

The risk in the capital market. Imperfections of measurement and analysis

Radoslaw Pastusiak¹

Abstract

The article is devoted to the problem of risk in the capital market. Simple risk measurement tools and whole systems are described. The capital market shows many situations which are not described by risk analysis models since the company can suffer from large losses. Common causes of bankruptcies or companies' losses are psychological factors, which are elements not included in the classical analysis of a random variable. Hence the goal of the paper is highlighting the role of the immeasurable factor in risk analysis and its significant impact on investments in the capital market. To achieve this goal, available risk measures have been examined by analyzing their mathematical and statistical nature. Then the cases of bankruptcies and financial problems of companies have been traced, with particular emphasis on LTCM fund. Within the scope of the investigated problem the N.Taleb approach seems to be particularly interesting, which describes the distortions and illusions, by which the investors are affected, what often results in large losses. However, it does not give a specific prescription how to cope with it and how to predict the arrival of the famous "black swan".

Key words

risk, capital market, market efficiency, LTCM

JEL Classification: E44, G11, G15, G33, D81, D84

1 Introduction

The concept of risk has always been associated with the stock market. Investors in their investments are accompanied by nervousness, haste and the constant fear of what will happen next. Often their mood indicator is the stock price, which is a verification of whether the investor accurately predicted the future. Investors are trying to absorb the flow of information which they use to draw conclusions allowing them for multiplying their capital. The stock market is changing permanently and the changes of prices are the source of risk. Taking risk gives the investors a chance to become richer, and enables the development of civilization [Feder-Sempach, 2011].

In finance there are two terms with a similar meaning - risk and uncertainty. In everyday language, the two terms are used interchangeably, but in scientific discourse different researchers show clear differences. The term risk means the danger in which there is an element of chance. Uncertainty is defined by the term risk, i.e. the situation containing risk or the element which is hard to predict. While the risk is measurable, related to future events, the probability of its occurrence is possible to estimate, the uncertainty is impossible to be measured using statistical methods [Feder-Sempach, 2011, Nahotko, 2011].

Because of the broadness of the risk issue it is difficult to analyze and describe in an orderly manner. It stems from the fact that risk is associated with fundamental aspects of

¹ Dr. Radoslaw Pastusiak, Faculty of Economics and Sociology, Univerzity of Lodz. Email: radoslaw.pastusiak@uni.lodz.pl

psychology, mathematics, statistics and history. Despite the conducted research on risk and multifaceted approach to risks both in the capital market as well as in the organization and wherever it occurs, particularly in the capital market the unforeseen circumstances occur, which are the source of huge losses for financial institutions and the problem to overcome for market supervisors. Hence my belief that the existing risk analyses ignore the important areas and risk assessment tools and the solutions used in the capital market do not fit the complexity of the behavior of the real world of finance.

The goal of this paper is a description of risk measurement tools in the capital market and an attempt to find errors that are made while using conventional, standard risk measurement and assessment methods. The hypothesis states that risk measurement methods in the capital market do not describe all risks. The variety of situations that occur, their different character, makes it impossible to prepare for and prevent crisis situations. In this perspective, the investors in the capital market are not prepared at least for some part of the risk.

2 The measurement of risk in the capital market

In the theory of risk, there are two approaches to risk depending on its effects - negative and neutral [Feder-Sempach, 2011]. Negative risk concept treats risk as a threat. According to it, the risk is considered as the possibility of suffering harm or loss. The neutral risk concept, on the other hand, treats it symmetrically - as a threat and as an opportunity. According to this concept the risk results from the possibility of obtaining the result different from expected. In this case, the risk can be measured and analyzed provided that a fixed reference point, an expected state, is set. Only then the deviation from this state, and thus the level of risk can be determined.

In the risk analysis there are some important elements associated with risk exposure and the size of losses [Feder-Sempach, 2011]:

- Level of losses - determines how large damage can occur with the assumption that exposure is defined in the context of the worst-case scenario that could take place. The scale of the losses is the size of the damage, which is likely to arise during the period.

- Likelihood - is related to the determination of chance that the risky event occurs. The greater the probability of this event, the bigger is the risk.

Taking the above into account, scientific experience clearly indicates that the risk can be measured, and its effects can be priced and described. Of high importance for the understanding of risk is its division into [Mentel 2012, Mayo 1997, Tarczyński at al. 2001]:

- Systematic risk - refers to the factors which affect the profits from all comparable investments. Due to the existence of such risk the purchase of similar securities does not diversify the source of risk.

- non-systematic, specific risk - covers the area of the entities' action and can be controlled by this entity. The most important cause of the risk is management of the company, competition, raw material availability, liquidity, bankruptcy of the company.

The behavior of market prices of securities and forecasting of their changes is for many investors an integral part of the investment. The research attempting to explain price fluctuations in markets have been carried out for many years and their analysis allows for the estimation of investment risk. The consequence of this is creation of the concept of three market efficiency levels: efficient market in the weak, half-strong and strong form [Feder-Sempach 2011]. The difference between them lays in accepting more and more accurate assumptions as to reflecting the relevant information in share prices. The adoption of such assumptions allows for a theoretical explanation of the volatility of stock prices. However, for

the purpose of investment strategies it is relatively difficult to apply such assumptions, because we do not know with what market type investor has to do at the moment.

In the financial literature the risk measures are divided into risk volatility measures, sensitivity measures and downside risk measures. However, if we accept the effects and sources of risk analysis as the criterion of distribution, this measures can be divided into:

- Measures incorporating the effects of risk - measures based on the statistical distribution of the random variable and the measures shown in descriptive form.
- Measures taking into account the sources of risk - measures resulting from risk factors dependent function.

The basic characteristics of capital investments are the rate of return on invested capital and risk. The rate of return is the relation of the effect of investment to the capital required to obtain it. The risk is measured by the standard deviation, which is defined as the deviation from the average rate of return [Mentel 2012].

The measures taking into account the effects of risk are the measures of dispersion of distribution, Quantiles of distribution, value of the probability distribution function. These measures are used to measure the risk understood in negative terms, but in neutral terms the measures of dispersion of the distribution are used. The classic and most popular measure is the standard deviation. The standard deviation, however, does not take into account risks arising from the fat tails of the distribution. Such measures as the skewness and kurtosis estimate the risk in this context in more detail.

Sensitivity measures that take into account the sources of risk are based on models making the analyzed risk variable dependent on certain variables called risk factors. These measures reflect the impact of risk factors on the analyzed risk variable. The stronger this impact, the higher the risk and vice versa. In this area, we distinguish deterministic and stochastic models. Deterministic model shows the exact relationship between risk variable and risk factors. Stochastic model indicates the approximate relationship between the risk variable and risk factors. This approximation is reflected by the presence of a random variable called a random factor.

The rate of return tells what part of invested capital will return to the investor in the form of income. In the capital market the rate of return is the primary carrier of information which is a basis for the further risk analysis. The formula of the rate of return on investment can be calculated as:

$$R = \frac{P_t - P_{t-1} + D_t}{P_{t-1}}$$

where:

R - rate of return in the period

P_t - price of the security

P_{t-1} - price of a security in the period P_{t-1}

D_t - dividend paid in period t

The above formula means that the rate of return calculated on the basis of historical data is a characteristic of the security from the past. Based on the rate of return the expected rate of return can be calculated, which gives information about the possible value of the rate of return on securities in the future.

The standard deviation is a deviation from the average rate of return. Its assessment makes sense when the probability distribution of positive and negative deviations from the expected rate of profit is not symmetric. The standard semi-deviation can also be used, which is a deviation from the average of negative rates of return. It makes sense in cases where the distributions of rates of return are not symmetrical.

When considering investments in securities, in this case in shares, investors are willing to invest their capital in instruments that will bring potentially the highest rate of return. It is important to remember that usually large profit is accompanied by higher risk. Therefore, it is important to search for shares giving the highest return with the lowest risk. Such a compromise may be the coefficient of variation of shares. It is interpreted as a value of risk per unit of the rate of return on shares.

$$V = \frac{S}{r}$$

where:

S - standard deviation

r - expected rate of return

In this case the most valuable shares are those that have the highest possible V value.

Another measure is range, determined as the difference between the maximum and the minimum rate of return. It gives more relative insight into the scale of risk of investing in shares. On the one hand it favors the shares for which the aforementioned difference is the highest, on the other hand it indicates their high potential riskiness.

Another coefficient is the skewness, which can be described by the formula:

$$(Q_3 - Me) + (Me - Q_1)$$

where:

Q₁ - lower quartile of rates of return in the analyzed period

Q₃ - upper quartile of rates of return in the analyzed period

Me - the median of rates of return in the analyzed period.

It is important that investor should try to choose the shares with maximal right hand asymmetry. Then the likelihood of interest rate drop below the expected value is small and the likelihood of achieving higher benefit is significant.

The first scientific analysis of risk and rate of return was the paper by Harry Markowitz Portfolio Selection, published in 1952. This paper was the foundation for the process of diversification and selection of efficient portfolio. In order to make money the investor has to take risk. Markowitz answered the question whether there is a method of selecting portfolio of securities, allowing for minimizing risk while maintaining maximum profitability of the portfolio [Feder-Sempach 2011].

Based on research and observations it can be concluded that in most cases there is a positive relationship between risk and return on investment. This means that the choice of shares having higher rates of return means acceptance of higher risk.

Kind of a natural continuation of this theory was the work of W. Sharpe focused on verification of the effectiveness of the model where the main variable, on which the return on shares is dependent, is the rate of return on the stock market index. The variable reflecting the risk in this model is a beta, which says what will be the change of the rate of return on the security, if the rate of return on the stock exchange index changes by 1%. This ratio is considered as a measure of market risk of shares [Mentel 2012].

Another trend in conducted analyses involved the assumption of comparison of rate of return on a security to a random variable. The commonly accepted theoretical approach in the risk analysis is random variable model used in probability theory. Random variable is characterized by its distribution. It can be distinguished between continuous and discontinuous random variable. When it is impossible to accurately measure the value of a variable characterizing the risk, only a discontinuous variable can be used, showing certain conditions, such as: low risk, medium risk, high risk. In practice, it is necessary to estimate the parameters of the distribution of the random variable. For this purpose fundamental

information about the analyzed variable, historical data and expectations are usually used [Feder-Sempach 2011].

In case of the capital market a widely adopted assumption is that the rates of return on shares have conditional normal distribution [Mentel 2012]. Technically, of course, changes in stock prices do not have continuous distributions due to the lower limit, however, for the purposes of this analysis this fact is ignored. Through statistical analysis the areas of higher incidence of certain levels of rates of return, both positive and negative, can be determined. Assuming that the characteristic of the share has not changed, you can expect a similar distribution of rates of return in the future.

This assumption was the basis for the application of such risk measures as Value at Risk or complex risk assessment programs as Risk Metrics.

Today's advanced risk analysis procedures are focused on building a model that would reflect the complexity of the processes taking place in the capital market and more broadly across the organization. Table 1 shows the key actions in this area important for the final specification.

Table 1. Model specification methods

Method	Goal
Verification of hypotheses	The choice of a „true model”
Interpretation	Interpretation of data, contained in the sample, related to the interdependent variables
Simplification	Constructing a useful model
Data searching	Choosing the right set of data for estimation and forecasting
Constructing a model after the preliminary analysis of the data	Correction of an existing model

Source: Kuziak, 2012

The data presented suggest the existence of a formal risk estimation procedure, used in analyzing risk across the organization or in a narrow range of security risk. The risk in the capital market for a particular financial instrument can be described as the probability of adverse changes in the value and thus the risk control methods focus on its reduction and avoidance. The history of the capital market is virtually the history of bankruptcies and business failures, hence, the conclusion is that risk management in its current form is incomplete.

3 Anomalies in the estimation of the risk and their consequences

Despite the existence of simple risk measures presented above as well as risk measurement systems cumulated in models, which are designed to assess the overall risk of an investment or business, bankruptcies occur from time to time for due to mistakes, fraud or unusual events in the capital market. Below a few cases of companies that have spectacularly lost millions of dollars in the market are described. This will highlight the importance of risk management in the capital market [Kuziak 2011, Lam 2003].

- Metallgesellschaft AG, the German mining and steel company lost approximately \$ 1.5 billion in 1993 on the hedging transactions in the oil market. Among the reasons the discrepancy of terms between crude oil supply contracts and short-term futures derivatives hedging them, can be mentioned. The company did not have a coherent risk management policy.

- Sumitomo Corporation - in July 1995 a general manager managing operations in the copper market admitted that he had been running unauthorized operations in this market for 10 years. His activities led to losses of \$ 2.6 billion.

- Ford Corporation lost \$ 933 million on activities related to protection of the supply of palladium. The reason for this situation was lack of cooperation between departments within the company, between the department of supply and treasury and lack of a uniform policy of risk management in the company.

- Enron went bankrupt in 2001 as a result of accounting fraud. The company transferred its liabilities to subsidiaries, showing a good financial situation.

- WorldCom collapsed in 2002. The cause of bankruptcy was an accounting fraud involving the overstatement of value of assets.

- The Italian company Parmalat was acting in the food industry. The company collapsed in 2003 after detecting accounting fraud that took place in years 1995-2002. The value of financial deficit of the company was estimated at \$ 10-13 billion.

- In the company Royal Ahold in 2003 the overstatement of profits by more than \$ 500 million was detected, which resulted from accounting fraud and unfair practices. This was the result of the risk management policy.

On a smaller scale, but also in Polish companies irregularities have been detected. Szczecin ESPEBEPE and Big Bank Gdansk may be an example. In 2008, over 15 thousand Polish companies have suffered losses from option transactions entered into in order to protect against risk. Zero-cost option structures transferred the risk of depreciation of the zloty, which actually occurred, on companies. As a result many companies went bankrupt.

The cases of the described above companies that suffered losses are examples of companies where there was no control and risk management. However, a very interesting example is the bankruptcy of the LTCM fund in 1998. It is interesting because although it was a company specializing in risk assessment, a hedge fund that used advanced risk evaluation models, it did not avoid bankruptcy.

The co-founders of the LTCM fund were Myron Scholes and Robert Merton – the laureates of the Nobel Prize for constructing a derivatives valuation model. The scientists built a model that allows for efficient transactions and maintaining position in the market. They used risk indicators such as VaR to estimate possible losses on transactions. However, VaR is able to predict the state of the market on the basis of historical data. If something has not happened, then it has low probability or is completely disregarded by the model. According to the theory of statistics, with the normal distribution (random walk) the flagship company of the American Stock Exchange - Microsoft - can fall by 3 s (standard deviations) once in four years, by 6s once in four million years of trading. In 1987 the research on the implicit phenomena at the ends of normal distribution was initiated. However, the cause of most crashes was the lack of liquidity and this was not noticed. In 1994, the LTCM fund was launched, using VaR as one of the basic methods of risk assessment. At the meetings indications given by the aggregator of risk were analyzed. One meeting was devoted to the sensitivity analysis, the catastrophic scenarios were discussed. One of the scenarios was a tenth grade earthquake in Tokyo, or what would happen if the U.S. job market encounters 35-percent slump in one day. It was considered that in the worst case, the fund would lose \$ 2.5 billion (half of its capital). It was not considered a likely event. The reason was that such non-

linear events are essentially unpredictable, nobody knows if they will happen tomorrow, in ten years, or will not happen ever. Most of the time the markets can be described by a statistical distribution, so that rates of return fall within predictable ranges.

The first loss and the announcement of LTCM disaster occurred in May 1998. The Fund recorded a loss of \$ 312 million (-6.42% of equity). This resulted in exceeding the VaR limit for the first time. Surprisingly, the situation deteriorated further in June: loss amounted to \$ 461 million (-10.14%). The reason was probably the U.S. mortgage market and liquidation of business of one of the hedge funds. At this point the problem arose, how to deal with this situation. It could be ignored and treated as, known from statistics, the so-called isolated value, or integrate it into the model and treat as a serious problem. However, the fund management completely ignored this fact and in order to explain it introduced a new foundation to the model. It was assumed that if the researcher knows the fundamental parameters of the model well enough, he can decide whether the observation is fundamental and can be neglected or not. In the case of the events of May and June 1998, it was concluded that they are not fundamental and do not result from market efficiency. It was a pure psychological trick based on the principle: "It is better to know why something is lost, than to have no idea about the reasons." So instead of radical measures it was only decided to slightly reduce the involvement in the market by selling the most liquid assets, such as bonds, with the aim of easy redeeming them later.

The Russian crisis of 1998 brought the losses to all western investors in this market. But it was not even all, as the crisis spread, causing a general fear and rumors about losses of business partners. In addition, the situation in global financial markets was deteriorated by the risk protection system - VaR. The combination of losses and increase of volatility resulted in exceeding of safety limits and many banks and funds had to reduce their involvement in the market. It was necessary to limit arbitrage transactions, and the fact that the majority of arbitrageurs had similar transactions caused that their simultaneous attempt to exit from the market deepened the losses even more.

In September 1998 the history of LTCM reached the end. Nicolas Dunbar in his book put it quite bluntly, but nonetheless accurately and truthfully: "The thirty-year heritage of finance theory turned out to be useless. Impressive experience and the Nobel Prize were no longer relevant."

Nobel laureates created a very sophisticated concept, but it did not survive in real, brutal world. Robert Merton and Myron Scholes developed a model of the world based on what is predictable, even though they knew about nonlinear events and considered their theoretical impact. Finally, they ignored them. Because how to take into account what is unpredictable and immeasurable? The world gave us once again a harsh lesson about its unpredictability and people's weaknesses.

It needs to be concluded that although the model approach, described above, gave a good description of reality, at the time of increasing losses the fund did not respond to the exceeded VaR but justified it theoretically, which was a huge mistake. For in this case not the theories matter, only the losses incurred by the particular strategy. Price movements in the market cannot be fully described by statistics and mathematics.

Interesting perception of risk was presented by N.Taleb, American author who promoted the existence of the so-called black swan in the financial market and in personal life. That means a rare event, positive or negative, which is changing the world of the person who met him [Taleb 2006]. According to Taleb, there is much more randomness in the capital market than we would like to admit. This results in a number of cognitive errors that are the best listed in Table 2:

Table 2. Table of confusion. Selected elements.

General	
Luck	Determinism
Randomness	Certainty
Probability	Knowledge, certitude
Theory	Causality, law
Forecast	Prophecy
Market performance	
Lucky idiot	Skilled investor
Survivorship bias	Market outperformance
Physics and engineering	
Noise	Signal

Source: [Taleb 2006, p.37]

Confusing the left side of the table with the right one is largely the result of human nature. We are looking for patterns and schemes in the surrounding world. Analyzing the phenomena, we move from the simplest explanations to increasingly complex ones, that can be understood only by a handful of people in the world, because what is, for example, the theory of chaos in the capital market, an attempt to explain the behavior of the system, in this case the stock exchange.

4 Summary

The effectiveness of the ways of risk measurement and management presented in this paper cannot be denied. The existence of the assumption of linearity of the random variable and its normal distribution allows researchers for quick estimation of 95% of market events and their significance for risk. However, the entire system, which is the financial market, cannot be described only by statistics.

There is also influence of rare events, which are hidden in the tails of the normal distribution and psychological factors related to managing persons. The presented extraordinary financial losses of companies, resulting from accounting fraud are connected with the behavior of man and his pursuit of wealth at any cost. A model approach to these circumstances seems to be impossible. But they still exist and have their serious consequences for the functioning of businesses. None of the presented measures takes into account this factor, though.

Rare events described by Taleb as "black swans" are normal part of the capital market, though they occur very rarely. This does not mean that one cannot be prepared for their effects. The main risk identified here is non-linearity. The lack of continuity is often a result of the lack of liquidity in the market and inability to obtain quotations for financial instruments. Another issue is the level of involvement in the instruments and the depth of the market. This means that it is necessary to choose the volume of instruments in which to invest and not to exceed the limit of involvement in the market. Another strategy used is to invest in

a decline of the value of assets, with appropriate limits and safeguards, of course. Then, the investor can make money while the market fails.

Risk is an integral element accompanying investors' actions in the capital market. It is necessary to be aware that it has multidimensional character and it cannot be fully described using statistical tools.

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