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METHODOLOGY OF PARAMETRIZATION OF SYSTEMATIC RISK IN ENTERPRISES NOT LISTED ON THE CAPITAL MARKET

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Purpose: The article deals with the problem of parametrization of systematic risk. The aim of the paper is to review possible solutions in this respect.
Design/methodology/approach: The article is a theoretical and cognitive study. The research was based on the systematic review method.
Findings: The proposed solutions may streamline the process of parametrization of systematic risk. Moreover, they make it possible to estimate this risk in conditions in which this calculation was not possible or did not produce rational results.
Practical implications: The practical implications of the conducted research are associated with the possibility of their application for the needs of management decisions in enterprises.
Originality/value Traditional and alternative methods of systematic risk assessment were analysed. At the same time, the possibilities and limitations connected with them have been indicated.

Keywords: systematic risk, market risk, beta factor.

Category of the paper: General review.

1. Introduction

Systematic risk, also known as market risk, plays a very important role in operations of companies. Its parameterization is usually carried out by means of the classical measure, which is the β-factor. The determination of this factor for a particular company is based on the application of a well-known formula, taking into account the rate of return on the shares of that company and the market rate of return. However, this formula is not adapted to the various market situations in which companies operate. For example, it is not possible to calculate the β-factor when a company is not listed on a stock exchange or when the listing period is too short. This is the research problem addressed in the article. To solve it in this paper, an alternative tool to the traditional β-factor has been analysed. The aim of this paper is to review possible solutions for the parameterization of systematic risk. The article is a theoretical and cognitive study. The research was based on the systematic review method – a systematic review of the literature on the basis of which a synthesis of the research problem was prepared.

2. β-factor as a traditional measure of systematic risk

Systematic risk is the risk associated with the company's operation that depends on the overall market situation. It is a risk determined by external forces independent of the company and is not subject to the control of the company. It is also called economy-wide or random risk. Traditional measure of systematic risk in a company is the so-called β-factor (also referred to as share risk index or risk index). It is taken into consideration in many economic and financial accounts kept in companies. For example, in methods of calculating the cost of capital, valuation of a company or valuation of shares (Gorczyńska, 2010, p. 90).

The β-factor measures the sensitivity of the company's shares to changes occurring on the entire market, determining the level of market risk associated with investing in the assets of a particular company (Michalak, 2011, p. 175). In practice, the β-factor reflects the volatility of share prices of a particular company against the volatility of the entire market. Market volatility is usually measured by the volatility of a selected stock exchange index. In Polish conditions, this may be, for example, the Warsaw Stock Exchange Index (WIG) or other indexes relating to selected areas of the market, for example:

- TECHWIG – index covering companies belonging to the Segment of Innovative Technologies.
- WIG-BANKI – index of the banking sector.
- WIG-ENERG – energy sector index.
- WIG-BUDOW – construction sector index etc.

If we would like to refer to the situation on world markets, we have at our disposal indexes of the largest world stock exchanges, for example:

- S&P index for companies listed on the New York Stock Exchange (NYSE) and the National Association of Securities Dealers Automated Quotations (NASDAQ) in the USA.
- SSE Composite index for companies listed on the Shanghai Stock Exchange (SSE) in China.
- Hang Seng Index for companies listed on the Hong Kong Stock Exchange (HKSE) in Hong Kong.
- All Ordinaries index for companies listed on the Australian Securities Exchange (ASX) in Australia.

- FTSE index for companies listed on the London Stock Exchange (LSE) in the UK.
- CNX NIFTY index for companies listed on the National Stock Exchange of India (NSEI) in India.

In practice, the value of β-factor is determined as the ratio of the share covariance with the market index to the market index variance. The covariance determines the correlation between the volatility of income from a particular share and the volatility of income from investment in the market portfolio (represented by a market index). The variance of the market index is a measure of the risk of the systematic market portfolio. The β-factor can be directly determined from the regression of historical data concerning a given share and stock exchange index.

Practically, the value of the β-factor can be determined by the following formula (Ogier et al., p. 43):

$$\beta = \frac{\operatorname{cov}(r_{it}, r_{mt})}{\operatorname{var}(r_{mt})} = \frac{\sum_{t=1}^{n}(r_{mt} - \bar{r}_m) \times (r_{it} - \bar{r}_i)}{\sum_{t=1}^{n}(r_{mt} - \bar{r}_m)^2}$$

where:

β - beta factor,

$\operatorname{cov}(r_{it}, r_{mt)})$ - covariance between the rate of return on shares of the company and the rate of return on the market index,

$\operatorname{var}(r_{mt})$ - variance of the rate of return on the market index,

r_{it} - rate of return on shares in the company in period t,

r_{mt} - return on the market index in period t,

$\bar{r}_m$ - average rate of return on the market index in period t,

$\bar{r}_i$ - average rate of return on shares in the company in the period t,

t – period, on the basis of which the parameters of the model are determined.

The β-factor is the slope of regression function (Bernstein, and Damodaran, 1999, p. 71). If the expected rate of return on a given share is equal to the market rate and moves in the same direction, then its covariance with the market would be equal to the variance of the whole market (Johnson, 2000, p. 145). In such a situation, the β-factor is equal to 1. The β-factor higher than unity characterizes shares showing higher volatility of the rate of return than the market index (aggressive shares), while shares with lower volatility of the rate of return in relation to the volatility of the rate of return on the market index (defensive shares) show a β-factor lower than unity (Melich, 2004, pp. 167-168; Mayo, 1997, p. 193). In specific cases, β-factor may be a negative number, which means that the rate of return on shares reacts inversely to changes in the rate of return on the market portfolio (market index). This is quite a rare case, desirable when the rates of return on the majority of shares in the market are expected to fall. Another unusual case may be the β-factor equal to 0. In such a situation, the rate of return on shares does not react to market changes (risk-free share, especially risk-free instruments such as treasury bills). In general, it is believed that companies with a higher β-factor level are more risky than those with a lower β-factor level (Rakow, 2010, p. 43).

3. Problems related to the determination of the β-factor

The calculation of the *β*-factor is associated with a number of problems that need to be resolved. One of the most important problems is to indicate the length of the estimation period, the so-called estimation window. It depends, to a large extent, on the type of market from which the observations are made and on the category of rates of return adopted in the calculation. If the observations come from financial markets characterized by high dynamics of development, for example from developing (emerging) markets, then the longer the estimation period (in terms of the length counted in years, and not in the numbers of observations, which depends on the frequency of measurement), the more unstable the *β*-factor will be. The *β*-factor estimation is particularly sensitive to a lack of uniformity in the variance of a random component, which can lead to erroneous estimates. The probability of error is greater the longer the statistical sample used to estimate the *β* parameter (Brzeszczyński, 2005, p. 52). The second factor influencing the choice of the time horizon is the frequency of observation. The longer the interval used to determine the rate of return, the longer the interval to be taken into account in the estimation sample in order to obtain a sufficient number of observations. Short return periods increase the number of observations. In this area, it is accepted that, based on daily rates of return, a shorter estimation period (e.g. 2 years) can be assumed, and based on monthly rates of return this period should be extended accordingly by several years. What is important in this area is that there is a requirement for a distribution of the normal rate of return on shares and the market index.

Pogue and Solnik (1974), as well as Black, Jensen and Scholes (1972), among others, have studied the impact of the length of the estimation period on the value of the *β*-factor. They suggest using five-year estimation period and monthly rates of return for the calculation of the β-factor. Gonedes (1973), Roenfelt, Grienpentrop and Pflaum (1978), Kim (1993), Odabasi (2003), Kowerski (2003), as well as Byrka-Kita (2004), Brzeszczyński, Gajdka and Schabek (2009) recommend a time horizon not longer than 5 years. Other authors (e.g. Wright, Mason, and Miles, 2003) claim that the number of observations obtained in this way is too small. In some works, one can even find attempts to estimate the beta factor in the horizons of 10 years or longer (cf. Bradfield, 2003, Eisenbeiss, Kauermann, and Semmler, 2007, as well as Gajdka, Brzeszczyński, 2007). Supporters of such long periods of time claim that the longest possible calculation period should be used, among others, in order to reduce the fluctuations of returns in economic cycles (Alexander, 1995, pp. 32-34). However, such a period seems too long, given the high dynamics of changes, both on a general economic scale and on the scale of the surveyed company, which significantly changes the risk of investing in a given company (Tarczyński et al., 2013, pp. 50-52). Currently, the A. Damodaran's approach is quite popular in terms of estimating the β-factor. He claims that, due to the fact that emerging markets undergo dynamic changes in short periods of time, estimation tests should be within the range from 2 to 5 years. However, for companies that have undergone restructuring, have been taken over or split up, and have significantly changed their capital structure, the period should be closer to the lower limit of the range. As regards the choice of the interval in which the rate of return is measured, daily, weekly, monthly, quarterly or annual data are available. In fact, rates of return can be measured even every fifteen minutes. However, Damodaran notes that the company's core assets and, at the same time, the risks associated with them do not change over such short periods of time, so using them is not justified. Damodaran recommends the use of monthly rates of return for research periods longer than 3 years and daily or weekly rates of return for shorter periods (Damodaran, 2012, pp. 9-11).

The problem is to estimate the β-factor and to determine the systematic risk for companies that are not listed on the stock exchange or do not have a sufficiently long history of listing to correctly determine the estimation window.

4. Sectoral β-factors as alternative measures of systematic risk

If it is not possible to determine the systematic risk by means of the classical β-factor, alternative solutions should be considered. One of them is the determination of average industry or sector β indexes. Sectoral β-factors are estimated, among others, by Ibbotson Associates for companies listed on the American market. The problem related to the application of the average sectoral β-factor is the requirement of the so-called business uniformity. It is assumed that, in order to include a company in the group of uniform businesses in a given sector, it should obtain a significant majority of revenues from this sector. Ibbotson Associates applies the principle that at least 75% of revenues must come from one category of activity (Zarzecki, 2009, p. 432). Such a solution could be applied in the case of companies not listed on the financial market, whose risk could be related to the risk of listed companies operating in the same sector. However, the problem is that all rated companies will have the same β-factor, which could lead to a large possible valuation error (averaging error).

5. Accounting β-factor as an alternative measure of systematic risk

Another alternative to the average sectoral systematic risk β-factors is the accounting β-factor (β^K). It can be calculated for unlisted companies on the basis of accounting information from the balance sheet, the profit and loss account or the cash flow statement. The accounting β-factor describes the relationship between the selected value in the financial statements of a single company and the sum of the same values in all companies in a given sector. In practice, the balance of cash flows, net profit, the amount of dividends paid etc. are often used here. The basic accounting β-factor formula is as follows:

$\beta^K = cov(x_i ; x_m) / var (x_m)$,

i – index of a particular company,

m – all companies in a particular sector,

x – selected value from the financial statements.

If the change in the selected value in the analysed company is more dynamic than the change in the corresponding aggregate value in all companies in the sector, then β^K will be greater than 1 and vice versa. β^K close to 1 means that the analysed company behaves just like the sector (Skoczylas, 2003, p. 209). There is one major problem with the use of the accounting β-factor, namely the need for a long time horizon due to the low frequency of data (reports are generally published at annual, semi-annual or quarterly frequency, shorter time intervals between the publication of the accounts are rare).

6. The idea of a total β-factor in the risk parameterization process

In some approaches, it is recommended to include specific risk factors in the β-factor, in addition to the systematic risk. Such postulate is put forward, for example, by A. Damodaran, who uses the concept of total risk, referred to as **total β**, by stating that (Bernstein and Damodaran, 1999, p. 70):

total β = average industry β / industry-market correlation

Due to the fact that the correlation cannot be greater than 1, total β cannot be smaller than normal (Butler, 2015; Byrka-Kita, 2007, p. 267). However, the problem of risk differentiation for different companies from the same market remains unsolved. The total β-factor does not seem to take into account all the risks of a single company. While companies operating in the same market are vulnerable to the same risk factors from further and closer environments, they are characterized by different internal factors. They have different financing structures, profitability etc.

7. Deleveraged β-factor and systematic risk measurement

In case of problems with direct calculation of the β-factor in unlisted companies or companies with too short listing history, one more model solution can be applied. It consists in an appropriate conversion of the β-factor calculated for similar listed companies and its adaptation to the specificity of the analysed company. The starting point is the solution proposed in the R. Hamada's model (Hamada, 1972, pp. 435-452). It assumes that the risk factor of a particular company is largely determined by its level of indebtedness. The risk index increases at the same time as the share of foreign capital in the capital structure increases (assuming that the other factors remain unchanged). It follows that the use of leverage in a company increases the risk associated with investing in its shares and has a direct impact on the level of the β-factor. According to the Hamada's model, the β-factor of a company using leverage can be recorded as a function of an analogous factor in conditions of non-use of foreign capital (Michalak, 2016):

$\beta L = \beta U[1+(1-T)(D/E)]$,

where:

βL – β-factor with "leverage" (leveraged β),

βU – β-factor without "leverage" (deleveraged β),

T – income tax rate.

By transforming the above formula, it can be written as:

$\beta U = \beta L/[1+(1-T)(D/E)]$

The usefulness of both formulas lies in the possibility to simulate the development of the β-factor depending on the changes in the level of leverage. It can be applied in companies not listed on the capital market, where β calculation by standard methods is not possible. The starting point is the selection of similar companies from the sector in which the analysed company operates. The cluster analysis may be useful in this respect. It is based on the selection of a research sample from among companies listed on national or world stock exchanges, which are similar to the company in which one would like to estimate the risk. Initial similarity may be established on the basis of the behaviour of companies in the same industry, a similar financing structure or a similar volume of production, sales etc., which may be used to determine the initial similarity. The selected companies should be listed on the stock exchange in order to be able to estimate their β-factor. In the next step, the average β-factor for selected companies and the average level of their financial leverage (D/E) are determined. On the basis of this information, the deleveraged βU-factor is calculated for comparable companies. In this way, the β-factor, which is an index of systematic risk, is obtained. It is then superimposed on the level of leverage in the analysed company and a leveraged βL-factor is calculated, which is a systematic risk index with a financial risk premium. The deleveraged β-factor is considered to be a universal measure of the systematic risk of companies and can be used in companies that are not listed on the capital market or whose listing history is too short.

8. Summary

A review of the existing literature on traditional and alternative methods of parametrization of systematic risk shows that, even in cases where this calculation was not possible according to the classical methodology or did not produce rational results, there are less common methods that can be used. Systematic risk is most difficult to parameterize when the company is not listed on the capital market or the listing period is too short. However, even in such a case, there are methods that enable such calculation and give reliable results. Apart from the traditional β-factor representing systematic risk, sectoral, accounting, total and leveraged β-factors were analysed, presenting the possibilities of their application and limitations.

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