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RESULTS OF MISTAKEN TIME PERIOD IN ANALYSIS IN THE CASE OF FRAMING EFFECT FOR SOME CAPITAL MARKETS' MODELS

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Abstract Economic activity around the world should be supported by analysis determined by the different level of difficulty of applied quantitative methods. The article presents the importance selecting a proper time window for analysis for correct diagnosing of situations based on information taken from TNI, BSOPM, Markowitz's, and Sharpe's models. TNI shows the role of expansiveness of media relations regarding the SE. The correct specification of the time window causes the proper valuation of price and risk. Behavioural finance flaming effect is a field of discussion in his research.

Keywords: behavioural finance, Black-Scholes Option Pricing Model, Tragic News Indicator, Sharpe's model, framing effect

INTRODUCTION

Economic activity around the world should be supported by analysis determined by the different level of difficulty of applied quantitative methods. Supporters of Becker's theory would claim that such a situation can be achieved by trying to calculate in the decision making process. Their opponents – behavioural economists – will explain such events as willingness to justify decisions or to blur responsibility for investment decisions. In both cases, the same problem is exact specification of time period for analysis.

The article presents the importance selecting a proper time window for analysis for correct diagnosing of situations based on information taken from TNI (tragic news indicator), BSOPM, Markowitz's, and Sharpe's models.

TNI shows the role of expansiveness of media relations regarding the Stock Exchange. The correct specification of the time window for TNI allows determination of how strong an influence negative information has on changes of the Stock Exchange indexes and how strong speculative information is (supported by BNI – bad news indicator and GNI – good news indicator). In the case of a capital market

model, correct specification of the time window causes the proper pricing of a financial instrument, and proper valuation of risk.

Statistical data used in this article are taken from the Warsaw Stock Exchange. Quotations of instruments of capital market in Poland from September 2008 to February 2009 and press information from Polish Press Agency are used.

The influence of wrong time period specification for three groups of financial market analyses were analysed in this paper:

- Technical analysis (Tragic News Indicator)
- Portfolio analysis (Markowitz and Sharpe models)
- Derivatives market analysis (BSOPM)

THEORETICAL ASPECTS

This article is closely tied with the prospect theory, because of its attempt to explain some motives to taking investment decisions.

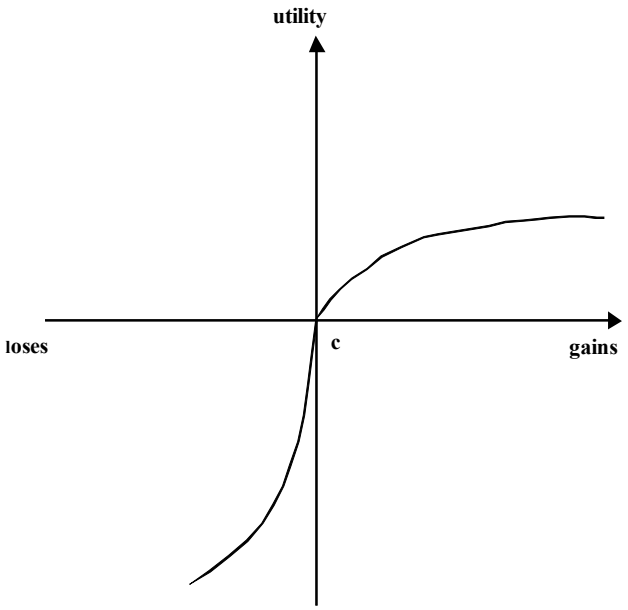
Human behaviour in the last twenty years has played an important role in building value of stock exchanges and creating interactions between market participants, etc. D. Kahneman and A. Tversky (1979) created a new theory, which has had to explain why people are not rational in the sense of G. Becker's theory (1990). In this work, the authors showed that there is significant difference between behaviour of investor incurring losses and gains. Figure 1 shows difference in level of emotions during a process of receiving information about results of economic activity.

The meaning of this chart is that a human is more sensible when incurring losses than earnings. This difference is about 2.5 times more for loses than earnings. It means that when an investor loses $100 he has to earn about $250 because of compensation losses (figure 1 shows such type of differences in utility of gains and losses).

The framing effect could be explained best by the two following citations:

1. "The term frame dependence means that the way people behave depends on the way that their decision problems are framed" (Shefrin 2000).
2. "The rational theory of choice assumes description invariance: equivalent formulations of a choice problem should give rise to the same preference order (Arrow, 1982). Contrary to this assumption, there is much evidence that variations in the framing of options (e.g., in terms of gains or losses) yield systematically different preferences (Tversky and Kahneman, 1986)."

Figure 1. Utility function for earning and loses with respect to point of reference c.



Source: [Rabin M., Psychology and economics, Department of Economics University of California – Berkeley, 1996], page 8.

MODELS USED IN THE RESEARCH

TRAGIC NEWS INDICATOR (TNI)

A point of view in most cases is formed by media. Mainly it concerns a perception of risk. People tend to assign greater risk to objects and events, on which the attention of media is more focused. This is due to form of presentation. For example, all plane crashes are presented in the form of pictures, stimulating imagination, yet car crashes are presented as statistical data. It is because the probability of plane crashes is smaller those of cars. However, if an ordinary consumer has been asked what kind of accident he fears more, most would choose plane crashes. Analogous with all information about crises, crashes and bankruptcy are overestimated.

There were many experiments, which aim to explain the influence of information on valuation of stocks in future. Andreassen (1987), presented fictitious news and quotations of stocks (positive and negative) to a selected group of investors. After that, investors had to estimate the new value of these stocks. An alternative group of investors in predictions of a stock's future value most often use regression as the mean process of a selected group. A selected group of investors predicted stable growth of stocks. This means that when an investor is under systematic press noise, he misuses knowledge and intuition in the valuation process.

Shiller (2001), described another such phenomenon – speculative bubble, which is closely tired with media influence on financial markets. A speculative bubble is an unsustainable increase in prices brought on by investors' buying behaviour, rather than by fundamental information. There are twelve factors that may explain existing or creation of speculative bubbles in the financial markets. One of them is an expansion in media reporting of business news.

Press economic information, taken from Polish Press Agency (PAP), could be treated as a source of media noise, which has an influence on the value of stocks quoted on the Warsaw Stock Exchange. All economic news should be divided into three groups: neutral information, positive information and negative information. For each type of negative information, it is possible to mark the most tragic news with respect to the economy. Negative information is a cause of an extreme behaviour of investors on the market and this a reason of focusing this research only on tragic information. As the most tragic news author recognized such news, which in its title have had such words as crisis, fall down, or panic. On the basis of this data, an indicator of media expansiveness was constructed. This indicator is a quotient of the number of articles in a chosen group of information, and the number of all PAP information in particular day.

$$TNI = \frac{NTN}{TNN} \cdot 100\% \tag{1}$$

where *TNI* – tragic news indicator; *NTN* – number of tragic headlines; *TNN* – total number of news items.

The authors used methods of correlation and regression analysis to identify the behavioural character of dependency between analysed variables. Because of a short time period in this research, statistical verification of significance of correlations is very important. The level of confidence in this case is set at 0.05.

In this research, correlation coefficients between rates of return of indexes of chosen Stock Exchanges were presented first. Next, the research will show how strong is the influence of media relations on the changes in prices of stocks quoted on the Warsaw Stock Exchange.

BLACK SCHOLES PRICING MODEL

This part of the efficiency tests is based on the Black-Scholes pricing formula, with six kinds of volatility used in the valuation process. Classical BSOPM formula could be presented using equations:

For a call option in t-th moment:

$$c = S \cdot N(d_1) - X \cdot e^{-r(T-t)} N(d_2) \tag{2}$$

where

$$d_1 = \frac{\ln(S/X) + (r + \sigma^2/2)\cdot(T-t)}{\sigma\sqrt{(T-t)}} \tag{3}$$

$$d_2 = \frac{\ln(S/X) + (r - \sigma^2/2)\cdot(T-t)}{\sigma\sqrt{(T-t)}} = d_1 - \sigma\sqrt{(T-t)}\,. \tag{4}$$

where S – The value of the underlying asset in moment t, X – Strike price of option, r – Domestic risk-free interest rate, T – Time to option expiry, σ – Volatility of the underlying asset, $N(d)$ – normal cumulative distribution function of d1 or d2, respectively.

With using put-call parity[1], we get an equation for European put option value:

$$p = X \cdot e^{-r(T-t)} N(-d_2) - S \cdot N(-d_1) \tag{5}$$

MV MODEL

Harry Markowitz created theory of effective selection of assets to portfolio (*MV – Mean-Variance Model*). This theory is a basis of most modern models in portfolio analysis. In this work, we use two classical formulas:

The first goal function:

$$S^2 = X' \cdot D \cdot X \rightarrow \min \tag{6}$$

where X – The vector of shares in portfolio, X' – the transposed vector of X, D – The matrix of variance and covariance of rates of return

With conditions:

1) $X_i \geq 0$ for $i = 1,2,\ldots,n$

2) $\sum_{i=1}^{n} X_i = 1$

The second goal function:

$$R_p = \sum_{i=1}^{n} X_i \cdot R_i \rightarrow \max \tag{7}$$

With conditions:

1),2) and

3) Sp = a, and a is a level of accepted risk

SHARPE'S MODEL

[1] Stoll H.R. (1969)

Sharpe's model is a simple econometric model, which aims to explain how sensible the effects of are rates of return are on changes in markets rate of return. The market rate of return is represented by that of the stock exchange index (in the Polish conditions WIG20).

We could show this model as an equation:

$$R_{it} = \alpha_i + \beta_i \cdot R_{mt} + u_t \tag{8}$$

where R_{ii} – rate of return, R_{mt} – market rate of return, α_i, β_i – structural parameters of an econometric model estimated by OLS procedure.

In addition, total risk is described by the formula:

$$S_i^2 = \beta_i^2 \cdot S_m^2 + S_e^2 \tag{9}$$

Where $S^2{}_i$ – total risk parameter, $S^2{}_m$ – variance of market rates of return

EMPIRICAL RESULTS

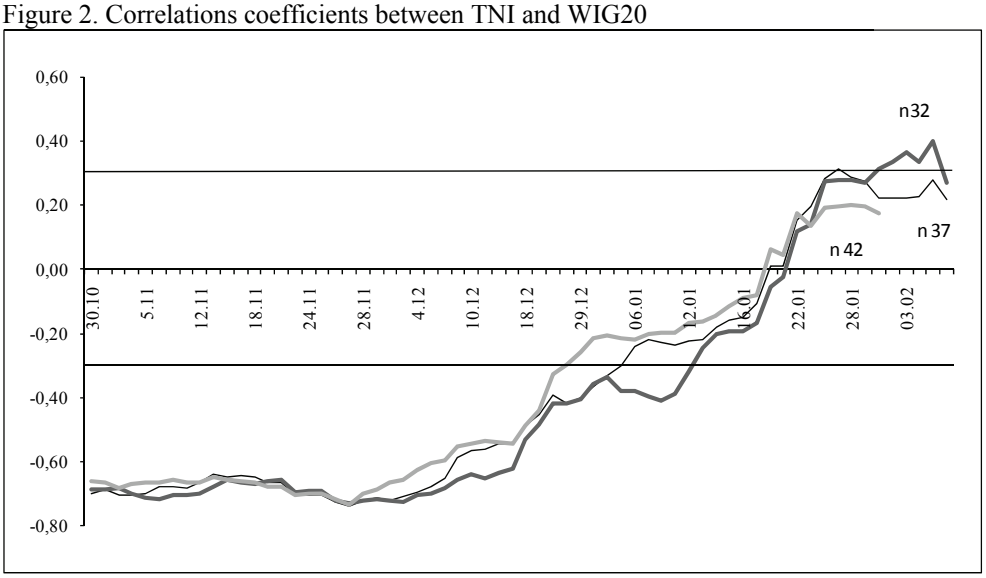
The correlation between TNI and changes in WIG20 was analysed in the beginning of the research. Authors observed changes in correlation coefficients, which were results of changing a time period (minimum 32 observations, and maximum 47 observations for the estimation of correlation coefficient). The results are presented in figure 2.

As shown in figure 2, generally the correlation coefficient implies that the importance of press information slowly loses power. In the beginning, the level of dependence was about -0.7, and then entered in the area of insignificancy (two black lines on the figure). The information taken from n32-line is untrue because of significant, positive value of the correlation coefficient. Moreover, because TNI comes from technical analysis, the reaction of n42-line is too slow. So frame coefficient (FC) was constructed for identifying the proper time window. The FC is presented as an equation:

$$FC = \frac{RR}{VaR} \tag{7}$$

where RR – rate of return (logarithm), VaR – value of risk

Figure 2. Correlations coefficients between TNI and WIG20



Source: own research

Table 1. Changes in frame coefficient for WIG 20 with the hypothetical investment value 1000 PLN

	RR36	RR37	RR38	RR39	RR40	RR41	RR35	RR34	RR33	RR32	RR31
max	73,75	58,85	69,42	80,26	90,75	114,03	79,89	80,40	80,37	107,47	107,47
VaR	23,58	23,45	23,45	23,35	23,32	23,22	23,69	23,84	23,96	23,86	24,00
FC	3,12	2,51	2,96	3,44	3,89	4,91	3,37	3,37	3,35	4,50	4,48

Source: own research

The Authors made the assumption that if an investor loses $100 he has to earn about $250 because of compensation losses, so FC should be close to 2.5. From this table it is possible to identify the best time window from the perspective of frame effect. In this case, RR37 (rates of return for 37 observations) has had the best estimations.

One of the most important variables in the BSOPM model is the volatility of underlying asset. Accordingly, the authors tested the volatility for defining the proper time window for the analysed model. The results are presented in Table 2:

It was necessary to construct a new one frame coefficient for this model. In addition, if the relation of earnings to possibility of gains is a point of discussion in this article, so a value of FC should be estimated using an equation:

$$FC = \frac{RR}{\sigma} \tag{8}$$

where RR – maximum of logarithmic rates of return for analysed time period (8,15%), σ – risk parameter defined by standard deviation (sigma).

Table 2. The frame coefficient for WIG 20 volatility

No. of days	VaR	ln RR	FC	Sigma
70	6,771	-23,64%	2,92	2,80%
75	6,900	-8,95%	2,81	2,90%
80	7,030	-21,43%	2,71	3,01%
85	7,168	-33,92%	2,60	3,13%
90	7,260	-43,51%	2,54	3,21%
95	7,225	5,33%	2,56	3,18%
100	7,173	7,82%	2,60	3,14%
105	1,792	-9,84%	2,59	3,15%
110	7,129	-1,64%	2,63	3,10%
Range	0,488	51,33 p.p.		0,42 p.p.

Source: own researches

The proper time window for this situation is 90 days, because the FC indicator is closer to 2.5. Interestingly, this sigma parameter is highest in the analysed group. Also, a one day-risked value for the amount of 1000 PLN for this time period is highest, and the gain is the biggest one (real logarithmic rate of return amounted to -43,51%).

Next, research was conducted to verify the time period for the portfolio selection model MV in two cases: minimization of risk, and maximization of rate of return. The analysed portfolio was constructed on a base of the 20 shares, which have the greatest capitalizations on the Warsaw Stock Exchange. Results are presented in Table 3:

In this table, there are results of two diversification attempts. If the FC coefficient is constructed in the same way as in the case of BSOPM testing, it is possible to underline an 80-day period as the best estimation, but only for maximization procedure. It is a normal situation, but only for models in which a goal is to increase hypothetical earnings. Interestingly, in this case the best potential rate of return is not for the best frame coefficient.

Table 3. Empirical results for Markowitz model

	min			max		
No. of days	Sigma	RR	FC	Sigma	RR	FC
70	17,57%	20,48%	1,17	27,94%	62,43%	2,23
75	17,82%	19,97%	1,12	31,52%	76,42%	2,42
80	**18,98%**	**23,39%**	**1,23**	**27,12%**	**66,82%**	**2,46**
85	19,84%	15,02%	0,76	32,06%	69,58%	2,17
90	**19,54%**	**13,61%**	**0,70**	**97,08%**	**36,80%**	**2,63**
95	19,36%	8,87%	0,46	85,07%	37,33%	2,28
100	19,21%	7,16%	0,37	37,02%	70,71%	1,91
105	19,05%	6,00%	0,32	40,38%	76,01%	1,88
110	18,72%	4,09%	0,22	42,01%	74,82%	1,78
Range	2,27 p.p.	19,30 p.p.		69,96 p.p.	39,62 p.p.	

Source: own researches

Next, a test of proper time period was made for Sharpe's model for portfolios constructed using Markowitz's procedure. Results of this calculation are presented in Table 4:

Table 4. Empirical results for Sharpe's model

No. of days	beta	alfa	Rp
70	0,773	0,005	-17,81%
75	0,887	0,005	-7,41%
80	0,757	0,004	-15,81%
85	0,767	0,006	-25,44%
90	0,848	0,008	-36,14%
95	0,872	0,007	5,32%
100	0,887	0,005	7,44%
105	0,929	0,006	-8,55%
110	0,969	0,006	-0,97%
Range	0,212		43,58 p.p.

Source: own researches

Table 4 presents econometric model parameters (β, α), and hypothetic rate of return for the portfolio. The highest level of earnings is reached with a 100-day time period, and the worst for a 90-day period. A difference (spread) between these two estimations of R_P is 43.58 percentage points.

For these critical cases, the authors present risk calculations in groups of specific, market, and total in Table 5:

The strongest characteristic in risk estimation is the fact that differences between 90-days time period and 100-days time period are very small in terms of total risk. The structure of total risk determines the final result in the level of rate of return. The smaller level of specific risk is positively correlated with potential earnings.

Table 5. Risk calculations for Sharpe's model

No. of days	specific	market	total
90	1,67%	2,26%	2,81%
100	1,48%	2,37%	2,80%

Source: own researches

The final test was focused on the results of options pricing with using Black Scholes Option Pricing Model. There were two kinds of results, presented separately: for call options and put options. Final solutions of BSOPM are shown in Table 6:

Table 6. Differences in option prices and theoretical results of BSOPM

No. of days	range call	range put
70	155,53%	**53,19%**
75	133,85%	54,52%
80	121,63%	55,27%
85	102,10%	56,57%
90	101,35%	57,38%
95	100,32%	57,94%
100	**85,34%**	61,58%
105	98,54%	58,60%
110	96,66%	59,11%

Source: own researches

In the analysed case, there are significant differences between results for put and call options, but the 90-days period proper for standard deviation is not one of them. It is important because in BSOPM the authors used standard deviation as a parameter of volatility. The best result was chosen based on the range (call or put). This range was a difference between maximum and minimum percentage deviation of a theoretical price of the option from a market price. For call options, the proper time period is 100 observations, and for puts 70 in the analysed case.

CONCLUSIONS

This work shows is the complications in making analyses of capital markets. Each investor waits for a method, which will give him enough time for making a decision. The most important factor is the interpretation of results. There are six separate conclusions to be drawn from this research:

1. There is no universal time period for financial models.
2. In case of technical analysis, even 6 days would change the meaning of an indicator.
3. For Markowitz's model, the best time was 80 and 90 days in the FC criterion.
4. We could use a FC goal function as maximization utility criterion.
5. For BSOPM the best results were for 70 days (put option), and 100 days (call option).
6. BSOPM is more effective for the level of exercise price, than for changing in the duration of volatility.

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Skutki błędnej cezury czasowej w świetle efektu framingu dla wybranych modeli rynku kapitałowego

Streszczenie: Prowadzenie każdej działalności gospodarczej na świecie wymaga wspierania jej przez prowadzone na różnym poziomie abstrakcji analizy. W niniejszym artykule zostanie zaprezentowane znaczenie wyboru wła-

ściwego okna czasowego do analiz dla prawidłowego diagnozowania sytuacji wynikającej z kształtowania się wskaźnika TNI, modelu Blacka-Scholesa, Markowitza oraz modelu Sharpe'a. Właściwe wyznaczenie przedziału czasowego skutkuje prawidłową wyceną instrumentu finansowego czy ryzyka. Behawioralny efekt *framingu* jest tłem prowadzonych w artykule rozważań.

Słowa kluczowe: finanse behawioralne, model Blacka-Scholesa, wskaźnik TNI, model Sharpe,a, efekt framingu