is the probability distribution of the exchange rate or stock prices at the $(t+1)$ moment;

$\overline{x}^t$ is the I-th factor probability distribution at the t-th moment;

$\Theta(0, t)$ is the resultant of the influence of other factors on the index of the $(t+1)$-th moment; *f* is regression.

Of course, forecasting in real time, i.e. at the moment when historical data develop and are announced, would not differ from the pre-

sented situation, except that a 160-day fore-cast would take a period of 160 days. For the sake of briefness, Picture 2 contains only five diagrams. These diagrams show a coincidence of historical and forecasting indices of the ex-change rates and stock prices presented in Ta-bles 2 and 3.

These forecasting data were used for prepa-ration of simple trading strategies, named maximas in the text. The maxima's content is the elementary truth: buy a stock for its clos-ing price if its price rises next day, and sell it if its price falls next day. For exchange rates, this provision could be expressed like this: capital should be considered as the first currency if its rate grows with respect to the second currency and, vice versa, as the second currency if this rate is falling.

While realizing maximas, it is very impor-tant to guess, the trend of change of exchange rate and stock prices i.e. whether they will rise or fall. That is why in each column of Table 2, in an extra line, the number of coincidences is shown when the forecast and real indices were changing in the same direction.

Picture 4 shows the results of utilization of naïve trading strategies – maximas – in dia-grams. Each diagram is formed by the follow-ing principle: the value of the initial capital is 100 units; the 1st line shows change of the ini-tial capital in case it becomes a deposit giving 8% of annual interest; the 2nd line shows the real change of the initial capital in the market; the 3rd line shows the possible growth of the initial capital, in case a simple strategy – maxima – is used.

2.3 Evaluation of maximas' possibilities in DMMECM system

Pictures 4 and 5 show real utilization possibili-ties of maximas, because the diagram (line 3)

is formed considering possible trade expenses. Using the possibilities of maximas, it is possib-le to increase the initial capital to a greater extent than using passive accumulation, i.e. deposit in bank. In many cases maximas allow to obtain a bigger capital than using the passive "buy and hold" trading strategy, i.e. to trust the situation directly generated by the market.

The possibilities of maximas directly de-pend on the accuracy and reliability of the forecast of exchange rates and stock prices. If while choosing maximas it is important to guess only the growth directions of currency exchange rates and stock prices, while form-ing the DMMECM subsystem of portfolio decisions forecast accuracy and reliability in a full sense of these categories are also im-portant. Therefore, let us analyze the ad-equacy of our forecasting system to the above mentioned adequacy requirements of the forecasting model, first of all while describ-ing the reliability and constructiveness of the forecasts.

Before describing the possibilities of the ap-plied forecasting method, let's have a look at fig. 6 (Picture 3), because it will be the base for empirical conclusions. This picture presents a comparison of the geometrical view of the empirical historical data and the forecast EUR/CHF rate change probability scatter of 95% reliable intervals. In section a, the upper and bottom lines of reliability zones are identified with the forecast probability distribution mean ± standard deviation with the corresponding values. In section b these lines are identified as a mode ± standard deviation from the cor-responding values of the mode. In section c, maximums of the lines analyzed in sections a and b are taken for the bottom line and mini-mums for the upper line.

Table 2: Comparison of historical (H) and forecast (F) indices: exchange rates in FOREX market
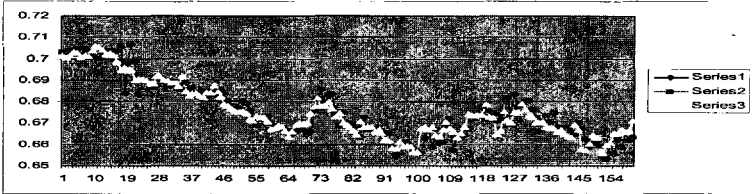
	Historical and forecast indices	Currency exchange rates									
		EUR/USD		EUR/GBP		EUR/CHF		EUR/JPY		EUR/CAD	
Days		F	H	F	H	F	H	F	H	F	H
I	1		1.1491		0.6834		1.5651		12.982		1.5197
	2		1.1435		0.6837		1.5658		12.871		1.5144
	3		1.1409		0.6823		1.5718		12.846		1.5247
	40		1.2376		0.7022		1.5538		12.684		1.5339
II	41	1.2452	1.2384	0.7031	0.701	1.5528	1.5532	12.7474	12.757	1.5343	1.5362
	42	1.2468	1.2401	0.7030	0.7006	1.5515	1.5583	12.7501	12.796	1.5512	1.5354
	43	1.2498	1.2399	0.7038	0.7015	1.5588	1.5586	12.8303	12.926	1.5562	1.5383
	189	1.1942	1.2158	0.6557	0.6645	1.5157	1.5187	13.2477	13.387	1.6392	1.6514
III	190	1.2285	1.2005	0.6619	0.6631	1.5144	1.5212	13.5081	13.31	1.6642	1.6786
	191	1.1967	1.2042	0.6585	0.657	1.5293	1.5085	13.1162	13.207	1.6823	1.6616
	192	1.1969	1.2138	0.6543	0.6562	1.5006	1.5105	13.2434	13.189	1.7013	1.6531
	193	1.1948	1.2142	0.6532	0.6599	1.5088	1.5098	13.3345	13.208	1.6457	1.6354
	194	1.2018	1.211	0.6623	0.661	1.5059	1.5094	13.5313	13.193	1.6783	1.6466
	195	1.2184	1.2114	0.6541	0.6649	1.5065	1.5132	13.3735	13.212	1.6364	1.6431
	196	1.1967	1.209	0.6614	0.6653	1.5209	1.5154	13.2153	13.116	1.6674	1.6593
	197	1.2138	1.2178	0.6529	0.667	1.5152	1.5146	13.2390	13.044	1.6435	1.6588
	198	1.2085	1.2154	0.6719	0.6657	1.5207	1.5187	13.1261	13.085	1.6674	1.6654
	199	1.2173	1.2195	0.6691	0.6663	1.5110	1.5212	13.1747	13.156	1.6815	1.6632
	200	1.2183	1.2155	0.6554	0.6711	1.5016	1.5242	13.1850	13.233	1.6491	1.6607
Number of trend coincidences		82 (160)		83(160)		69(160)		89(160)		86(160)	

Historical and forecast Index	Days	WMT Wal-Mart Stores		GM - General Motors		F- Ford Motor		C - Citigroup		GE - General Electric		T - ATandT		VZ - Verizon Comm.		IBM		JPM - JP Morgan Chase	
		H	**F**	**H**	**F**	**H**	**F**	**H**	**F**	**H**	**F**	**H**	**F**	**H**	**F**	**H**	**F**	**H**	**F**
I	1	56.9		36.04		10.58		45.45		27.41		19.82		35.67		81.85		34.94	
	40	58.42		41.88		11.63		44.7		31.93		22.3		35.51		90.29		34.6	
II	41	57.59	57.84	41.69	41.80	11.49	11.34	44.94	44.39	31.72	31.24	22.35	22.53	35.55	35.40	90.63	90.91	34.66	34.48
	189	58.1	57.82	47.77	46.51	13.56	13.32	49.21	50.86	30.47	31.00	18.3	19.45	37.26	37.21	90.65	91.74	38.54	39.30
III	190	58.35	58.96	48.27	46.13	14.94	13.73	49.14	50.09	30.7	29.88	18.59	18.30	37.69	37.37	91.26	91.03	37.68	37.95
	191	58.6	58.62	48.84	52.07	15.77	15.60	49.66	49.80	30.85	30.88	18.03	18.73	37.76	38.00	90.74	90.92	38.38	36.94
	192	58.97	58.59	49.18	49.49	15.7	18.31	49.18	50.25	30.69	31.08	18.34	18.19	37.54	37.81	91.28	89.55	38.3	38.14
	193	58.14	59.07	49.33	49.15	15.69	15.66	48.99	48.82	30.75	31.03	18.31	17.73	37.74	37.82	90.43	90.61	38.55	38.01
	194	58.6	57.95	49.5	49.47	16.03	15.18	48.96	48.73	30.55	30.92	18.14	18.30	37.5	37.79	91.11	90.15	38.62	37.72
	195	57.98	58.69	48.5	49.56	15.5	14.58	48.43	48.03	30.02	30.62	17.85	17.73	37.66	37.60	90.41	90.35	37.93	38.19
	196	57.57	57.41	47.62	48.46	15.37	14.31	48.17	47.95	30.05	30.52	17.49	17.60	37.79	38.18	89.08	90.59	37.65	39.23
	197	57	57.32	47.42	47.29	15.36	15.11	48.09	48.40	29.95	30.19	17.15	17.76	37.74	37.93	88.17	89.50	37.6	38.14
	198	56.54	56.65	48.29	47.32	15.27	9.28	48.56	48.41	30.3	29.97	17.09	18.10	37.69	37.79	88.02	88.61	37.86	37.87
	199	56	55.96	47.94	42.95	15.41	14.44	48.84	47.68	30.44	30.12	17.09	17.23	37.89	37.32	89	87.66	38.31	37.77
	200	55.86	55.34	47.56	47.92	15.12	15.04	48.63	48.74	30.49	30.22	17.3	17.10	37.83	37.77	88.96	101.41	38.05	38.07
Number of trend coincidences		88(160)		86(160)		88(160)		82(160)		103(160)		73(160)		81(160)		71(160)		94(160)	

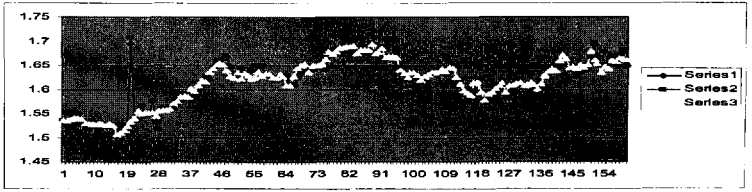## 1. EUR/ USD
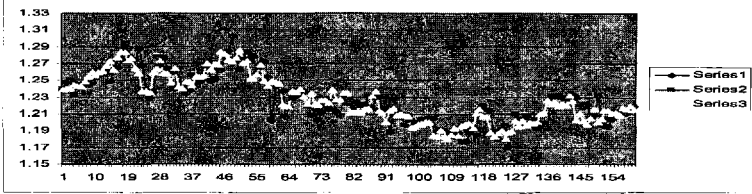
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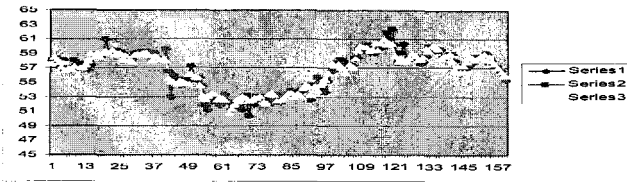

3. EUR/ CHF
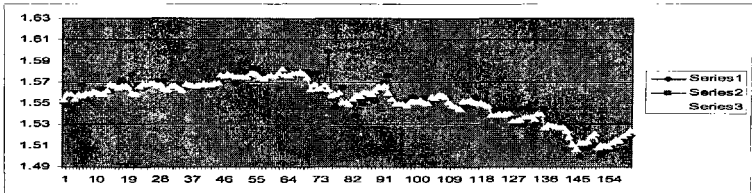
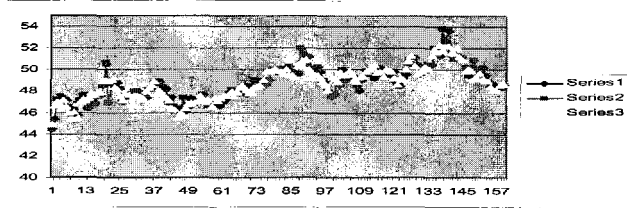## 4. EUR/ JPY
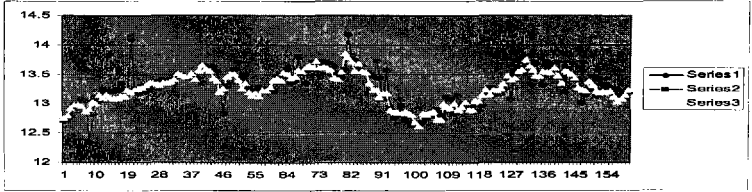
5. EUR / CAD

Picture 2: Graphical comparison of historical and forecast exchange rate indices
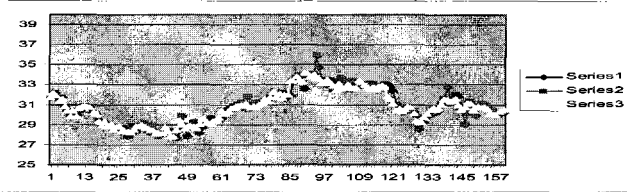
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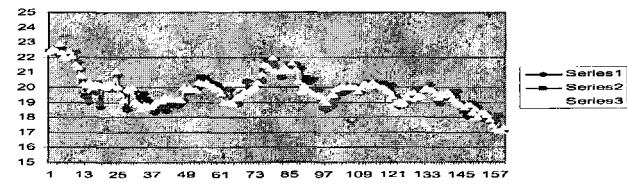## 1. WMT Wal-Mart Stores
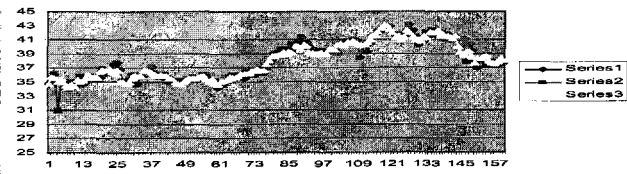

2. C - Citigroup
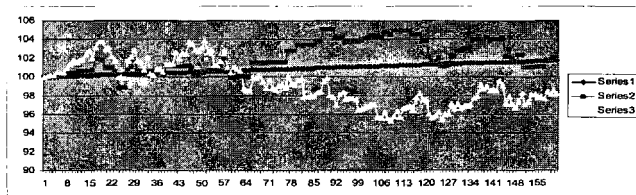

3. GE - General Electric
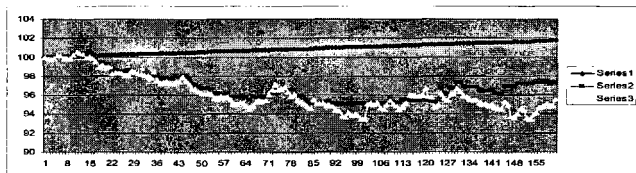

4. T - ATandT

5. JPM - JP Morgan Chase

Picture 3: Graphical comparison of historical and forecast stock price indexes

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1. EUR/ USD

2. EUR/ GBP

3. EUR/ CHF
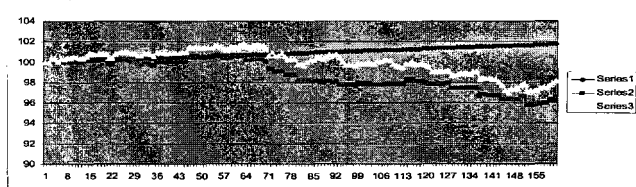
4. EUR/ JPY
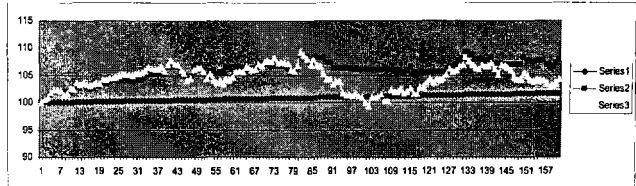
5. EUR / CAD
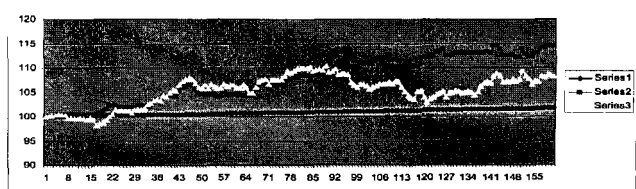
Picture 4: Possibilities of utilization of maximas in currency market (FOREX)

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1. WMT Wal-Mart Stores
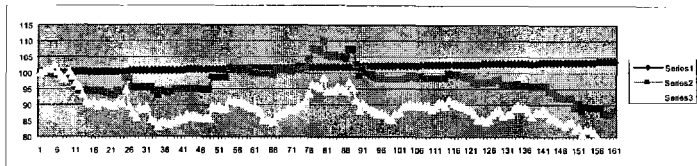
2. C - Citigroup

3. GE - General Electric

4. T - ATandT

5. JPM - JP Morgan Chase

Picture 5: Possibilities of utilization of maximas in stock market (NYSE)

Picture 6: Geometrical view of a comparison of EUR/CHF rate empirical historical data and forecaste reliability intervals

3. Portfolio decision making management as the core of DMMECM

3.1. Creating a portfolio adequate for profit stochasticity

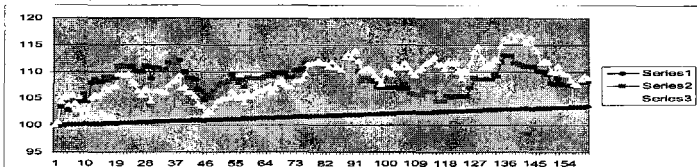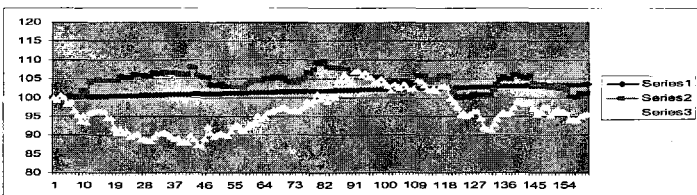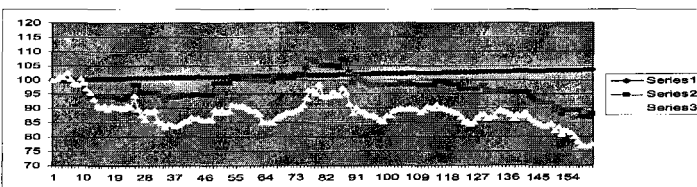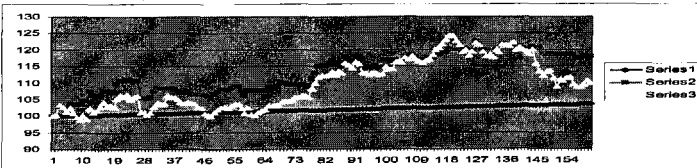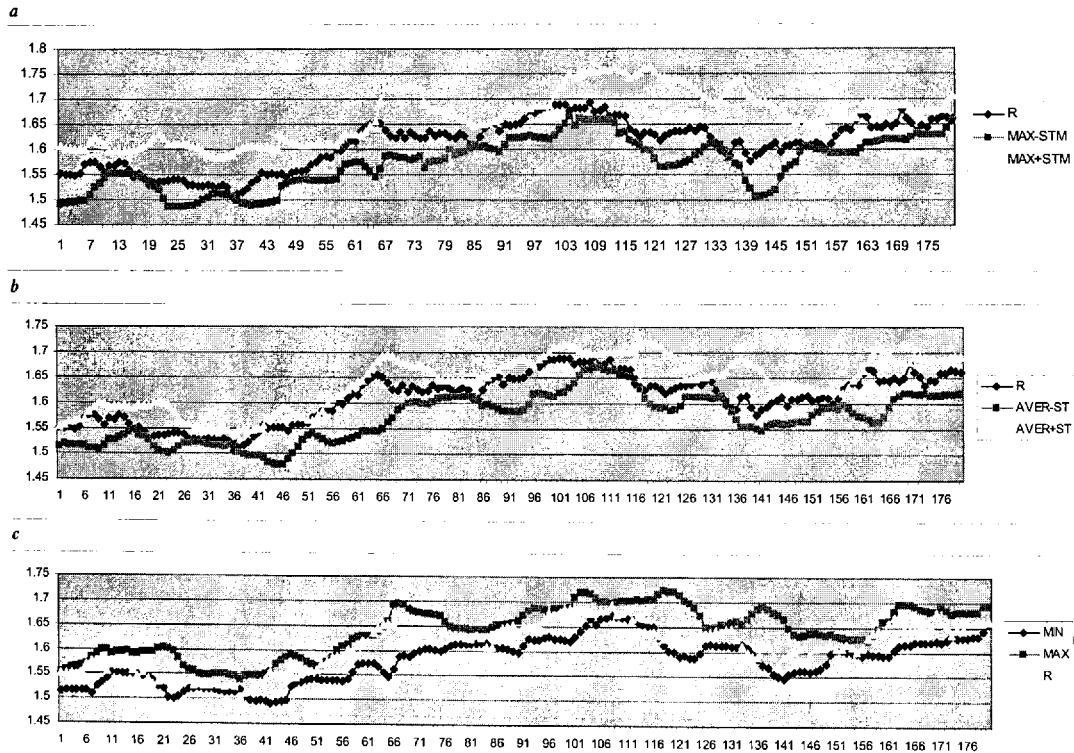The classic scheme of analysis, management or other use of portfolio is rather clear and convenient for practical application, but the way towards this simplicity is quite sophisticated. The functional expression of effectiveness and envelope (convex) curves, which is necessary in the practical portfolio use, is not obvious in the common case. But if we want to choose and manage a portfolio, it is necessary to present (imagine) different states of that portfolio, to describe the interactions of those states or to study other properties of the portfolio. The portfolio, when it is presented only by its profit average and standard deviation, in a sense is no more stochastic and gives no possibility to evaluate the reliability of many events connected with the portfolio.

Moreover, the scheme of modern portfolio selection is not yet adequate for some urgent needs of portfolio owners:

- many of risk recipients could hardly present their own impartiality curve, while the function of utility is quite understandable;
- profit expectation, which in modern portfolio theory is identified with the mean profit, is not the most probable profitability value, as the mean profit can turn to be very low;
- to ensure the desirable level of profit reliability, it is necessary to be able to select portfolios not only on the basis of two targeted indices as in the modern portfolio scheme (mean and standard deviation), but on any level of quintile – standard deviation;

- for defining the efficiency zone, i.e. the zone which shows all profit possibilities at any risk (standard deviation) level.

For a better understanding of an adequate scheme (Risk metrics group, 1999; Rutkauskas A. V., 2000; Rutkauskas A. V., 2003; Rutkauskas A. V., Miečinskiné A., 2002; Rutkauskas A. V., Stankevičiené J., 2003) of investments portfolio risk analysis (see Picture 7), let us compare the scheme of classic portfolio study and the adequate scheme. As already mentioned, according to the modern portfolio theory the investor should be interested only in the portfolios that are located on the efficiency line. The efficiency line is understood as a set of maximum possible values of profits (averages) calculated for a concrete standard deviation magnitude of a portfolio set. Joining the existing investments into a portfolio in all possible proportions creates a set of possible portfolios; then the total portfolio's profit averages and the standard deviations are evaluated.

However, in reality investments are monitored and realised not by their profit averages, but by the possible values that depend on the investment market and purchasing price. Thus, it is important for the investor to see the profit possibilities of the whole set of portfolios, but not only of the portfolios that are on the efficiency line. Therefore the investor is interested in the whole efficiency zone, which is understood as a set of efficiency lines for all possible quintiles. So, studying the efficiency line on which we have the portfolios' maximum averages, for each value of a possible portfolio standard deviation turns into studying the efficiency zone. The investor's indifference curves in their turn should be changed (expanded) by the usefulness functions.

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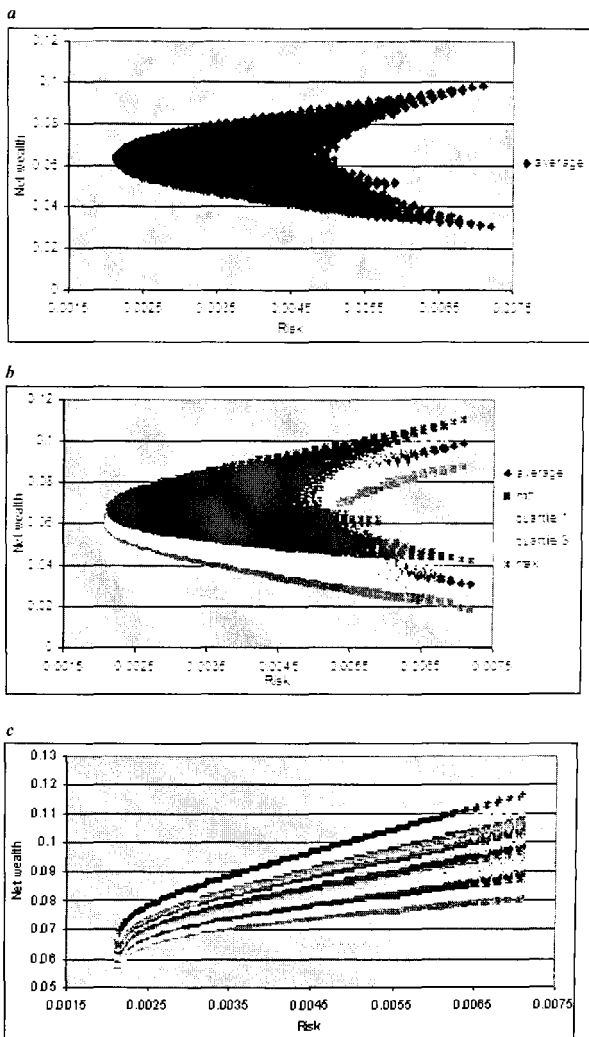
Picture 7: Complex picture of portfolio risk analysis:
a – a set of mean value – standard deviation portfolios;
b – a bunch "all quantiles" or a bunch of quantile–standard deviation portfolios;
c – the efficiency zone.
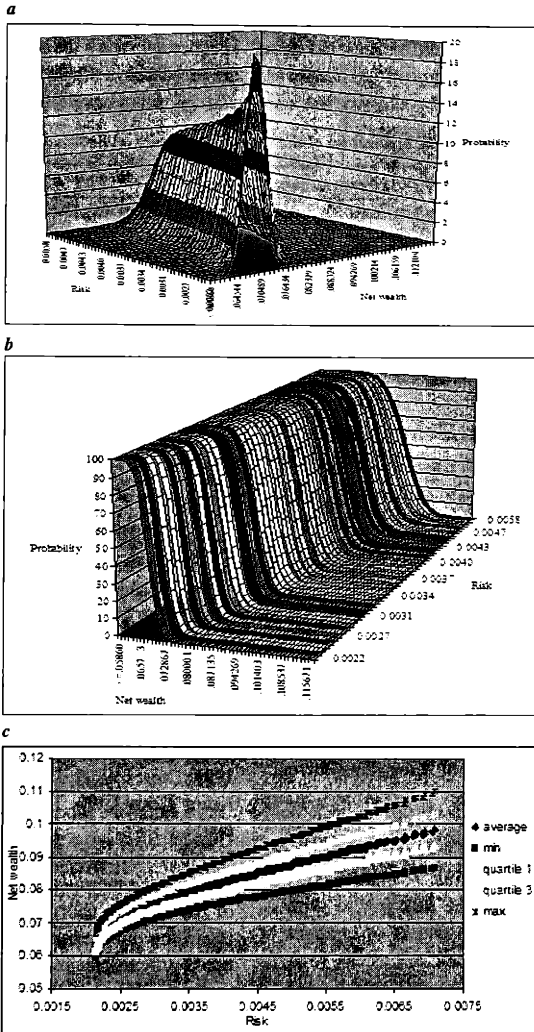
Picture 8: Common sight and view properties of the efficiency zone:
a – a family of distribution (density) functions at different levels of risk;
b – a family of survival functions at different levels of risk;
c – minimal and all quartiles confidence level isoguaranties.

Summarizing this stage, it is important to note once again the basic differences that arise when applying the classic portfolio theory (it is often called 'modern' in the literature) and the adequate portfolio theory proposed here. They are presented in (Table 4).

Table 4. Basic differences in the application of classic portfolio theory and adequate portfolio theory

Classic portfolio theory	Adequate portfolio theory
• determines the efficiency line, in which portfolios have the maximum average profitability among all portfolios with the same riskiness from the possible set of portfolios • the indifference curve of each investor allows to choose a portfolio in which the investor reaches his maximum profit • profitability of separate investments and portfolios in general is considered only through the interaction of the mean values and standard deviations	• determines the efficiency zone, in which there is a probability distribution of maximal possibilities of all quintiles for each level of risk of a possible set of portfolios • allows to choose the level of risk and the maximum distribution of possibilities for every investor, which maximises both the benefits of the investor and investment • all profitability possibilities for separate investment and for the whole portfolio are considered together with risk recipient utility functions, which account for possibility differences

3.2. Subsystem of portfolio decision management in currency and capital markets

The described system of forecasting currency rates and stock prices is a component of information support for porfolio decisions in currency and capital markets. If using the elementary strategies – maximas – in forecasting systems the task was to show as often as possible the trends of changes of currency rate or stock prices, as regards portfolio decisions also the reliability and accuracy of the forecast is important.

Portfolio decisions whose origin was the investment market by their content were directed to the possibilities of combining the profitability of optimal investments and the riskiness. This purpose of portfolio decisions remains in the currency as well as in the capital markets – to optimally balance the desirable capital growth and risk (Benth, 2001; Browne, 1999; Dieter, 1999; Dupacova, 1999; Heyeng-Keun Koo, 1999; Hiroshi, Wijayanayake, 2001).

Neverthless, the concept of riskiness whose quantitative measure is usually the instability of the process (here – profitability growth) regarding the medium level is not the feature used by the risk recipient to measure his benefit or loss. We may hardly doubt that the individual designs his behaviour with due regard for its most probable consequences, whereas most commonly used means of risk assessment, such as standard deviation and the value of risk, do not allow evaluating such

features of the possibilities as the guarranty to have certain profit, etc. Therefore, risk management requires the new possibilities of portfolio formation and management. In this case, no alternatives are left for choosing adequate investment or trade in the capital and currency markets.

Portfolio decision making management in exchange and capital markets. In this article, as is mentioned before, decisions made in the exchange rate and capital markets will be divided into simple and portfolio decisions. In the previous section we analyzed the possibilities of simple decision making management by participating (trading) in exchange rate and/or capital markets, using the forecasting system suggested there. The main provision of this forecasting system requires a practical regard to all main relationships between separate exchange rates and stock prices, which emerges in those markets and which can be identified and analyzed using only historical market data. Taking portfolio decisions we will use the same forecasting system of exchange rates and stock prices. However, if using the primitive, naive strategies (maximas) we used only the forecast information about the trend of changes of rates and prices, in portfolio decisions we will make a full use of information about exchange rates and stock prices as the possibilities for stochastical value variations. While choosing the strategy of participating (trading) in the market, we will use the possibilities offered by the adequate portfolio, thus seeking for the solutions that would satisfy both their riskiness and reliability (guaranty) requirements.

Thus, now the results of forecast, as we see in Table 5, are presented as the variation of exchange rates and prices of distribution N (a_i; S_i) with the forecast average a_i and standard deviation S_i. the form of the distribution N in various situations is different, but in this particular situation N was identified as a normal distribution. This means that the forecast couple of the parameters fully describes the variation possibilities of exchange rates and stock prices. The 190–200-day forecast presented in Table 5 was received using only earlier historical data. In Table 5, part *a* shows exchange rate forecast and part *b* only five forecasts of the NYSE stock prices, although naturally in the portfolio formation all nine selected stocks took part. The real historical data of 190–200 days presented next allow us to evaluate the accuracy and reliability of the forecast.

Since the obtained forecasts were used for choosing portfolio decisions in exchange rates and stock markets, the accuracy and reliability of forecast are evaluated only/not only according to formal methods but and/or from the view of portfolio decision effectiveness. After using an adequate portfolio model in each of 191–200 steps, stock and exchange portfolios were made. In the stock market, it was admitted that some initial capital, named in one monetary unit, was invested at the end of the step t into the named stocks, seeking that in the next ($t+1$)-e step we seek the optimal capital increase, considering the risk which is measured by standard deviations of stock price variation possibilities. Analogously in exchange rate markets we admitted that a certain, named in units, amount at the end of the period t was invested into USD, GBP, CHF, JPY and CAD, seeking that at the end of the $t+1$ period we have the optimal, regarding the risks of exchange rates, increase of capital measured in euros.

Table 6 (and 5) allows to assess the effectiveness of portfolio decision making. It can be done by comparing the capital increase that could be obtained with help of the made

Days	Currency exchange rates									
	EUR/USD		EUR/GBP		EUR/CHF		EUR/JPY		EUR/CAD	
	H	F	H	F	H	F	H	F	H	F
190	1.20	N(1.21;0.01)	0.66	N(0.66;0.00)	1.52	N(1.52;0.01)	13.31	N(13.40;0.13)	1.68	N(1.65;0.01)
191	1.20	N(1.21;0.01)	0.66	N(0.66;0.00)	1.51	N(1.52;0.01)	13.21	N(13.38;0.13)	1.66	N(1.66;0.01)
192	1.21	N(1.21;0.01)	0.66	N(0.66;0.00)	1.51	N(1.51;0.01)	13.19	N(13.37;0.14)	1.65	N(1.66;0.01)
193	1.21	N(1.21;0.01)	0.66	N(0.66;0.00)	1.51	N(1.51;0.00)	13.21	N(13.33;0.13)	1.64	N(1.65;0.11)
194	1.21	N(1.21;0.01)	0.66	N(0.66;0.00)	1.51	N(1.51;0.00)	13.19	N(13.30;0.11)	1.65	N(1.65;0.01)
195	1.21	N(1.21;0.01)	0.66	N(0.66;0.00)	1.51	N(1.51;0.00)	13.21	N(13.27;0.09)	1.64	N(1.65;0.01)
196	1.21	N(1.21;0.01)	0.67	N(0.66;0.00)	1.52	N(1.51;0.00)	13.11	N(13.24;0.06)	1.66	N(1.65;0.01)
197	1.22	N(1.21;0.01)	0.67	N(0.66;0.00)	1.51	N(1.51;0.00)	13.04	N(13.23;0.07)	1.66	N(1.65;0.01)
198	1.22	N(1.21;0.01)	0.67	N(0.66;0.00)	1.52	N(1.51;0.00)	13.08	N(13.21;0.09)	1.67	N(1.65;0.01)
199	1.22	N(1.21;0.01)	0.67	N(0.66;0.00)	1.52	N(1.51;0.00)	13.16	N(13.20;0.10)	1.66	N(1.66;0.01)
200	1.22	N(1.21;0.01)	0.67	N(0.66;0.00)	1.52	N(1.51;0.00)	13.23	N(13.17;0.08)	1.66	N(1.66;0.01)

b

Days	Stock prices									
	1		2		3		4		5	
	H	F	H	F	H	F	H	F	H	F
190	58.35	N(58.19;0.98)	49.14	N(51.26; 1.00)	30.70	N(31.03;0.42)	18.59	N(19.18;0.44)	37.68	N(40.69;1.31)
191	58.60	N(58.08;0.85)	49.66	N(51.07;1.11)	30.85	N(31.03;0.42)	18.03	N(19.10;0.43)	38.38	N(40.40;1.47)
192	58.97	N(58.01;0.74)	49.18	N(50.93;1.16)	30.69	N(31.05;0.40)	18.34	N(19.00;0.49)	38.30	N(40.16;1.49)
193	58.14	N(58.05;0.77)	48.99	N(50.73;1.17)	30.75	N(31.06;0.39)	18.31	N(18.93;0.51)	38.55	N(39.90;1.44)
194	58.60	N(58.02;0.76)	48.96	N(50.54;1.21)	30.55	N(31.04;0.40)	18.14	N(18.85;0.50)	38.62	N(39.70;1.41)
195	57.98	N(58.02;0.76)	48.43	N(50.32;1.18)	30.02	N(30.97;0.39)	17.85	N(18.76;0.50)	37.93	N(39.49;1.31)
196	57.57	N(57.94;0.71)	48.17	N(50.07;1.15)	30.05	N(30.87;0.43)	17.49	N(18.63;0.47)	37.65	N(39.25;1.24)
197	57.00	N(57.92;0.71)	48.09	N(49.83;1.15)	29.95	N(30.78;0.45)	17.15	N(18.50;0.49)	37.60	N(39.00;1.16)
198	56.53	N(57.94;0.68)	48.56	N(49.60;1.13)	30.30	N(30.68;0.46)	17.09	N(18.36;0.56)	37.86	N(38.77;1.64)
199	56.00	N(57.89;0.76)	48.84	N(49.37;0.93)	30.44	N(30.59;0.39)	17.09	N(18.22;0.60)	38.31	N(38.52;1.73)
200	55.86	N(57.86;0.83)	48.63	N(49.21;0.79)	30.49	N(30.56;0.37)	17.30	N(18.10;0.64)	38.05	N(38.41;1.60)

portfolio, with an increase that could be obtained according to a model based on the index principle, which further will be called standard portfolio. Its essence in the market will be described so that each index of the portfolio w_i^t structure is received by dividing the i-th stock turnover value in the t-th interval by the sum turnover value of all stocks in the t-th period.

In Table 6 (5) part a on the left side, exchange rates for each of the chosen ten days and on the right side the conditional portfolio generating capital increase both in each step and in sum for the whole ten-day period are presented. Part b (left side) presents the structure of the proposed, i.e. managed portfolio, and on the right side we show the capital increase given by the managed portfolio increase. Part c presents the so-called virtual model: its essence is that to the five currency rate positions of the managed portfolio a sixth position – investment to stock market, called active – is attached.

Analogously (see section c in Table 6) results of investing in capital market are presented, but here not capital increase but capital growth rates are compared.

Table 6: Comparison of 190–200-day standard and managed portfolio effectiveness in exchange rate market

a

Days	Currency exchange rates					Change of standard portfolio value
	EUR/USD	*EUR/GBP*	*EUR/CHF*	*EUR/JPY*	*EUR/CAD*	
190	1.2005	0.6631	1.5212	1.331	1.6786	
191	1.2042	0.657	1.5085	1.3207	1.6616	0.006532
192	1.2138	0.6562	1.5105	1.3189	1.6531	-0.0003
193	1.2142	0.6599	1.5098	1.3208	1.6354	0.000782
194	1.211	0.661	1.5094	1.3193	1.6466	-0.00088
195	1.2114	0.6649	1.5132	1.3212	1.6431	-0.0016
196	1.209	0.6653	1.5154	1.3116	1.6593	-0.0005
197	1.2178	0.667	1.5146	1.3044	1.6588	-0.00069
198	1.2154	0.6657	1.5187	1.3085	1.6654	-0.00117
199	1.2195	0.6663	1.5212	1.3156	1.6632	-0.002
200	1.2155	0.6711	1.5242	1.3233	1.6607	-0.00203
190–200						-0.00193

b

Days	Currency portfolios					Change in managed portfolio value
	EUR/USD	*EUR/GBP*	*EUR/CHF*	*EUR/JPY*	*EUR/CAD*	
190						
191	0	0	0.8	0.1	0.1	0.008538
192	0	0.1	0	0.1	0.8	0.004372
193	0	0.2	0	0	0.8	0.007537
194	0	0	0.1	0.8	0.1	0.000256
195	0	0	0	0.4	0.6	0.000703
196	0	0	0.1	0.2	0.7	-0.00552
197	0	0	0	0.8	0.2	0.004476
198	0	0.7	0	0.2	0.1	0.000344
199	0	0.2	0	0.8	0	-0.0045
200	0.1	0	0.1	0.8	0	-0.00452
190–200						0.01169

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c

Days	Currency portfolios						Change in managed portfolio value
	EUR/USD	**EUR/GBP**	**EUR/CHF**	**EUR/JPY**	**EUR/CAD**	**DEPOSIT**	
190							
191	0	0	0.3	0.7	0	0	0.0079849
192	0	0	0.1	0	0	0.9	0.0003179
193	0	0	0.1	0.2	0	0.7	0.0001084
194	0	0	0	1	0	0	0.0011367
195	0	0	0.1	0.3	0	0.6	-0.0003829
196	0	0.8	0.1	0.1	0	0	0.0001058
197	0	0	0.6	0	0	0.4	0.0005170
198	0.9	0.1	0	0	0	0	0.0019724
199	0	0	0.8	0	0.1	0.1	-0.0011324
200	0.2	0	0	0	0.8	0	0.001862
190–200							0.018444

4. Infrastructure of decision making management in exchange rate and stock market

4.1 Structure of DMMECM system functioning

Picture 9 shows the main principles of DMMECM system functioning. One can see how the total of historical records, which are accumulating in exchange rate and stocks markets, are transformed into information needed for managing decision-making in the process of achieving the desired goals. Dashed lines indicate that the changing situation in the market raises new demands of currency exchange
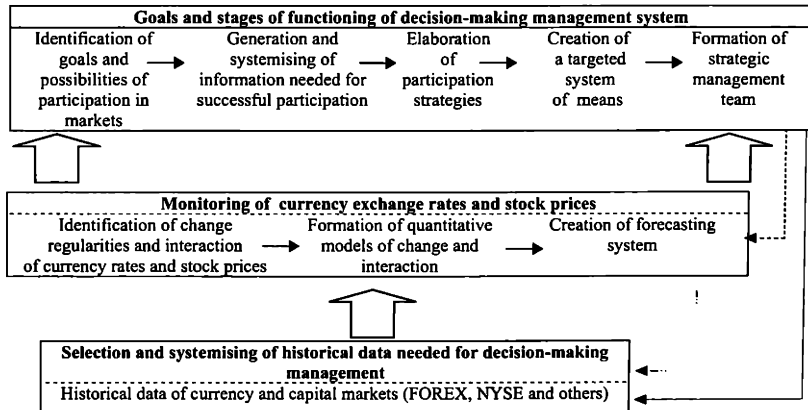
Picture 9: Structure of decision-making management system in exchange rate and capital markets

Days	Stock prices										Change in managed portfolio value
	WMT Wall-Mart Stores	GM - General Motors	F- Ford Motor	C - Citigroup	GE - General Electric	T - ATandT	VZ - Verizon Comm.	IBM	JPM - JP Morgan Chase	Deposit	
190	58.35	48.27	14.94	49.14	30.7	18.59	37.69	91.26	37.68		
191	58.6	48.84	15.77	49.66	30.85	18.03	37.76	90.74	38.38		1.007223
192	58.97	49.18	15.7	49.18	30.69	18.34	37.54	91.28	38.3		1.000972
193	58.14	49.33	15.69	48.99	30.75	18.31	37.74	90.43	38.55		0.998684
194	58.6	49.5	16.03	48.96	30.55	18.14	37.5	91.11	38.62		1.00201
195	57.98	48.5	15.5	48.43	30.02	17.85	37.66	90.41	37.93		0.987121
196	57.57	47.62	15.37	48.17	30.05	17.49	37.79	89.08	37.65		0.992372
197	57	47.42	15.36	48.09	29.95	17.15	37.74	88.17	37.6		1.002677
198	56.54	48.29	15.27	48.56	30.3	17.09	37.69	88.02	37.86		1.002677
199	56	47.94	15.41	48.84	30.44	17.09	37.89	89	38.31		1.003158
200	55.86	47.56	15.12	48.63	30.49	17.3	37.83	88.96	38.05		0.997207
190– 200											0.985689

Days	Stock portfolios										Change in managed portfolio value
	WMT Wall-Mart Stores	GM - General Motors	F- Ford Motor	C - Citigroup	GE - General Electric	T - ATandT	VZ - Verizon Comm.	IBM	JPM - JP Morgan Chase	Deposit	
190											
191	0	0.6	0.2	0	0	0	0	0.2	0	0	1.017057
192	0	0.2	0.6	0	0	0.2	0	0	0	0	1.002168
193	0	0	0.2	0	0.6	0	0.2	0	0	0	1.002111
194	0	0.4	0.6	0	0	0	0	0	0	0	1.01438
195	0	0.4	0	0	0	0	0.6	0	0	0	0.994479
196	0	0	0	0	0	0	0.2	0	0.6	0.2	0.996361
197	0	0	0	0	0.2	0.4	0	0	0.4	0	1.003704
198	0	0.4	0.6	0	0	0	0	0	0	0	1.003823

rate and stock price monitoring as well as to the primary selection and systemising of data.

4.2 Decision-making management versus search of optimal decisions

If we understand the market as an exchange mechanism which brings together buyers and sellers of commodities (products, services, production elements, financial means) in order to set their prices, the question arises whether and how price change forecasts based on historical data can influence the dynamics of prices.

If we assume that every commodity at a particular moment has its intrinsic value, which by its nature is a stochastic quantity, the concrete (current) price can be perceived as one of the possibilities of stochastic realization of the stochastic quantity. In this case the DMMECM system, which allows an accurate and reliable forecast of a possible scatter of the intrinsic value, reduces the distribution interval of current prices. In turn, the reduction of the scatter or confidence interval allows to reduce the buyers' and sellers' common loss caused by the discrepancy between the current and the most likely expected prices. Factually, whatever the method of price forecast, it influences the behaviour of sellers and buyers. This influence can be negative if the forecast information implies an increase in the reliability intervals. These circumstances show the importance of price forecast reliability and accuracy. Arguments presented in this paragraph show that the DMMECM system is something more than a system of search for optimal decisions, because its application can rationalize the behaviour of market participants in the process of price selection.

Analytical calculations have shown that portfolio decision possibilities, if analyzed in the common market of currency exchange rates and stocks, greatly increase as compared to the possibilities in the currency or the capital markets alone. Adding one component of the other market to the portfolio increases the profitability possibilities of this portfolio no less than 1.3 times (see, for example, Table 5 parts *b* and *c*). This component is called active for the currency portfolio and deposit for the capital market.

DMMECM monitoring and mathematical information methods. As is shown in Pic. 9, the monitoring basis of currency and capital markets consists of:

- identification of of change regularities and interaction of currency rates and stock prices;
- formation of quantitative models of change and interaction of currency rates and stock prices;
- creation and utilization of the forecasting system.

However, considering the formation of the above mentioned virtual portfolio, in many different markets (currency and stock exchange, real estate, etc.) new, especially important functions of monitoring appear. First of all it is the monitoring of the interaction among different markets, their analysis, modelling and forecast. In many cases these problems are not given a quantitive analysis at all.

As regards the mathematical informational methods of DMMECM, it seems reasonable to note three groups of tasks that required imitation technologies to be created and used for solving them:

- large systems of complex stochastic equations and stochastic programming problems;
- implicit stochastic equations;
- assessment of the influence of process interrelations.

Conclusions

The current study allows several conceptual, pragmatic and technical conclusions.

- **Conceptual conclusions:**
- investigations of the possible changes in currency exchange rates and stock prices are usually constricted by the illogical and non-adequate presumption that the intrinsic value of currency rate or stock and the price expressing it are strictly predetermined, i.e. accepted as point-estimated. Here we have to agree to the universal wisdom that future, if it were possible to point-estimate it, would never come. The future price of a stock can be understood and thus analyzed only as a certain range of possibilities, which can be often treated as a cognizable stochastical magnitude;
- although analysis of the behaviour of the currency and capital markets, i.e. of the mechanism that uses all the available information to investigate price generation, is based on a rather perfect and throughly verified idea of market effectiveness, at the level of the main categories no adequate agreement has been reached so far.

First, the effectiveness of a market in the field of prices could be realized as its ability to generate the prices that wouldn't allow constructing the trade strategies better than those naïve ("buy and hold"). In this case, checking the hypothesis of market effectiveness would mean checking whether having any kind of information the market does it. Further, as regards the range of the possibilities, the meaning of the frequently used category "expected" should be concretized as the most probable (mode), especially in many cases when it is wrongly assumed to be the average value;

- practical models describing price dynamics do not account for the circumstance that the behaviour of price as a stochastical pro-cess strongly depends on the state of its possibilities, and that depending on the change of this state both the content and form of the model and the factors influencing price change should also change.

- **Pragmatic conclusions:**
- concrete calculations have shown that even in the most globalized markets such as FOREX, NYSE and others there exist visible shoals of market effectiveness, i.e. situations when using only historical information and the "buy and hold or sell" strategy it is possible to obtain a significant advantage over the "buy and hold" attitude;
- analysis of the possibilities of portfolio decision management has shown that in currency and in stock markets, using only the dynamics of historical prices and their interrelations, it is possible to obtain a significant advantage over the "buy and hold" strategy according to the market portfolio structure;
- in practice, decisions of investment portfolio become considerably more profitable if a common currency rate and stock portfolio is formed. Practical calculations have shown that the guaranty of the gain higher than the market average of a thus constructed portfolio is close to unity.

- **Technical conclusion:**
- for the search and management of solutions in currency rate and capital markets, mathematical and informational methods are needed to solve large-scale systems of stochastic programming, in which the variables have to meet the restrictions of complex interrelation changes and are interrelated with the help of implicit functions. Besides, the solutions must be obtained within a real time, i.e. almost at the time the tasks are formed. In such cases no alternative is left for imitation technologies allowing to obtain, though usually approximate, solutions of a needed accuracy.

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VALIUTŲ KURSŲ IR KAPITALO RINKOS VEIKSMINGUMO SEKLUMOS

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S a n t r a u k a

Šio straipsnio tikslas yra aprašyti preliminarius tyrimo, skirto sprendimų priėmimo valdymui valiutų ir kapitalo rinkose, rezultatus. Tyrimo objektas – sprendimų priėmimo valdymas valiutų ir kapitalo rinkose (SPVVKR). Konkretus tyrimo tikslas buvo prekybos valiutų kursais ir akcijomis sistemos, kuri remiasi tik istoriniais tos prekybos duomenimis ir leidžia sukurti prekybos strategijas su norima garantija, užtikrinančias teigiamus prekybos rezultatus, sukūrimas ir praktinis panaudojimas.

Koncepcinis straipsnio tikslas buvo parodyti, remiantis specialiai sukurtomis, tiek paprastomis, tiek portfelinėmis prekybos strategijomis, kad šiandieninėse valiutų kursų ir kapitalo rinkose egzistuoja realios galimybės gauti didesnį negu vidutinį rinkoje prekybos pelną, t.y. parodyti, kad šiose rinkose egzistuoja tam tikros veiksmingumo seklumos, kurios gali būti suprantamos kaip tų rinkų neveiksmingumo požymiai.