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# **APPLICATION OF MATHEMATICAL AND STATISTICAL METHODS IN COMPANY MANAGEMENT**

APLIKACE MATEMATICKÝCH A STATISTICKÝCH METOD V ŘÍZENÍ SPOLEČNOSTI

## **BACHELOR'S THESIS**

BAKALÁŘSKÁ PRÁCE

### **AUTHOR**

AUTOR PRÁCE

Ivo Chládek

### **SUPERVISOR**

VEDOUCÍ PRÁCE

Ing. Karel Doubravský, Ph.D.

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Department: Institute of Management  
Student: **Ivo Chládek**  
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Supervisor: **Ing. Karel Doubravský, Ph.D.**  
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Pursuant to Act no. 111/1998 Coll. concerning universities as amended and pursuant to the BUT Study Rules, by the Director of the Institute, you have been assigned a Bachelor's Thesis entitled:

## **Application of Mathematical and Statistical Methods in Company Management**

### **Characteristics of thesis dilemmas:**

Introduction  
Aims of the work, methods, and procedures of its processing  
The theoretical basis of management and statistical analysis  
Analysis of the selected company  
Own suggestions for improving the current situation of the company  
Summary  
References  
Attachments

### **Objectives which should be achieve:**

The aim of the work is to assess selected indicators of a selected company and formulate proposals to improve its current situation.

### **Basic sources of information:**

BREALEY, Richard A. a Stewart C. MYERS. Principles of corporate finance. 3rd ed. New York: McGraw-Hill, 1988. ISBN 0-07-007386-4.

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SHIM, Jae K. a Joel G. SIEGEL. Handbook of financial analysis, forecasting and modelling. New Jersey: Prentice Hall, 1988. ISBN 0-13-377995-5.

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L. S.

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doc. Ing. Robert Zich, Ph.D.  
Director of the Institute

---

doc. Ing. Vojtěch Bartoš, Ph.D.  
Dean

## **Abstract**

This bachelor's thesis is focused on evaluation of financial situation of a company with use of selected financial indicators and ratios and statistical methods for period 2015-2019. The thesis has three parts. Theoretical part explains theoretical background of financial analysis, time series and regression analysis. Analytical part contains company's introduction, analyses of financial records for the given period, statistical analysis for assessment of trend and prediction of future results and evaluation of outputs. Last part is devoted to proposal of measurements that would improve financial situation of the company.

## **Abstrakt**

Bakalářská práce se zabývá posouzením finanční situace společnosti s použitím vybraných metod finanční analýzy a statistiky za období 2015-2019. Práce má 3 části. V teoretické části jsou vysvětlena teoretická východiska finanční analýzy, časových řad a regresní analýzy. Analytická část obsahuje představení společnosti, analýzu finančních výkazů za zvolené období, statistickou analýzu pro stanovení trendu a předpověď budoucích výsledků a také zhodnocení dosažených výsledků. Závěrečná část je věnována návrhům opatření pro zlepšení finanční situace podniku.

## **Keywords**

Financial analysis, statistics, prediction, time series, regression analysis

## **Klíčová slova**

Finanční analýza, statistické metody, predikce, časové řady, regresní analýza

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**DECLARATION OF ORIGINALITY**

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Brno, 16th May 2021

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Signature

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## **INTRODUCTION**

Information is something incredibly valuable, and regarding decisions in a company's management, financial analysis is an inevitable and requisite source of information. Together with statistical methods enabling predictions of future progression, they make a complex tool for financial management.

Companies tracking evolution of their financial performance can quickly react to situation emerging from both internal and external environment, avoid financial difficulties and make sound decisions. On top of that, it helps in relations with external stakeholders. Adding statistical methods of time series and regression analysis allows the company to estimate development of financial indicators in future, assuming immutable conditions. Although these predictions are not 100 % accurate due to environment constantly changes, they create a solid background for further planning of financial management.

The thesis itself is divided into parts. The thesis' aim and methods of elaboration are described in the first part, theoretical background in the second part, and the third part contains elaboration of analysis of selected financial indicators and ratios and statistical analysis with data from company's financial statements, followed by evaluation of results. In the last chapter I will provide suggestion for improvement of company's financial performance.

# **1 OBJECTIVES AND METHODS**

In this chapter, I will explain goals of my bachelor's thesis together with methods that will be used for its elaboration.

## **1.1 Objectives of thesis**

Main aim of my bachelor's thesis is to evaluate financial situation in a company employing mathematical and statistical methods and to create proposals for improvement of the situation based.

## **1.2 Methods of elaboration**

I will calculate selected financial indicators and proceed with time series and regression analysis. These are statistical methods that will help us determine trend in development of indicators and predict values for 2 years ahead. The next step is to use results for unbiased evaluation of current financial situation of a company and suggest how to achieve betterment. Indicators are analysed for fiscal years 2015-2019.

## **2 THEORETICAL PART**

This chapter addresses theoretical fundamentals necessary for execution of analysis of selected financial indicators and ratios with use statistical methods. Theory is split into two parts focusing on financial theory, meaning its sources, methods and chosen indicators, and statistical theory, namely regression analysis and time series, separately to provide essential information in a synoptical form.

### **2.1 Financial analysis**

Great definition of financial analysis is *“Financial analysis is necessary in evaluating internal operations and activities to optimize profit and efficiency while at the same time reducing risk.”* (1, p. xi)

Financial analysis is a crucial tool in a life of a company. It provides its management with valuable information about financial situation of the company, comparing present and past situation and estimating future development. These outcomes can be further used to determine future actions and plan in order to improve company’s financial health and its performance. (2)

The basis for a good financial analysis are sources of appropriate quality. These come mostly from accounting reports such as balance sheet, income statement, also known as profit & loss statement, and cash flow. (3)

Besides company’s management, other stakeholders might also be interested. Creditors, such as banks, will be interested in company’s ability to repay its liabilities in a timely manner. Owners of the company want to know about profitability, investors also about level of risk connected to their investment. Government care whether the company makes profit and pay appropriate taxes, whereas for employees a height of wages is the key factor. Each stakeholder should be delivered analysis elaborated the way considering their interest. (2)

#### **2.1.1 Sources of data for financial analysis**

To achieve elaboration of financial analysis of high quality containing useful and relevant outputs appropriate data are required. (2) We will take more detailed look at before mentioned accounting reports bellow.

### **2.1.1.1 Balance Sheet**

Balance sheet is one of accounting reports legally required by a taxation office. It captures value of company's assets, owner's equity and liabilities at one given moment, usually to the last day of the calendar year, which is also the end of a taxation period. In the balance, value of assets must be equal to the sum of values of owner's equity and liabilities. Balance sheet also provides us with information on whether funding for assets is internal or external. (3),(4)

### **2.1.1.2 Income statement**

Income statement is another accounting report legally required by the Tax office. On the contrary to the balance sheet, income statement covers a period of time, usually being a calendar year for legal or managerial purposes but can be useful for financial management also in shorter time resolutions such as a month or a quarter. It provides data about company's revenues and expenses over a given period and shows its profit or loss. However, the numbers in the income statement don't correspond with actual cash flow, as it is based on accrual principle, meaning transactions are recorded at the time they occur, not the time they are paid. (3),(4)

### **2.1.1.3 Cash flow statement**

Cash flow records company's sources and use of cash or short-term financial assets over a period. Information in cash flow shows whether a company can meet its financial obligations on time and its current financial situation. We recognize three categories in cash flow statement – operating, investing, and financing activities. (3),(4)

## **2.1.2 Methods of financial analysis**

There is a vast majority of methods to perform financial analysis. However, the ones we will work with are so-called **elementary methods**. We recognize several categories among those elementary methods, namely:

- analysis of absolute indicators,
- analysis of difference indicators,
- analysis of ratio indicators,
- systems of ratios. (2)

### 2.1.3 Analysis of absolute indicators

Analysis of absolute indicators consists of horizontal and vertical analysis.

#### 2.1.3.1 Horizontal analysis

Horizontal analysis compares changes of items from statements or indicators in a time sequence. The height of absolute change is calculated together with its percentual expression to the base period, usually year. It allows us to see trends over time as various indicators increase or decrease. (2),(6)

$$\text{absolute change} = \text{indicator}_t - \text{indicator}_{t-1} \quad (1)$$

$$\text{percentual change} = \frac{\text{absolute change} \times 100}{\text{indicator}_{t-1}} \quad (2)$$

#### 2.1.3.2 Vertical analysis

Vertical analysis is based on expressing items from statements as a percentual fraction of chosen base item, which represents 100 %. This base item is usually total assets or total liabilities in the balance sheet and total revenues or expenses in the income statement. (2),(5)

$$\text{percentual value} = \frac{\text{value of chosen item} \times 100}{\text{value of base item}} \quad (3)$$

### 2.1.4 Analysis of difference indicators

Difference indicators are focused on measuring company's liquidity. (2)

#### 2.1.4.1 Net working capital (NWC)

Net working capital expresses company's ability to meet its current obligations, such as short-term debts and accounts payable. The higher NWC's value is, the more of a financial reserve company possess. Using NWC, we should take into account that all of company's current assets might not be of sufficient liquidity to meet instant cash requirements. (2)

$$NWC = \text{current assets} - \text{current liabilities} \quad (4)$$

#### 2.1.4.2 Net prompt resources

Net prompt resources show instant liquidity and ability to meet short-term obligations by a company. Compared to NWC, net prompt resources show instant liquidity, as only cash and possibly instantly tradable short-term assets are considered to be available for payment of obligations which are due date, or even payment is delayed. (2)

$$\text{Net prompt resources} = \text{prompt cash assets} - \text{immediate obligations} \quad (5)$$

#### 2.1.5 Analysis of ratio indicators

Financial ratios are numbers resulting from dividing an account from one financial statement by another account from a financial statement. Financial ratios are great for evaluating performance of a company as well as for benchmarking it with competition. (8)

Ratios have a great advantage in providing accurate information, as it omits problems with “size difference“, as numbers we calculate with always scale from the same base, making, e.g. benchmarking of competitors of diverse size easier. We can count several kinds of ratios focusing on various sides of company’s financials: liquidity, efficiency, leverage and profitability ratios. (7),(9)

##### 2.1.5.1 Liquidity ratios

*“Liquidity ratios measure company’s ability to meet short-term obligations in a timely fashion.”* (8, p. 421) is a perfect way to describe liquidity ratios.

When becoming a creditor of a company, you want to make sure they are able to pay their liabilities to you on time. Taken from another end, it is necessary to know whether you’ll be able to meet payable accounts to date, anticipating possible fees or penalties, possibly insolvency. As current assets may quickly change value, companies possess changing amounts of them, and it’s good to calculate ratios with values from the date statements to reflect reality. (6)

**Current ratio** measures how many times company’s current assets cover its current liabilities. A company should have enough current assets to be able to pay for its short-term obligations, and thus current ratio is a good indicator of health of a company. Having

insufficient funds at hand can expose a firm in danger in case of unexpected cash outflows. Companies with a higher current ratio are more liquid and thus more resistant. However, too high current ratio can point at poor usage of available resources. What is being considered a healthy number for current ratio diverse across industries, considering various needs of different companies, although some texts suggest ratio between 1,8 and 2,5 as the ideal ratio of current assets to current liabilities. (7)

$$\text{current ratio} = \frac{\text{current assets}}{\text{current liabilities}} \quad (6)$$

**Quick ratio** or acid test ratio takes current ratio but adds the factor of inventories not always being possible to turn into cash. For companies with large stocks or long turnover periods, quick ratio can more accurately show liquidity at a given moment, as well as in cases when inventories must would've been sold below their book value. The suggested optimal value is between 1 and 1,5. (7),(9)

$$\text{quick ratio} = \frac{\text{current assets} - \text{inventories}}{\text{current liabilities}} \quad (7)$$

**Cash ratio** targets the highest level of company's liquidity, comparing only cash and marketable securities to current liabilities. Recommended value is between 0,2 and 0,5. (6), (7)

$$\text{cash ratio} = \frac{\text{prompt cash assets}}{\text{current liabilities}} \quad (8)$$

**Interval measure** is a less known ratio, which indicates how many days a company would've been able to pay its daily expenses in case of 0 cash inflows from the moment. It reflects how large its daily expenses are compared to its liquid assets. (6)

$$\text{interval measure (days)} = \frac{\text{prompt cash assets}}{\text{average daily operational expenses}} \quad (9)$$

### 2.1.5.2 Efficiency ratios

Known also as asset management ratios, efficiency ratios provide insight on how efficiently company's assets are being used to make revenue. (7)

**Inventory turnover** compares the value of company's inventory to cost of goods sold during a period, giving us insight into how many times a company can sell its inventory during a period, usually a year, on average. Companies can ideally hold as much stock to



be able to satisfy all orders on time, but no more to avoid unnecessary investment in inventories, which is inefficient. (9)

$$\text{inventory turnover} = \frac{\text{cost of goods sold}}{\text{inventory}} \quad (10)$$

**Days' sales in inventory** is used to calculate how many days it averagely takes a company to sell its stock one time. The less time it takes for a product to be sold from the date of its acquisition, the less money needs to be devoted to keeping inventories. (9)

$$\text{days' sales in inventory} = \frac{365}{\text{inventory turnover}} \quad (11)$$

**Receivables turnover** measures how many times a year company manages to collect amount of its receivables. The higher it is, the better as it signals good management of assets and early collection of receivables from credit customers. (9)

$$\text{receivables turnover} = \frac{\text{sales}}{\text{account receivables}} \quad (12)$$

**Days' sales in receivables** shows how many days in takes a company to collect value of its current receivables one time. That is roughly the number of days it takes a company to convert receivables into cash. (9)

$$\text{days' sales in receivables} = \frac{365}{\text{receivables turnover}} \quad (13)$$

**Total assets turnover** displays how big revenue of a company was in comparison with its total assets. If a company manages its assets well, it will be able to generate more sales with less assets resulting in higher total asset turnover. (9)

$$\text{total asset turnover} = \frac{\text{sales}}{\text{total assets}} \quad (14)$$

**Fixed assets turnover** evaluates use of fixed assets in a company, which can be more precise to evaluate companies which need lot of equipment to generate revenue. (9)

$$\text{fixed asset turnover} = \frac{\text{sales}}{\text{fixed assets}} \quad (15)$$

### 2.1.5.3 Leverage ratios

Financial leverage ratios or solvency ratios puts company's ability to pay for its long-term obligations at question. Some of these ratios examine ability of paying interest expenses from companies own streams of earnings. (8)

**Debt ratio** shows us to which extent a company is financed by external sources. Higher the ratio is the more assets are paid from company's indebtedness, increasing financial leverage but also risk for creditors. It is generally recommended to have 30-60 % debt ratio. (9)

$$\text{debt ratio} = \frac{\text{total liabilities}}{\text{total assets}} \quad (16)$$

**Debt-to-equity ratio**, as the name indicates, measures ratio of stockholders capital to borrowed capital. (9)

$$\text{debt} - \text{to} - \text{equity} = \frac{\text{total liabilities}}{\text{total equity}} \quad (17)$$

**Times interest earned** is number of times company's pre-tax earnings cover value of interest a firm is obliged to pay. (9)

$$\text{times interest earned} = \frac{EBIT}{\text{interest expense}} \quad (18)$$

**Cash coverage ratio** adjusts times interest earned formula, adding depreciation to nominator. Depreciation is deducted from statement on a regular basis, which is not accordingly to expense for depreciated facility. Thus adding depreciation to EBIT improves accuracy with which it reflects actual ability of a company to pay for interest expenses. (9)

$$\text{cash coverage} = \frac{EBIT + \text{depreciation}}{\text{interest expense}} \quad (19)$$

### 2.1.5.4 Profitability ratios

Profitability ratios, also called rentability ratios, are examining how well a company makes use of its assets in generating revenue and how efficiently it converts sales into profit. These ratios generally provide great insight on performance of a business. (9)

### **Gross profit margin**

Gross profit margin shows how large part of revenue counts into profit, when cost of producing or buying is deducted. It indicates how significant part of a product's selling price will be left for a company to cover other expenses related to selling and to generate profit. (7)

$$\text{gross profit margin} = \frac{\text{sales} - \text{cost of goods}}{\text{sales}} \quad (20)$$

### **Operating profit margin**

Operating profit margin is similar to gross profit margin, but it also includes all other expenses of sales, leaving only tax and interest expenses out, thus omitting impact of choice of financing source. This ratio tells us how well a company can create profit with its operations. (9)

$$\text{operating profit margin} = \frac{\text{operating profit}}{\text{sales}} \quad (21)$$

### **Net profit margin/Return on sales (ROS)**

Net profit margin, which is often also referred to as to return on sales, incorporates all expenses, including tax and interest expenses into equation. It basically shows percentage of revenue that will make it all the way into "company's pocket". (9)

$$\text{net profit margin} = \frac{\text{net income}}{\text{sales}} \quad (22)$$

### **Return on assets (ROA)**

ROA ratio compares firm's net income to total value of its assets, telling us how efficiently assets of a company are managed in pursuit of profit creation. (9)

$$\text{ROA} = \frac{\text{net income}}{\text{total assets}} \quad (23)$$

### **Return on equity (ROE)**

ROE compares net income to value of stockholder's equity, providing a look on efficiency with which investments of owners are being used to generate profit and

therefore it also expresses percentual yield on stockholder's investments. Please, note that it is also possible to calculate ROE with EBIT or EAT instead of net income, changing incorporation of expenses of taxation and interest on borrowed money, depending on focus of analyst. (9)

$$ROE = \frac{\textit{net income}}{\textit{total equity}} \quad (24)$$

### **Return on capital employed (ROCE)**

By adding other source of financing, liabilities, into denominator, we can get a more comprehensive view at how overall capital employed in a company is used towards profit generation. As in previous case, it is also possible to employ EAT instead of EBIT. (7)

$$ROCE = \frac{\textit{EBIT}}{\textit{owners equity} + \textit{long - term liabilities}} \quad (25)$$

### **2.1.6 Analysis of cumulative indicators**

Each of previously presented ratios is designed specially to address company's performance or stability in a specific field, such as its solvency or liquidity, for example. Therefore, none of them can be used separately in order of delivering a complex overall evaluation of firm's financial health. Analysis of cumulative indicators solve this problem, as they connect multiple indicators from different research areas of financial analysis and examine their mutual connections and dependencies. (2)

**Pyramid decomposition** is one popular type of analysis of cumulative indicators. In pyramid decomposition, an indicator or possibly a calculated ratio on top is split into other indicators with mathematical relationships between them on each level of the pyramid structure. (2)

**Bankruptcy and credibility** models focus on calculating a single number, which would serve as a complex indicator of financial situation of a company. It is calculated from multiple indicators. Bankruptcy models are examining whether a firm is in a danger of default at the given moment, whereas credibility models serve as tools for evaluating financial performance seamlessly. (2)

### 2.1.6.1 DuPont analysis

DuPont analysis belongs among tools of pyramid decomposition category. It focuses on assessment of financial health of a company, tangibly its return on equity (ROE). In DuPont analysis, we determine ROE by 3 components: net profit margin ( $\frac{\text{net income}}{\text{sales}}$ ) total asset turnover ( $\frac{\text{sales}}{\text{total assets}}$ ) and the equity multiplier ( $\frac{\text{total assets}}{\text{total equity}}$ ). ROE can be calculated by multiplying these 3 ratios together.

$$ROE = \frac{\text{net income}}{\text{sales}} \times \frac{\text{sales}}{\text{total assets}} \times \frac{\text{total assets}}{\text{total equity}} \quad (26)$$

In diagram below, we can see the way in which ROE is compounded by the 3 ratios and how those are tied to indicators from a company's balance sheet (green-coloured cells in diagram 1) and income statement (orange-coloured cells). Note than in DuPont analysis, ROA is calculated by multiplying net profit margin with total asset turnover and ROE therefore equals ROA multiplied by equity multiplier. By breaking ROE down in particular ratios and indicators, it is easier for a firm's management to see what causes changes of ROE's value or it is differences in benchmarking with competition.

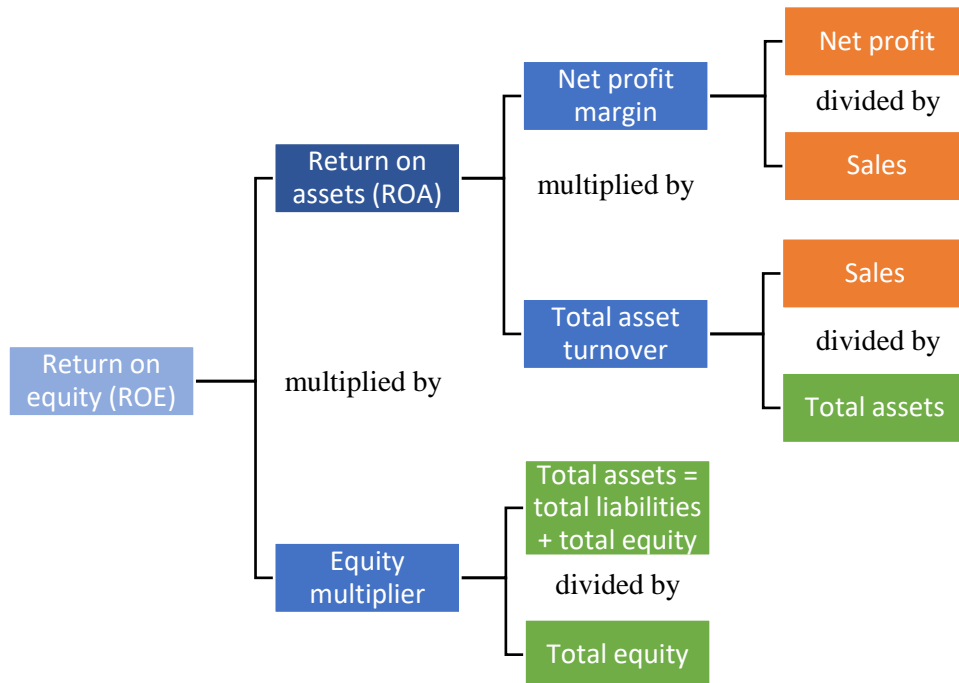


Diagram 1: DuPont analysis (9)

### 2.1.6.2 Altman's Z-score

Altman's model is one of the best-known formulas for evaluation of financial health of a company, in this particular case likelihood of firm going bankrupt. Therefore, we can recognize Z-score as a bankruptcy model. The model was invented in the year 1968 and since then, some variations have been added into practice. The original model was developed mainly for publicly traded companies, however, we will use newer version for privately held companies, as we will focus on analysis of a SME. (1), (2)

$$Z = 0,717 \times X_1 + 0,847 \times X_2 + 3,107 \times X_3 + 0,42 \times X_4 + 0,998 \times X_5 \quad (27)$$

$$X_1 = \frac{\textit{working capital}}{\textit{total assets}} \quad (28)$$

$$X_2 = \frac{\textit{retained earnings}}{\textit{total assets}} \quad (29)$$

$$X_3 = \frac{\textit{EBIT}}{\textit{total assets}} \quad (30)$$

$$X_4 = \frac{\textit{book value of equity}}{\textit{total liabilities}} \quad (31)$$

$$X_5 = \frac{\textit{sales}}{\textit{total assets}} \quad (32)$$

For interpretation of score achieved by a company, ranges are used. If achieved Z-score is 3 or higher, a company is in so-called safe zone and is considered financially stable and healthy. Z-score in range 1.81 – 2.99 is assessed as a grey zone and here firm's financial stability is not assured, but not critically problematic either. Z-score of 1.8 or lower gets a company in a bankruptcy zone, where risk of failure is very high and assessed company likely has severe financial troubles. In such case, it is up to company's management to recognize from which areas problems are and focus on improving in that area. (1)

## **2.2.Statistical theory**

Financial analysis deals with large amount of data, and for such, there are statistical methods quite useful for comparison, forecasting and finding of dependencies among financial indicators of a company. Namely time series and regression analysis are statistical tools we are going to look at.

### **2.2.1 Time series**

Time series is a sequence of values for an indicator arranged in a chronological order, where the indicator must be comparable, meaning data were obtained in time periods of the same length and data definition such as units and collection method is alike. (10), (11)

Time series help us track evolution of indicators, find trends, and forecast future development. We can classify time series based on (10):

- decisive time periods as either absolute or point time series;
- periodicity of indicator monitoring as either long or short-term time series;
- type of indicator either in absolute values and straight units or derived characteristics

#### **Interval time series**

Interval time series express value of indicator over an interval of time. The value of interval indicator depends on length of interval and therefore length of interval for each indicator must be the same to allow comparison. It is possible to sum up more interval indicators meaningfully. An example for interval time series could be number of newly infected or number of sales for a period. (11)

#### **Point time series**

Point time series express value of indicator relating to a particular moment in time. We employ specialized numerical characteristic, chronological mean, to group the data. Number of hospitalized patients or number of inventories at given time may serve as an example of point time series. (11)

#### **Short-term time series**

In this case, values of indicator are tracked multiple times a year, usually quarterly or monthly. Take CPI (consumer price index), which is compared for particular months as an example. (10)

### **Long-term time series**

These are measured annually. GDP stands as a good example. (10)

### **Absolute values time series**

Here we procure indicators directly, with unambiguous statistical units and characteristics. For instance, number of unemployed belongs here. (10)

### **Derived characteristics time series**

They are based on the absolute data, including characteristics such as percentual unemployment rate.

#### **2.2.1.1 Characteristics of time series**

Thanks to characteristics of time series, it is achievable to get comprehensive information out of the data contained in time series. Averages of time series, growth differences and coefficient and averages of those are among the elemental characteristics. We always assume that the same time distance is between neighbouring midpoints of time intervals or time points. Values are supposedly always positive. (10), (11)

### **Average of interval time series**

Arithmetic average is available to use for calculation interval time series' average. (10)

$$\bar{y} = \frac{1}{n} \sum_{i=1}^n y_i \quad (33)$$

### **Chronological mean**

Average of point time series is referred to as chronological mean. It is used in following form in cases when distance between time points of values is the same. (10)

$$\bar{y} = \frac{1}{n-1} \left[ \frac{y_1}{2} + \sum_{i=2}^{n-1} y_i + \frac{y_n}{2} \right] \quad (34)$$



### First difference

Called as well absolute increment, it is the simplest of time series' characteristics. It is calculated as difference of two consecutive values from time series. (11)

$${}_1d_i(y) = y_i - y_{i-1}, \quad i = 2, 3, \dots, n \quad (35)$$

### Average of first differences

Average of absolute increments is calculated as arithmetic average of all absolute increments. It reflects about how much have on average neighbouring values changed over the course of entire monitored period. (11)

$$\overline{{}_1d(y)} = \frac{1}{n-1} \sum_{i=2}^n {}_1d_i(y) = \frac{y_n - y_1}{n-1} \quad (36)$$

### Coefficient of growth

Coefficient of growth states the rate of development, either growth or decline, of consecutive values of time series. (11)

$$k_i(y) = \frac{y_i}{y_{i-1}}, \quad i = 2, 3, \dots, n \quad (37)$$

### Average coefficient of growth

Calculated as geometric mean of coefficients of growth, it expresses average rate of growth coefficient's change. (11)

$$\overline{k_i(y)} = \sqrt[n-1]{\prod_{i=2}^n k_i(y)} = \sqrt[n-1]{\frac{y_n}{y_1}} \quad (38)$$

#### 2.2.1.2 Decomposition of time series

Analysis of economical time series is based on the assumption that time series  $y_i$  can be decomposed into four components: trend, seasonal, cyclic and random component. Two models for decomposition of time series exist: additive and multiplicative model. Additive model is used more often. Values are expressed in form of addition. (11)

$$y_i = T_i + S_i + C_i + E_i \quad (39)$$

Multiplicative model uses multiplication instead of addition. (11)

$$y_i = T_i \times S_i \times C_i \times E_i \quad (40)$$

There are several reasons why we may want to decompose time series. By analysing particular components, we may determine behaviour of examined indicator easier. By removing some components, it is then easier to compare other among a few time series. It is also useful when forecasting future development, as we can calculate predictions for components at first and then combine them together to get prediction of former time series. (10), (11)

#### **Trend component $T_i$**

Trend component expresses long-term tendencies in development of tracked indicator. Trend is either rising, decreasing, or oscillating around a constant. (10)

#### **Seasonal component $S_i$**

Seasonal component indicates changes of values of time series, which occur regularly on a yearly basis. It is caused by influences such as seasonality or human traditions. (10)

#### **Cyclic component $C_i$**

Cyclic component describes non-regular fluctuations around trend. Phases of growth and decline are taking turns in non-regular cycles longer than a year. Its presence might not be evident, especially within time series of short interval. (10)

#### **Random component $E_i$**

Random component is made of random and non-systematic changes of values, including measurement errors. (10)

### **2.2.1.3 Description of trend by regression analysis**

Regression analysis is preferred way to describe time series', as it allows its user not only to cover progression of time series', but also forecast future development. In regression analysis, it is assumed that analysed time series can be decomposed into trend and random components. (13)

$$y_i = T_i + e_i, \quad i = 1, 2, \dots, n \quad (41)$$

It is important to choose the most suitable regression model, which we can determine with help of time series' progression's graphical interpretation or on the basis of assumed characteristics of trend component. (13)

## 2.2.2 Regression analysis

Regression analysis is used to analyse and mathematically describe dependencies of two or more variables and to predict value of dependent variable  $y$  from independent variable  $x$ . The dependence is expressed by a regression function. (11), (12)

$$y = \varphi(x) \quad (42)$$

### 2.2.2.1 Linear regression function

In regression analysis, linear functions are those with linear regression coefficients. (11)

#### Constant trend

Constant trend assumes trend has static value.

$$\eta = \beta_0 + \bar{y} \quad (43)$$

#### Regression line

Regression line is the simplest and the most often used type of regression function. Its equation is (11):

$$y = \beta_1 + \beta_2 x \quad (44)$$

In this line's equation, parameter  $\beta_1$  appoints intercept of the line with  $y$  axis and parameter  $\beta_2$  determine its tilt. (12)

To find the most appropriate line to describe collected data we will use method of least squares. In this method we are trying to find values of parameters  $\beta_1$  and  $\beta_2$  that minimalize value of  $Q$ , thus marking closer accordance of collected data with regression model. (10)

$$Q = \sum_{i=1}^n [y_i - \beta_1 - \beta_2 x_i]^2 \quad (45)$$

To find the minimal value of  $Q$ , we calculate first partial derivative and set it equal to zero. We substitute parameters  $\beta_1$  and  $\beta_2$  for  $b_1$  and  $b_2$  and do algebraic adjustments, thus

get system of 2 normal equations. By solving these equations, we are then able to extract values of  $b_1$  and  $b_2$ . (10)

$$\begin{aligned} b_1 &= \bar{y} - b_2 \bar{x} \\ b_2 &= \frac{n \sum y_i x_i - \sum x_i \sum y_i}{n \sum x_i^2 - (\sum x_i)^2} \end{aligned} \quad (46)$$

Estimate of the regression line has form:

$$\eta = b_1 + b_2 x \quad (47)$$

Regression line function is not suitable for any given data, so we may use other linear regression functions, which can describe the data better.

### **Parabolic regression**

Parabolic regression is one of linear regression functions and has this form (10):

$$\eta = \beta_0 + \beta_1 x + \beta_2 x^2 \quad (48)$$

Method of least squares is used to find the most fitting values of parameters. Process is the same as with regression line, just in this case we must calculate system of 3 equations, as we search values for 3 parameters. (10)

### **Hyperbolic regression**

Hyperbolic regression function is as well a linear regression function. For estimation of parameters, method of least squares is used for this type of regression function as well. (10)

$$\eta = \beta_0 + \frac{\beta_1}{x} \quad (49)$$

### **Logarithmic regression**

Again, logarithmic regression belongs among linear regression functions and least squares method is used for estimating parameters' values.

$$\eta = \beta_0 + \beta_1 \ln x \quad (50)$$

#### **2.2.2.2 Non-linear regression functions**

Non-linear functions have non-linear parameters and least squares method cannot be applied. (10)

### Linearizable functions

Sometimes it is possible to transform a non-linear regression function into a function which depends on its parameters linearly. We determine parameters by regression line or one of other linear regression function and by backwards transformation we obtain estimates into former non-linear function. (10)

*Power function* is common non-linear function, which is linearizable with help of logarithmic transformation. (10)

$$\eta = \beta_0 x^{\beta_1} \quad (51)$$

### Non-linearizable functions

Three of non-linearizable functions, which are often used to describe economic processes, are modified exponential trend and logistic trend.

*Modified exponential trend* is used in cases when a regression function is bounded at the bottom or bounded from above. (13)

$$\eta = \beta_0 + \beta_1 \beta_2^x \quad (52)$$

*Logistic trend* is both at the bottom and from above bounded function with inflection. It is an of S-curve symmetrical around its inflection point. (13)

$$\eta = \frac{1}{\beta_0 + \beta_1 \beta_2^x} \quad (53)$$

#### 2.2.2.3 Choice of regression function

To choose the right regression function, which will show least deviation from input data, we may employ **determination index**. (10)

$$I^2 = \frac{S_T}{S_y} \quad (54)$$

In the formula of determination index  $S_T$ , also called explained sum of squares, is sum of squared deviations of predicted values from mean of original data and  $S_y$  equals total sum of residual squares. Index of determination expresses intensity of dependency described by regression function. The closer  $I^2$  is to 1, the stronger is dependency between data and model. (10)

## **3 ANALYSIS OF CURRENT SITUATION**

This chapter is devoted to introduction of company selected for analysis of selected financial indicators and ratios, execution of analysis with chosen indicators and ratios followed by statistical analysis and evaluation of results. As the company wants to remain in anonymity, I will address it as ABC Ltd.

### **3.1 Introduction of company**

ABC Ltd. is a family-owned limited liability company established in 1999 at regional court of Ostrava. Its main activity is both wholesale and retail sale and distribution of tools, instruments and machines. Company is owned solely by one person with owner's equity of 1 million CZK. (14)

#### **3.1.1 Company's strategy**

ABC operates mainly in the Czech republic and Slovakia. It distributes and sells goods from 2 their buildings, which are located in the same area and each specializes on different type of products. These are accompanied by an e-shop, where you can order from entire assortment. ABC sells both to B2C and B2B customers. Revenues from international trade in tracked period make around 8 % of total revenue. (14)

Management of the company has flat structure with 2 executives, one in charge of trade and sales and other in charge of firm's economy and HR. Besides them ABC has 34 employees. (14)

ABC Ltd. values quality of provided service and satisfied customers are among their top goals. The company also maintains park like landscaping around their buildings, contributing to the quality of surrounding environment. ABC's as well striving to increase offered assortment, stock capacity and range of services. ABC Ltd. is a holder of ISO 9001:2016 certificate for quality control. (14)

#### **3.1.2 Recent history**

In recent years, ABC focused on growth of their business, investing in construction of 2<sup>nd</sup> building in 2016 to acquire more space for operations. Transfer to this new building was executed successfully without significant impact on firm's performance. In this year, as

well project focused on increase in technological level and competitiveness under donated Ministry of Industry and Trade's programme been undertaken as well and it has been fully implemented during the next year, together with acquisition of new equipment. ABC is evaluating the project as a good investment which has resulted in increased performance of developed department. Other than that ABC is involved in project of education of employees supported by the EU. (14)

Overall modernization consisting of above-mentioned investments has been finished completely in the year 2018. During years 2019 and 2020 company managed pandemic situation without significant difficulties and created its e-shop to provide customers with more convenient and save method of purchasing. (14)

Simultaneously with described growth of a business, ABC is hiring new professionals and number of employees is rising every year. In 2014, ABC had only 19 employees and maintained to almost double the number into 34 qualified employees by 2020. (14)

ABC next objective is to implement a system of economic monitoring in order of decreasing expenses on administration and infrastructure, which is an important aspect as the company is expanding. (14)

### **3.1.3 Product range**

ABC ltd. assortment consists of 3 major categories, which are also distributed among company's departments and buildings. First category is wide range of tools, goods, facilities and materials for constructions, workshops and gardening. Second category comprise various metallurgical materials and products from them. In third category are specialized facilities for machines and equipment such as power chucks, hydraulic cylinders, machine vices, toolholders etc. (14)

## **3.2 Results of financial and statistical analysis**

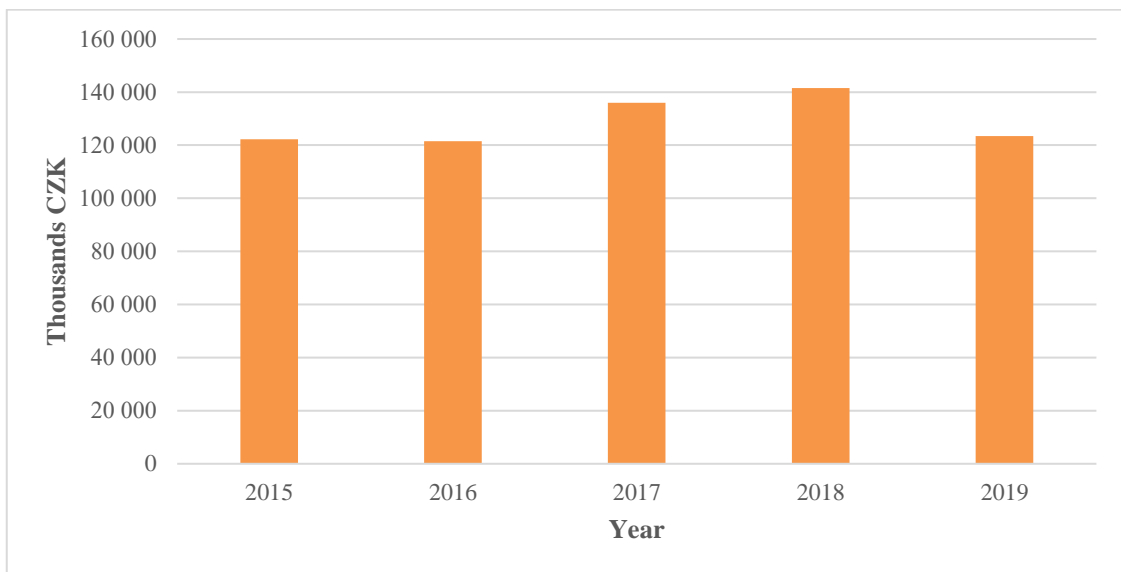
In the following part are calculations of particular indicators and financial ratios of company ABC Ltd., statistical analysis and evaluation of these. Financial statements from years 2015 to 2019 have been used for the analysis. Company's fiscal year is set from 1<sup>st</sup> April to 31<sup>st</sup> March. Used balance sheets and profit/loss statements are to be found in attachments.

### 3.2.1 Revenue

Revenue, yet simple, is a valuable indicator which can tell us about trend in ability of generating income. We can see development of ABC's revenues in table 1 and graph 1 below. Values of revenue for particular years create interval time series.

Table 1: Revenues of ABC Ltd. (Source: own processing)

Year					
	2015	2016	2017	2018	2019
Revenue (in thousands CZK)	122 201	121 497	135 940	141 505	123 469



Graph 1: Revenues of ABC Ltd. (Source: own processing)

#### Statistical analysis of revenues

Table 2 contains characteristics of revenue's time series and values according to regression model. Average revenue was approximately 128,9 million CZK with average yearly increase of 317 thousand CZK and growth coefficient's average of 1,0026. Values of time series characteristics were calculated with formulas from chapter 2.2.1.1.



Table 2: Characteristics of revenue's development (Source: own processing)

Year	Order $x_i$	Revenue $y_i$ (th. CZK)	First difference $1d_i(y)$ (th. CZK)	Coefficient of growth $k_i(y)$	Predicted value $\hat{y}_i$ (th. CZK)
2015	1	122 201	-	-	118 193
2016	2	121 497	-704	0,9942	129 778
2017	3	135 940	14 443	1,1189	135 142
2018	4	141 505	5 565	1,0409	134 286
2019	5	123 469	-18 036	0,8725	127 211
Average	3	128 922	317	1,0026	-
2020	6				113 914
2021	7				94 398

Parabolic regression was chosen as a regression function for balancing time series values.

Parabolic regression function is described with formula (48):

$$\eta = \beta_0 + \beta_1 x + \beta_2 x^2$$

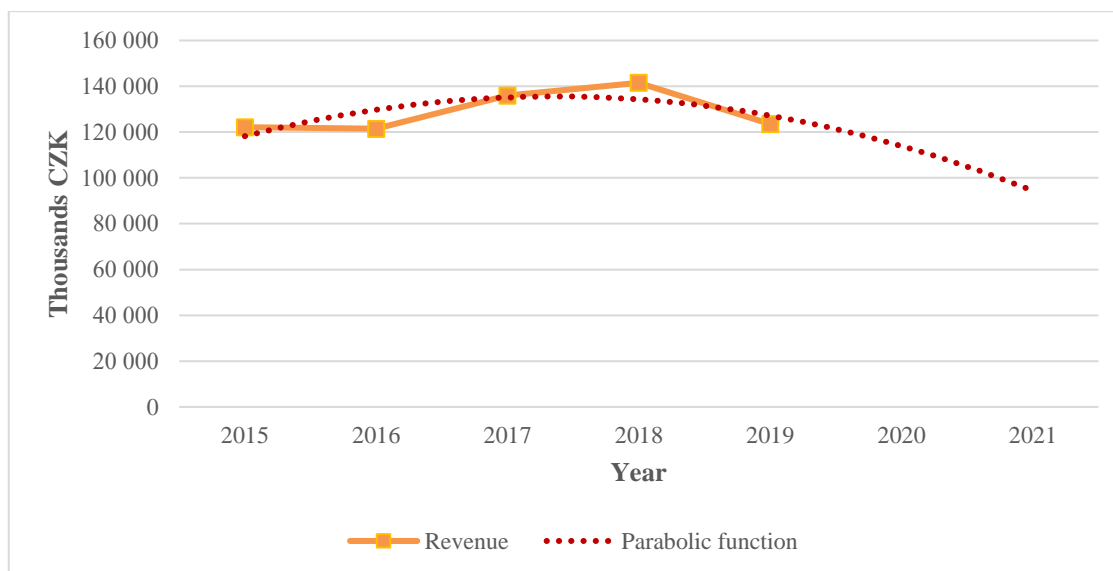
After calculation of function's parameters, we get:

$$\eta = -3110,1x^2 + 20915x + 100388$$

Determination index of this function is (see formula 54):

$$I^2 = 0,5516$$

Graph 2 with revenues' times series balancing can be seen below.



Graph 2: Prediction of future revenues of ABC Ltd. (Source: own processing)

Predictions for future years continue in last year's decreasing trend, estimating revenues as 113,9 million CZK in 2020 and 94,4 million CZK in 2021.

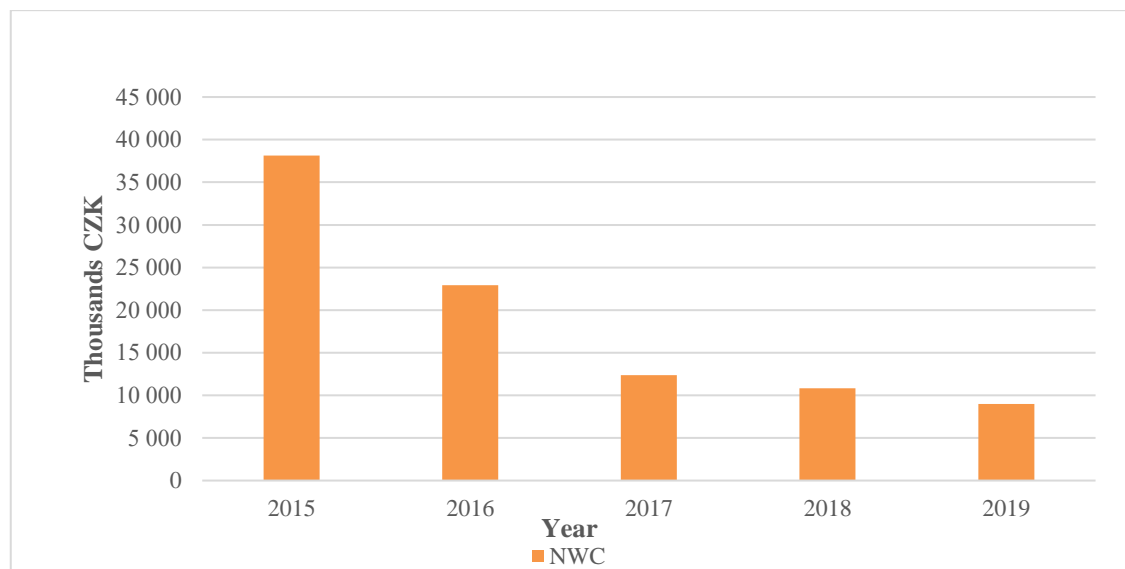
### 3.2.2 Analysis of difference indicators

Difference indicators points out ability to pay for short-term obligations. NWC is indicator used in this purpose, calculated by formula. I don't use net prompt resources, as there is no record of any payments that would be due-date or overdue from side of ABC. NWC is also subject to following statistical analysis. See evolution of net working capital between years 2015 and 2019 in table 3 and graph 3.

Table 3: NWC (Source: own processing)

Difference indicators (in thousands CZK)	Year				
	2015	2016	2017	2018	2019
Net working capital	38145	22930	12358	10811	8978

NWC is decreasing over the years, although we can see slowdown of decreasing between 2017 and 2019.



Graph 3: NWC (Source: own processing)

#### Statistical analysis of NWC

Table 4 provides characteristics of time series of NWC, calculated with formulas from chapter 2.2.1.1, namely first difference and growth coefficient for each tracked year together with average values, and values predicted by chosen regression function.

Table 4: Characteristics of NWC's development (Source: own processing)

Year	Order $x_i$	NWC $y_i$ (th. CZK)	First difference ${}_1d_i(y)$ (th. CZK)	Coefficient of growth $k_i(y)$	Predicted value $\hat{y}_i$ (th. CZK)
2015	1	38 145	-	-	39 120
2016	2	22 930	-15 215	0,6011	20 476
2017	3	12 358	-10 572	0,5389	14 021
2018	4	10 811	-1 547	0,8748	10 717
2019	5	8 978	-1 833	0,8305	8 701
Average	3	18 644	-7 292	0,6965	-
2020	6				7 338
2021	7				6 354

Power function is model fitting the best to our data (see formula 51):

$$\eta = \beta_0 x^{\beta_1}$$

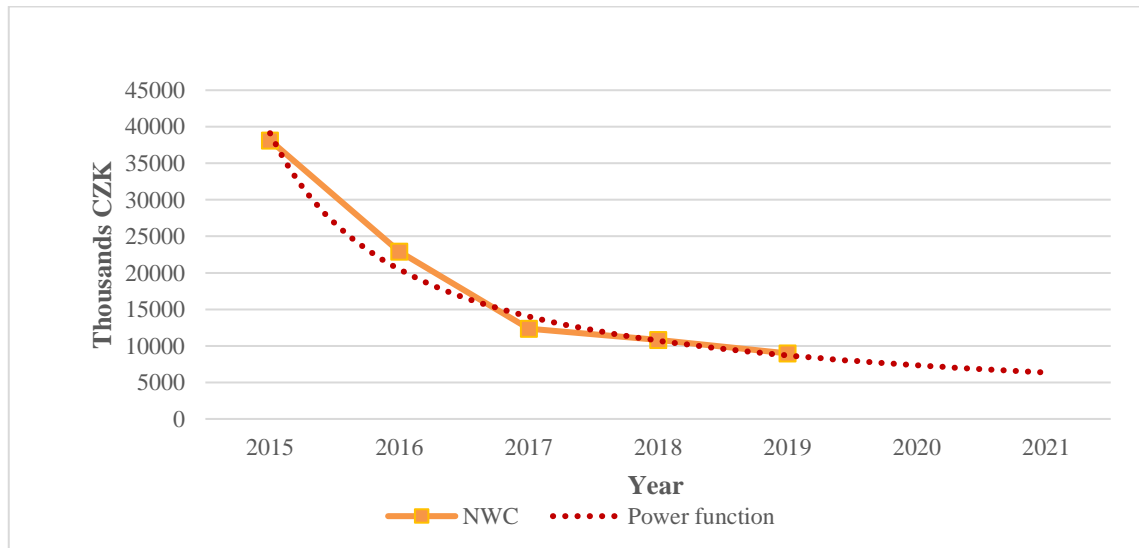
After calculations we get power function:

$$\eta = 39120x^{-0,934}$$

To assess power function's ability to balance NWC's time series determination index was used (see formula 54):

$$I^2 = 0,9788$$

Chosen regression function is able to express over 97 % of NWC's time series' values. See graph 4 for visual demonstration of regression function's prediction.



Graph 4: Prediction of NWC's development (Source: own processing)

Regression model estimates NWC of ABC ltd. to decrease further to values of 7,3 and 6,3 million CZK in the next 2 years.

### 3.2.3 Analysis of ratio indicators

Part of ratio indicators is divided into 4 parts and just as in theoretical part, these are ratios examining firm's liquidity, efficiency, leverage, and profitability.

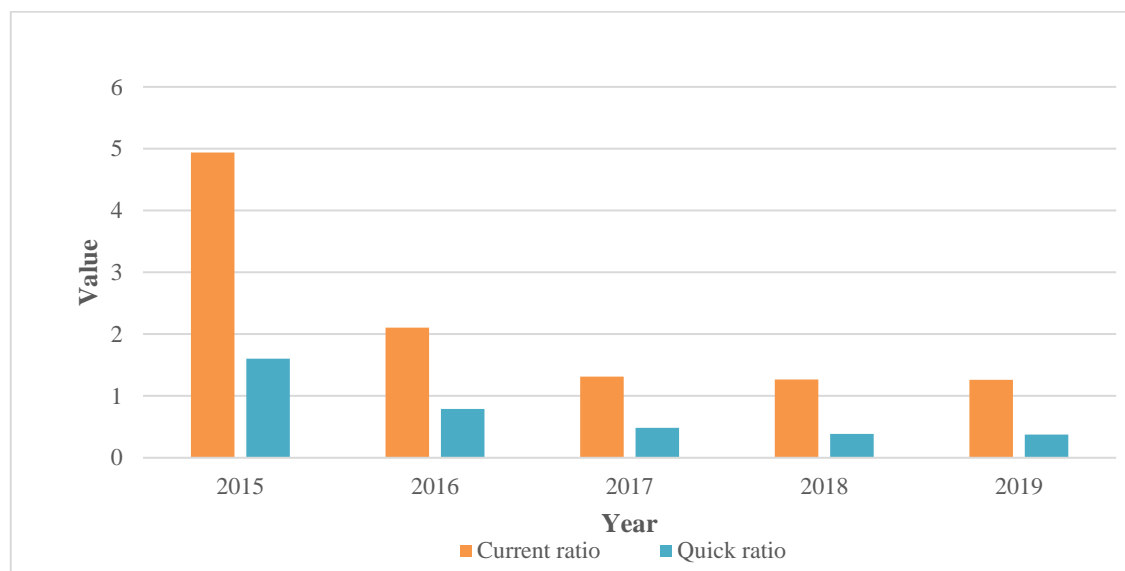
#### 3.2.3.1 Liquidity ratios

Similarly, to difference indicators, liquidity ratios consider firms ability of meeting short-term liabilities. Table 5 below includes current, quick and cash ratios and interval measure for period 2015-2019, calculated with formulas (6), (7), (8) and (9). Out of these, current ratio is then used in statistical analysis.

Table 5: Liquidity ratios (Source: own processing)

Liquidity ratios	Year				
	2015	2016	2017	2018	2019
Current ratio	4,9378	2,1062	1,3133	1,2665	1,2608
Quick ratio	1,6036	0,7877	0,4864	0,3859	0,3774
Cash ratio	0,0887	0,0118	0,0060	0,0041	0,0128
Interval measure (days)	2,9075	0,8200	0,6844	0,4792	1,3926

Values in table show decline of ratio between current resources and liabilities. Alike difference indicators, they tend to show highest values of liquidity in 2015 and slowing decrease throughout the other year, as can also be seen in graph 5.



Graph 5: Liquidity ratios (Source: own processing)

## Statistical analysis of current ratio

See development of current ratio's time series' characteristics (see chapter 2.2.1.1) and values predicted by regression model in table 6. Negative values of first differences averaging at -0,9 points at significant decline, which according to average growth coefficient was almost 29% decrease per annum or it was total of almost 75% decrease for entire tracked period.

Table 6: Characteristics of current ratio's development (Source: own processing)

Year	Order $x_i$	Current ratio $y_i$	First difference $1d_i(y)$	Coefficient of growth $k_i(y)$	Predicted value $\hat{y}_i$
2015	1	4,9378	-	-	4,3364
2016	2	2,1062	-2,8316	0,4265	2,3432
2017	3	1,3133	-0,7929	0,6235	1,6347
2018	4	1,2665	-0,0467	0,9644	1,1851
2019	5	1,2608	-0,0058	0,9955	1,0386
Average	3	2,1769	-0,9192	0,7109	-
2020	6				0,8833
2021	7				0,7703

Chosen function is once more a power function (see formula 51):

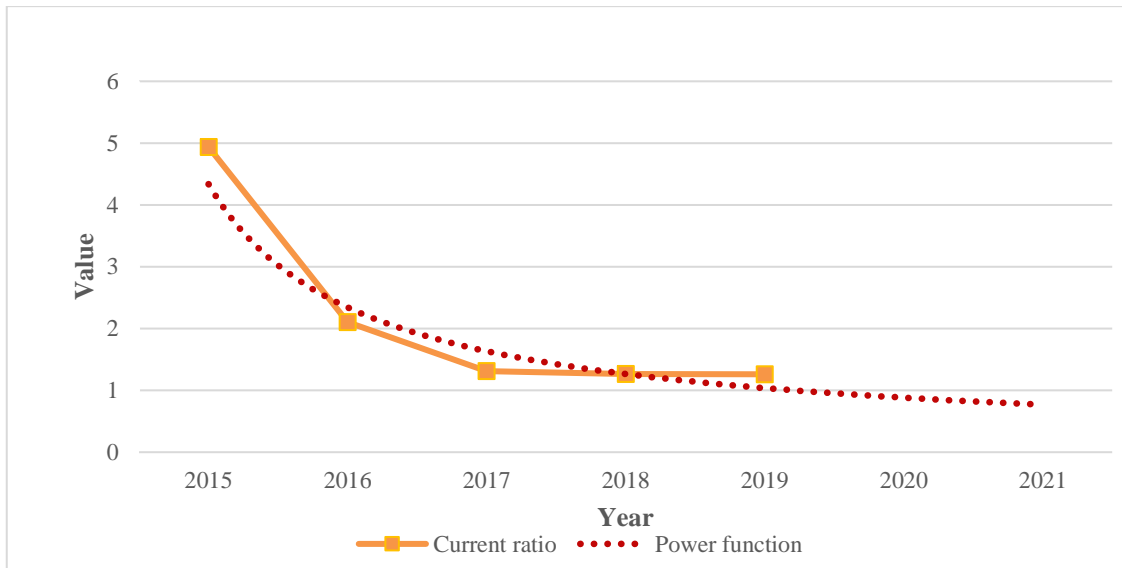
$$\eta = \beta_0 x^{\beta_1}$$

Resulting power function and its determination index (see formula 54):

$$\eta = 4,3664x^{-0,888}$$

$$I^2 = 0,9181$$

Adopting decreasing trend from past years, power function which expresses 92 % of current ratio's values predicts current ratio continue dropping in the next two years down to 0,88 in 202 and 0,77 in 2021. See graph 6 for visualization.



Graph 6: Prediction of current ratio's development (Source: own processing)

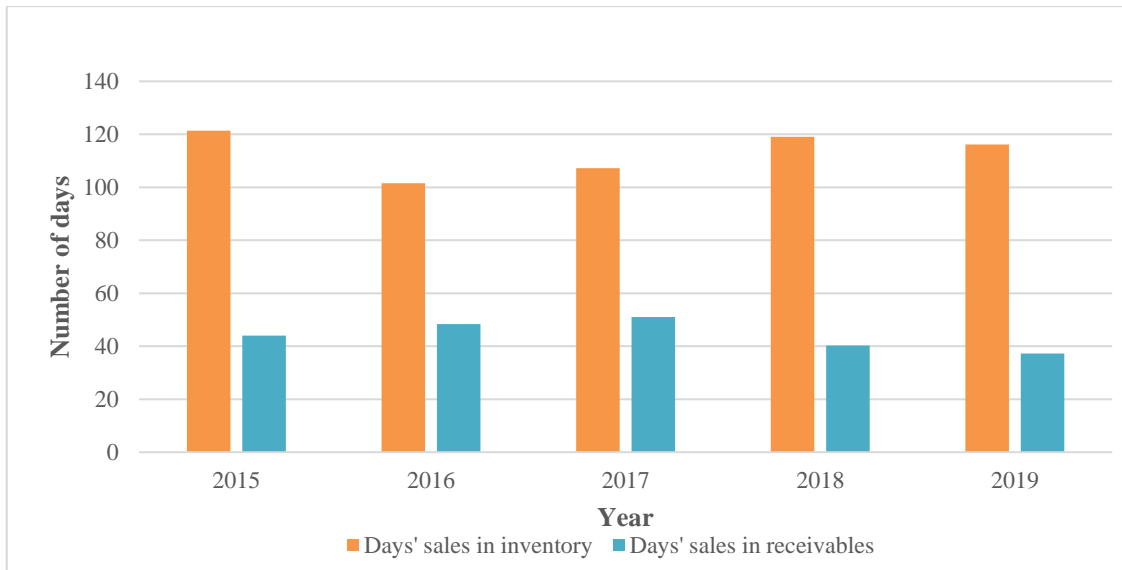
### 3.2.3.2 Efficiency ratios

Efficiency ratios evaluate how well company is using its assets or how long firm's resources are tied in some assets. Ratios in table 6 (calculated with formulas 10, 11, 12, 13, 14 and 15) tell us about efficiency of maintaining inventory, receivables and using its fixed or overall assets to for revenue creation.

Table 7: Efficiency ratios (Source: own processing)

Efficiency ratios	Year				
	2015	2016	2017	2018	2019
<b>Inventory turnover</b>	3,01	3,59	3,40	3,07	3,14
<b>Days' sales in inventory (days)</b>	121,35	101,58	107,26	119,03	116,21
<b>Receivable's turnover</b>	8,28	7,55	7,16	9,07	9,79
<b>Days' sales in receivables (days)</b>	44,07	48,33	51,01	40,25	37,27
<b>Total assets turnover</b>	1,53	0,93	0,94	1,01	0,98
<b>Fixed assets turnover</b>	3,85	1,40	1,48	1,62	1,50

Graph 7 illustrates past development of number of days necessary to sell over value of current inventory and number of days required to collect value of all current trade receivables during tracked period. These ratios will be as well subject to analysis with time series and regression methods.



Graph 7: Efficiency ratios (Source: own processing)

### Statistical analysis of days' sales in inventory

Let us first examine characteristics of time series created from days' sales in inventory values and values balanced by regression model in table 8. In the year 2016 it took the lowest, only approx. 101 days sell entire inventory, while the average value is approximately 113 days. See also first difference and coefficient of growth. Formulas from chapter 2.2.1.1 were used to calculate values of characteristics.

Table 8: Characteristics of days' sales in inventory's development (Source: own processing)

Year	Order $x_i$	Days' sales in inventory $y_i$	First difference ${}_1d_i(y)$ (days)	Coefficient of growth $k_i(y)$	Predicted value $\hat{y}_i$ (days)
2015	1	121,35	-	-	113,09
2016	2	101,58	-19,76	0,8371	113,09
2017	3	107,26	5,68	1,0559	113,09
2018	4	119,03	11,76	1,1097	113,09
2019	5	116,21	-2,81	0,9764	113,09
<b>Average</b>	3	113,09	-1,28	0,9892	-
2020	6				113,09
2021	7				113,09

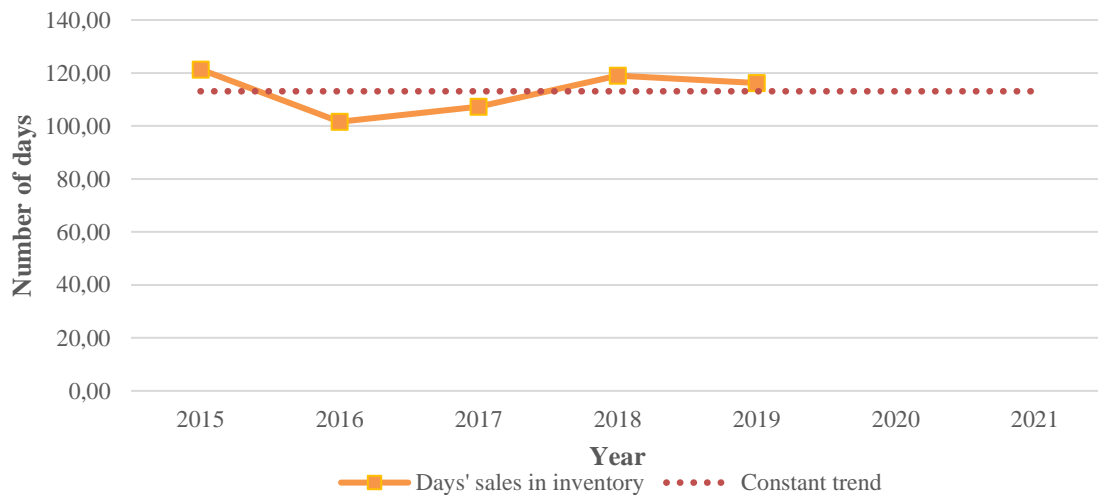
Constant trend described by formula (42) is chosen regression function:

$$\eta = \beta_1 + \bar{y}$$

For this regression analysis, the model took shape:

$$\eta \doteq 113,09$$

The value of days' sales in inventory was relatively stable in the past and because of that I have selected constant trend as a regression function. This can be seen as well in graph 8 and so future value is predicted to be 113 days in both years.



Graph 8: Prediction of days' sales in inventory's development (Source: own processing)

### Statistical analysis of days' sales in receivables

Second analysed efficiency ratio is days' sales in receivable. Characteristics of its time series, averages, first differences and growth coefficients calculated using formulas from chapter 2.2.1.1, can be found in table 9 together with predicted values. Number of days required to collect receivables rose up to 51 days in 2017, but then decreased by almost 14 days till 2019, setting average first difference to  $-1.70$  days.



Table 9: Characteristics of days' sales in receivables' development (Source: own processing)

Year	Order $x_i$	Days' sales in receivables $y_i$	First difference ${}_1d_i(y)$ (days)	Coefficient of growth $k_i(y)$	Predicted value $\hat{y}_i$ (days)
2015	1	44,07	-	-	48,52
2016	2	48,33	4,27	1,0968	46,35
2017	3	51,01	2,68	1,0554	44,19
2018	4	40,25	-10,75	0,7892	42,02
2019	5	37,27	-2,99	0,9258	39,85
Average	3	44,19	-1,70	0,9590	-
2020	6				37,68
2021	7				35,52

Regression line is chosen as regression model (see formula 47):

$$\eta = b_1 + b_2x$$

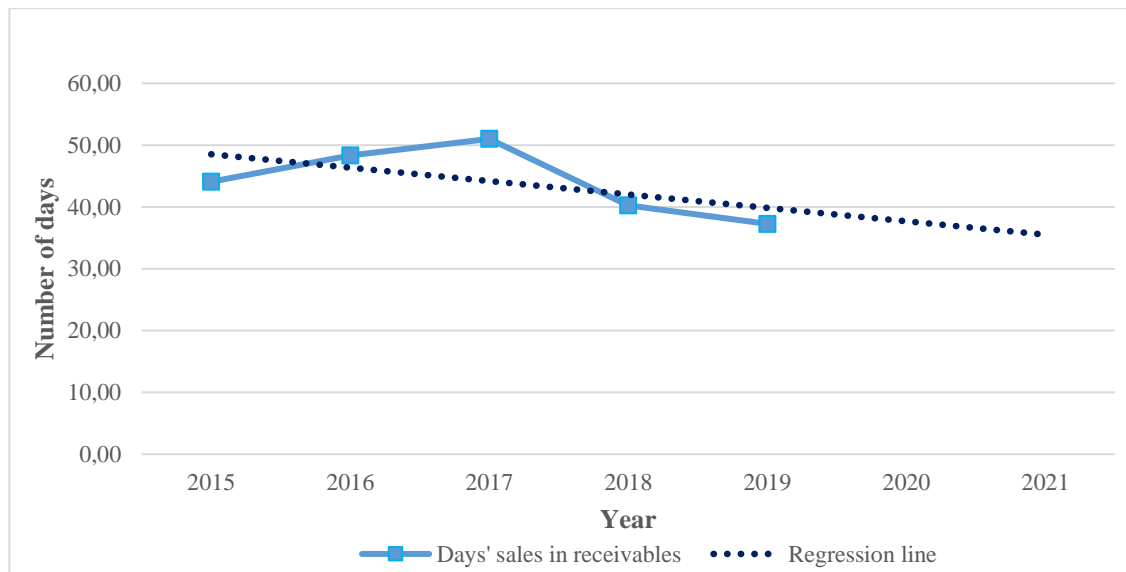
Calculating parameters, we got this regression line:

$$\eta = -2,1677x + 50,689$$

Determination index was calculated using formula (54):

$$I^2 = 0,3698$$

Although higher values of determination index over 0,8 was achieved for balanced parabolic regression function, I have decided to go with regression line instead of parabolic function, as the parabolic model predicted values very improbable in real environment. Graph 9 offers visual representation of regression line and intrinsic values' evolution. According to the regression line, values will be gradually decreasing down to 35,5 for 2021.



Graph 9: Prediction of days' sales in receivables' development (Source: own processing)

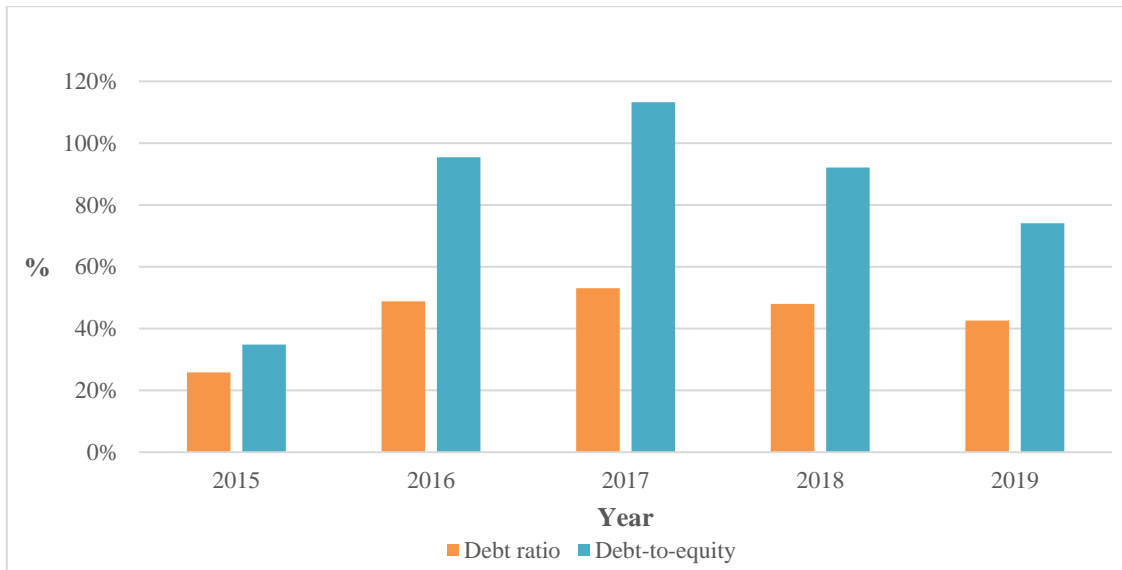
### 3.2.3.3 Leverage ratios

To analyse ABC's indebtedness we employ leverage ratio, namely debt and debt-to-equity ratios to see how significant part of assets is financed by external sources and times interest earned with cash coverage ratios as indicators of company's ability to meet its financial obligations. Table 10 contains leverage ratios values for concerned period, calculated with formulas (16), (17), (18) and (19).

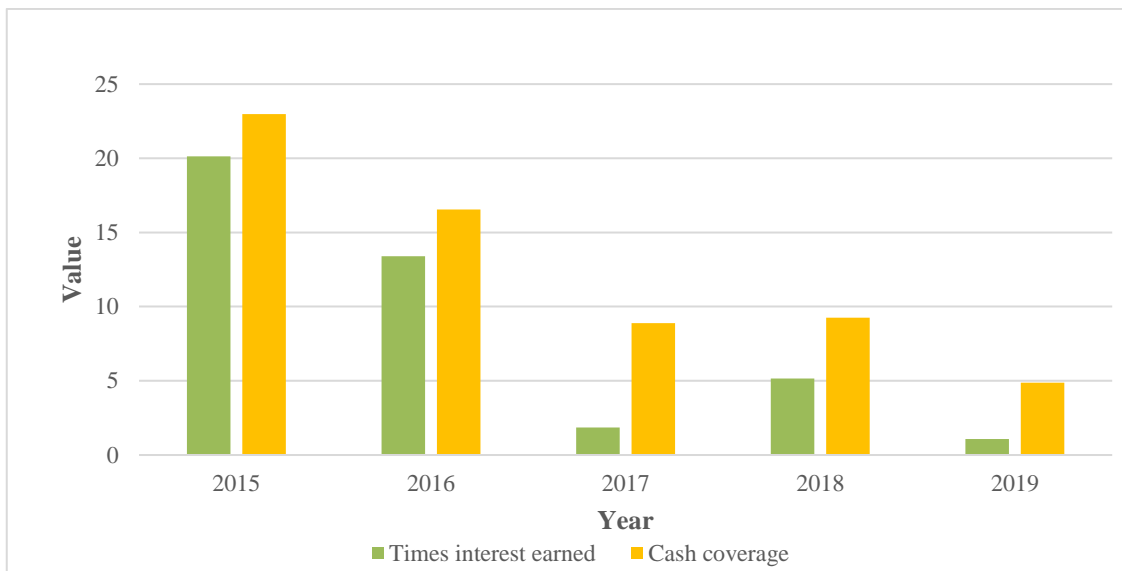
Table 10: Leverage ratios (Source: own processing)

Leverage ratios	Year				
	2015	2016	2017	2018	2019
<b>Debt ratio (%)</b>	25,83	48,83	53,11	47,95	42,56
<b>Debt-to-equity (%)</b>	34,82	95,41	113,25	92,12	74,09
<b>Times interest earned</b>	20,13	13,40	1,85	5,17	1,08
<b>Cash coverage ratio</b>	22,98	16,54	8,89	9,26	4,87

Graph 10 and graph 11 exhibit past evolution of leverage ratios. We can see that ABC's indebtedness was at peak in 2017, however the company is gradually doing worse considering their buffer for repayments of interests. Debt ratio was selected as a subject for statistical analysis.



Graph 10: Leverage ratios #1 (Source: own processing)



Graph 11: Leverage ratios #2 (Source: own processing)

### Statistical analysis of debt ratio

Table 11 containing values of debt ratio, its first differences, growth coefficients and averages (see chapter 2.2.1.1 for formulas). Year 2015 was removed from debt ratio's time series, because a huge loan burdens were added during 2016 and 2017. This change in debt ratio would heavily influence trend's behaviour and therefore we will examine only the development after borrowing a major loan in 2016. From the table we can see that there is decreasing trend according to averages of first difference and growth coefficient.

Table 11: Characteristics of debt ratio's development (Source: own processing)

Year	Order $x_i$	Debt ratio $y_i$ (%)	First difference ${}_1d_i(y)$ (%)	Coefficient of growth $k_i(y)$	Predicted value $\hat{y}_i$ (%)
2016	1	48,83	-	-	49,28
2017	2	53,11	4,28	1,0877	51,71
2018	3	47,95	-5,16	0,9029	49,30
2019	4	42,56	-5,39	0,8876	42,05
Averages	2	48,11	-2,09	0,9553	-
2020	5				29,96
2021	6				13,03

Parabolic regression (see formula 48) was regression model fitting the best to intrinsic values of examined debt ratio:

$$\eta = \beta_0 + \beta_1x + \beta_2x^2$$

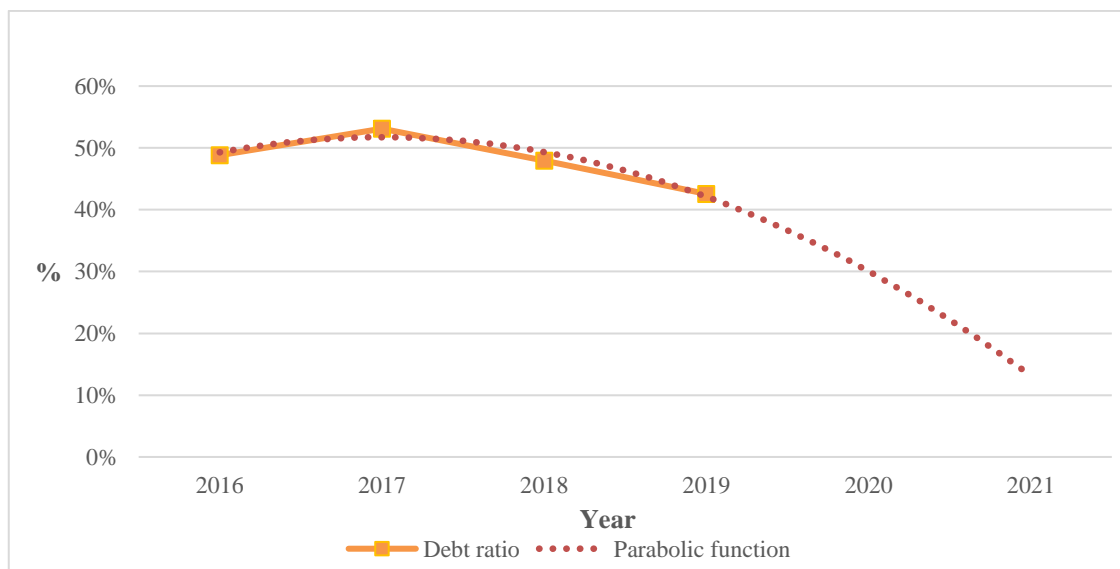
Appointing values of parameters, we get a function form:

$$\eta = -0,0242x^2 + 0,0969x + 0,4201$$

Determination coefficient of 0,9247 marks that 92,5 % of debt ratio's time series can be expressed employing chosen debt ratio (see formula 54):

$$I^2 = 0,9247$$

See graph 12 which illustrates intrinsic values and regression function's progression. Future values of debt ratio are predicted to decrease to 29,96 in 2020 and 13,03 in 2021, which suggests indebtedness of ABC will continue decreasing.



Graph 12: Prediction of debt ratio's development (Source: own processing)

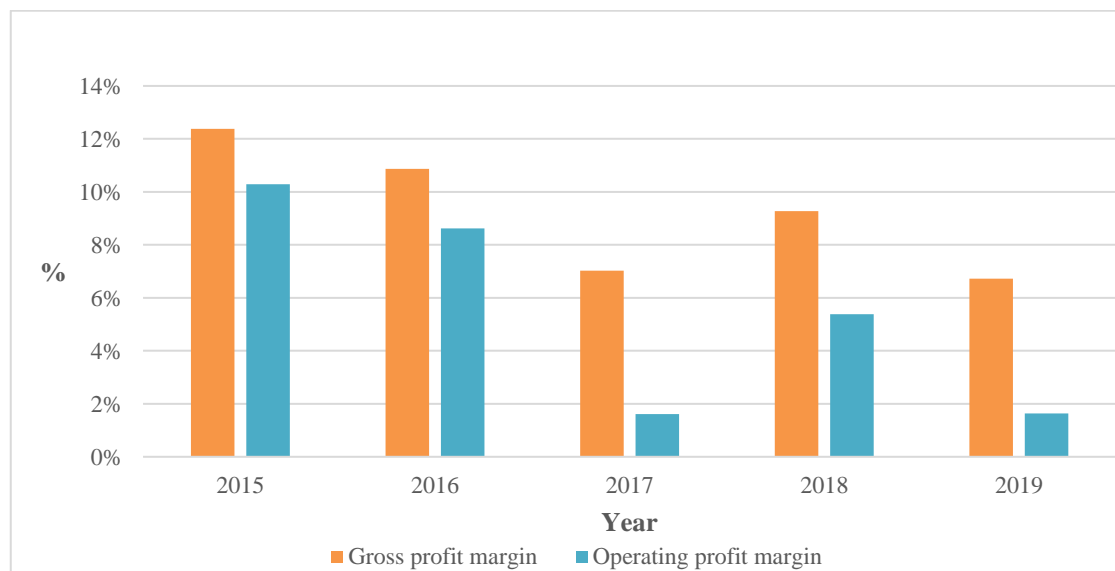
### 3.2.3.4 Profitability ratios

In table 12, you can find values of profitability ratios for years 2015 to 2019, calculated by formulas (20), (21), (22), (23), (24) and (25). These ratios address firm's ability of generating profit. ROS is then selected for statistical analysis.

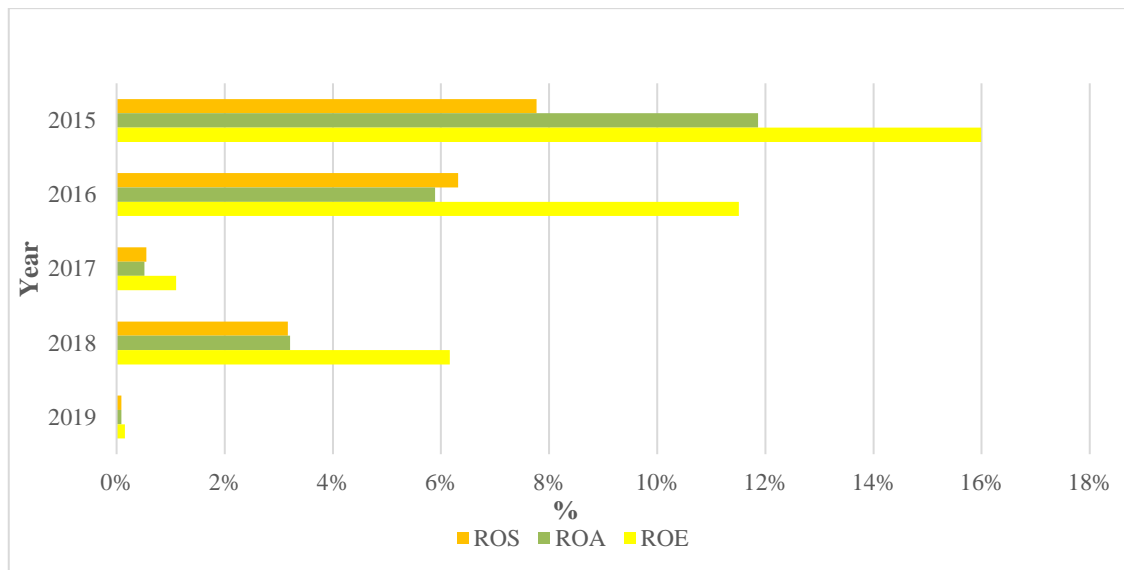
Table 12: Profitability ratios (Source: own processing)

Profitability ratios	Year				
	2015	2016	2017	2018	2019
Gross profit margin (%)	12,38	10,87	7,03	9,27	6,72
Operating profit margin (%)	10,29	8,62	1,62	5,38	1,63
ROS (%)	7,77	6,32	0,55	3,17	0,09
ROA (%)	11,86	5,89	0,52	3,21	0,09
ROE (%)	15,99	11,51	1,10	6,16	0,15
ROCE (%)	17,65	9,32	1,81	7,40	1,91

We can see that years 2017 and 2019 were critical, and although gross profit margin have reduced by half since 2015, ratios comparing net profit to other values have declined close to 0, as in case of ROS. We can see evolution of gross profit margin and operating profit margin in graph 13 and of other ratios except ROCE in graph 14.



Graph 13: Profitability ratios #1 (Source: own processing)



Graph 14: Profitability ratios #2 (Source: own processing)

### Statistical analysis of ROS

ROS, also known as net profit margin, determines ratio between firm's net profit and revenue or just how much money company is left with after paying everything including taxes. Table 13 holds values of characteristics of time series of ROS (see formulas used in chapter 2.2.1.1) such as growth coefficient, average of 3,6 % return on sales, first differences with average value of -1,92 %. Predicted value from regression analysis is to be found in the last column.

Table 13: Characteristics of development of ROS (Source: own processing)

Year	Order $x_i$	ROS $y_i$ (%)	First difference $1d_i(y)$ (%)	Coefficient of growth $k_i(y)$	Predicted value $\hat{y}_i$ (%)
2015	1	7,77	-	-	8,09
2016	2	6,32	-1,45	0,8133	4,83
2017	3	0,55	-5,77	0,0867	2,93
2018	4	3,17	2,62	5,7768	1,57
2019	5	0,09	-3,08	0,0280	0,53
<b>Averages</b>	3	3,58	-1,92	0,3268	-
2020	6				-0,33
2021	7				-1,06

Logarithmic function (see formula 50) was selected regression model for balancing ROS' time series:

$$\eta = \beta_0 + \beta_1 \ln x$$

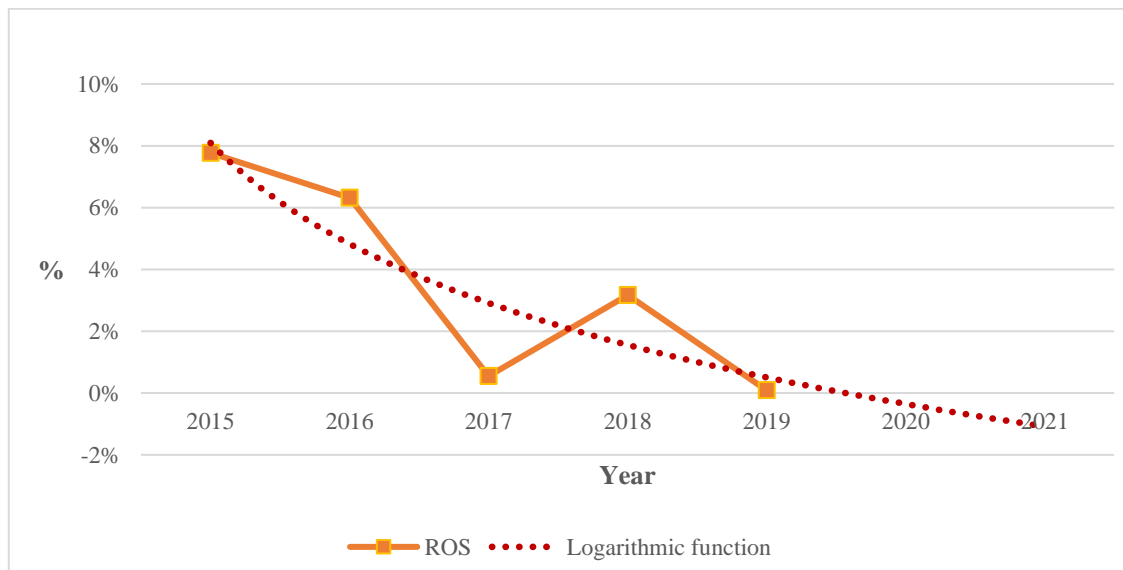
Calculating the function its final form is:

$$\eta = -0,047\ln(x) + 0,0809$$

Determination index, calculated with formula (54), has value:

$$I^2 = 0,7706$$

Graph 15 shows progression of ROS' values and its time series balancing by logarithmic regression, which predicts ROS value for 2020 to be -0,33 % and -1,06 % for 2021.



Graph 15: ROS (Source: own processing)

### 3.2.4 Altman's Z-score

Altman's Z-score is cumulative indicator or also bankruptcy model selected for this financial and statistical analysis. Tables 14 and 15 present values of Z-score's coefficients and of Z-score for ABC, ltd. within monitored period. Formulas (27), (28), (29), (30), (31) and (32) were used for Z-score's calculation.

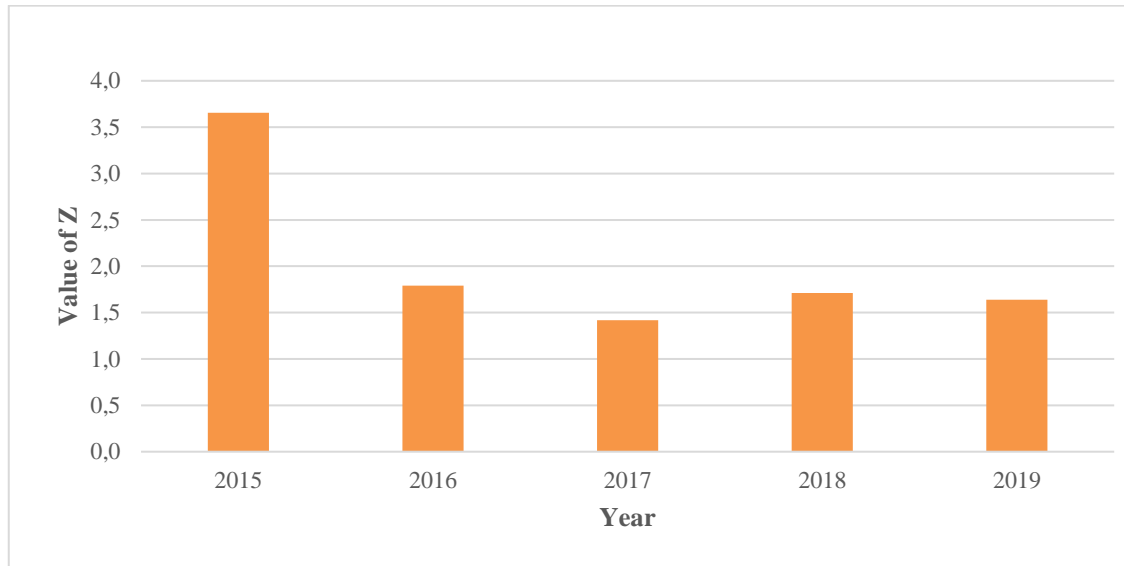
Table 14: Z-score's coefficients (Source: own processing)

Z-score's coefficients	Year				
	2015	2016	2017	2018	2019
X1	0,4792	0,1760	0,0859	0,0780	0,0714
X2	0,1186	0,0589	0,0052	0,0321	0,0009
X3	0,1550	0,0784	0,0131	0,0524	0,0139
X4	2,8722	1,0481	0,8830	1,0856	1,3496
X5	1,5270	0,9321	0,9429	1,0130	0,9780

Table 15: Altman's Z-score (Source: own processing)

Year					
Z-score	2015	2016	2017	2018	2019
	3,66	1,79	1,42	1,71	1,64

Company achieved the highest Z-score of 3,66 in the year 2015. See graph 16.



Graph 16: Z-score (Source: own processing)

### Statistical analysis of Z-score

We can find values of Z-score's time series' characteristics in table 16. These characteristics, such as first difference or coefficient of growth were calculated using formulas from chapter 2.2.1.1. We can also see predicted values of regression balancing in the table.

Table 16: Characteristics of Z-score's development (Source: own processing)

Year	Order $x_i$	Z-score $y_i$	First difference ${}_1d_i(y)$ (%)	Coefficient of growth $k_i(y)$	Predicted value $\hat{y}_i$ (%)
2015	1	3,66	-	-	3,21
2016	2	1,79	-1,87	0,49	2,37
2017	3	1,42	-0,37	0,79	1,87
2018	4	1,71	0,29	1,21	1,52
2019	5	1,64	-0,07	0,96	1,25
Averages	3	2,04	-0,50	0,82	-
2020	6				1,03
2021	7				0,84

Initially high Z-score decreased by more than half in 2016 and has been fluctuating around value 1,6 ever since.



Function used for regression of Z-score's time series is the logarithmic function (see formula 50):

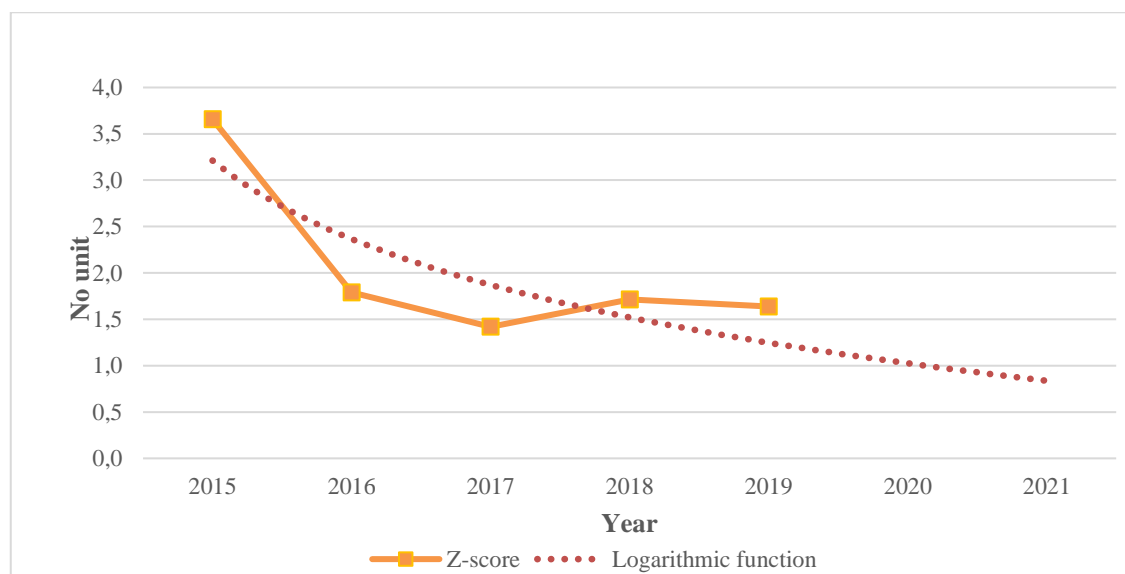
$$\eta = \beta_0 + \beta_1 \ln x$$

Logarithmic function after calculations of parameters and index of determination (see formula 54):

$$\eta = -1,22\ln(x) + 3,2115$$

$$I^2 = 0,7227$$

As demonstrated in graph 17, regression model assumes that Z-score for ABC, ltd. will be stagnating in the next 2 years.



Graph 17: Prediction of Z-score's development (Source: own processing)

### 3.3 Overall evaluation

This chapter provides space for summarization and possible comment of results gained from executed financial and statistical analyses.

#### 3.3.1 Revenue

Revenue of ABC, ltd. was the first analysed indicator. Company managed to generate 122 million CZK in 2015 and slightly less in 2016. In years 2017 and 2018 together revenue grew by 15 % to 141,5 million CZK, but unfortunately fell by 13 % to 123,5 million CZK in 2019.

According to regression analysis, revenues will even more in the next 2 years, which is something the company should try to avoid. Although the company evaluated 2019's revenue as satisfying, it should pursue sustained growth of revenues in the future.

### **3.3.2 Difference indicators**

NWC was 38 million CZK in 2015. Due to increase in current liabilities in 2016 and 2017, NWC lowered by 26 mil. CZK from its former value down to 12,4 mil. CZK. In year 2018 there was fluctuation and then in 2019 decrease of current liabilities, but NWC was still shrinking down to 9 mil. CZK due to simultaneous drop in current assets. Regression power model estimates the values ought to worsen during next 2 years with NWC becoming 7,3 mil. CZK and 6,4 mil. CZK.

### **3.3.3 Liquidity ratios**

Current ratio gives us ratio of company's current assets with current liabilities. Recommended value is between 1,8 to 2,5 and such values are signs that there is enough liquidity to meet current liabilities, but not too much to tie unnecessary amount of money. ABC had very high current ratio of 4,9 in 2015, got in the middle of recommended values in 2016 with value of 2,1 and is fluctuating at value 1,3 since then. That is already below recommended range, but still above 1, meaning company should have sufficient liquidity. Average of current ratio for previous 5 years is 2,18, which would make a good constant value.

We can see similar behaviour of values of quick ratio and cash ratio, which were above optimal ranges (1-1,5 for quick ratio and 0,2-0,5 for cash ratio) in 2015, followed by decline and fluctuation.

Cash ratio and interval measure shows there is insufficient cash possessed by ABC to pay for pertinent expenses – in case no revenue would be generated, it would take less than half a day for the company to drain their cash assets if no revenue were made and receivables collected.

Regression model applied to current ratio, which was power regression, predicted current ratio to drop further below recommended values, reaching 0,88 in 2020 and 0,77 in 2021. That means ABC could have serious problem meeting their current liabilities on time.

### **3.3.4 Efficiency ratios**

Total assets turnover and fixed assets turnover show the highest values, which reflect better utilization of assets, in year 2015. The decrease in the year 2016 is in both cases, however, caused primarily by large increase in ABC's assets. Both ratios' values were, except for 2019, rising since then and hopefully ABC will manage to take the best advantage from acquired facilities and reach former values again.

Examining efficiency of maintaining inventory and collecting receivables, values of both days' sales in inventory and days' sales in receivables seem to be fluctuating around their averages, 113 days for inventory and 44 days for receivables, although ABC is currently having success with full receivables collection taking only 37 days.

Parabolic regression predicts days' sales in inventory to lengthen and take 135 days to sell full inventory in 2020 and 156 days in 2021, which isn't good news. On the other hand, regression line used for prediction of days' sales in receivables estimated decreasing trend to continue in the future.

### **3.3.5 Leverage ratios**

Evolution of debt ratio and debt to equity nicely demonstrate expansion of ABC's external financing, as company was using borrowed money to construct a new building and buy new facilities and equipment throughout 2016 and 2017. In 2017, external resources made up to 53 % of ABC's passives, being the highest value. On 2018's and 2019's progression we can see that ABC manages to swiftly repay these burdens.

Statistical analysis catches up on this trend and predicts debt ratio to further decrease to 30 % in 2020 and 13 % in 2021. Note that for purpose of balancing with parabolic function only values from 2016 and newer are included.

Times interest earned and cash coverage ratio expose low earnings in years 2017, 2019 and particularly 2018, which together with growing interest expenses create ugly situation of EBT being only 126 thousands CZK.

### **3.3.6 Profitability ratios**

Profitability ratios alike many other show best values back in 2015. In case of gross and operating profit margin, the evolution reflects also rise in personal expenses every year,

as company is hiring qualified employees for open positions. However, it must be paid for such workforce and trend in revenues doesn't follow that of personal expenses.

With values of ROS, ROA and ROE so close to zero, ABC was just a pinch away of ending in loss.

Regression analysis estimates it is likely to happen, with  $-0,33\%$  and  $-1,06\%$  being predicted as ROS's values for the next 2 years.

### **3.3.7 Altman's Z-score**

Looking at overall evolution of ABC's Z-score, it had the best value of 3,66 in 2015, being above grey zone without risk of financial difficulties. It dropped the next year and since then value of Z-score is fluctuating just below border of grey zone, meaning company is likely to have financial troubles.

Regression analysis have predicted Z-score's value to worsen in upcoming two years, dropping to 1,03 in 2020 and 0,84 in 2021, which is a real warning sign for ABC.

To unriddle tendencies behind Z-score's shift, we can have a look at coefficients used to calculate Z-score, how they have been developing and what problematic they refer to.

Values of coefficients have been all at maximum values in 2015. Coefficient  $X_1$  is decreasing every year, pointing at increasing gap between NWC and total assets.  $X_2$  got close to 0 and  $X_3$  is also very low, both copying profit's evolution, concretely comparing EAT and EBIT to total assets. On the contrary,  $X_4$  seems to already be rising since 2017, reflecting ABC's decreasing indebtedness.  $X_5$  is fluctuating since 2016 and it has not been influenced so significantly in 2015, yet it also fallen by 39 % that year, reflecting relation between assets and sales as it is in fact total assets turnover.

Comparing significancy of changes in coefficients,  $X_2$  and  $X_3$  are the biggest troublemakers, underlining findings from profitability ratios about almost no profits in recent years.

### **3.3.8 Summary from analyses' evaluation**

Revenue is one of indicators showing alert signs. ABC's management evaluated 2019's revenue as satisfying and due to fiscal year 2019 taking place till 31<sup>st</sup> March 2020, revenues might be slightly affected by outbreak of covid-19. Yet after success of

increasing sales in 2017 and 2018 following major investments and growth of company, 2019's revenue's decrease wasn't a good sign and ABC should focus more on increasing its sales.

Net working capital was decreasing every year since 2015, but because it still has sufficient values to cover current liabilities, I would not say there is any issue as long as the company manages to keep recent values or rather extend NWC to avoid its further decrease, which was predicted.

Liquidity ratios approve sufficient liquidity of ABC, Ltd. now, but as well informs us of insufficient amount of cash resources and warns about possible difficulties with meeting current liabilities in the future.

Activity of the company is at fine levels, however ratios indicating efficiency of asset utilization decreased simultaneously with increase of assets. Management of receivables seem to perform great with values improving both recently and in prediction. Inventory management could be improved, but it isn't among priorities as prediction shows it should remain stable.

Evaluating debt management, ABC is performing fine and repay its obligations. However, there should be effort to increase company's net income to prevent red numbers.

That situation in area of earnings is not great is also clear from profitability ratios. Because of additional depreciation from new assets and more wages for new employees weren't accompanied by accordingly increase in revenue, ABC's operations are not generating enough income. New assets, employees and additional financial resources invested in these are not being used accordingly and money are pumped into debt repayment and therefore rentability indicators stagnate with ROS being predicted to go negative indicating loss in the next 2 years.

Z-score evaluates current financial health of ABC, Ltd. as critical and predicts it will get worse and ABC should deal with this fact as soon as possible.

## **4 SUGGESTED PROPOSALS**

Based on findings from previous chapter's financial and statistical analysis of firm's financial situation in last 5 years, this chapter is devoted to my own recommendations for improvement of financial health of company ABC, Ltd.

### **4.1 Revenues**

Company should definitely strive to increase their sales. In recent years ABC invested significant resources into company's growth and development and without rise in revenues these investments would come into vain.

ABC focuses on both B2B and B2C and should take advantage of both. B2C market is limited by geographics, as it is mainly carried out at store. ABC has major position among local competition, as it is the biggest store with widest assortment in the area and there is not much to do aside keeping customers satisfied.

More focus should be on the other hand given to online environment. ABC recently invested into its e-shop which offers customers to order from comfort of their homes and I suggest promoting this opportunity to potential customers. Major advantage is that audience is not geographically limited as even large items are to be delivered. Although many craftsmen prefer to shop for their equipment in person to check quality a pick the right items, even in-store customers can be taught to come back online.

Considering B2B market, I recommend seeking for customers also in other countries than the Czech republic and Slovakia. Poland, Austria, and Germany are missed opportunities at the moment. ABC may not be known on these markets, but as it has long history and focuses among other on specialized machine facilities and equipment, with active marketing approach there are potential sales abroad. Sales abroad currently contributes to total revenue by approximately 8 % and ABC should make effort to strengthen their position on international market.

Attention in field of specialized equipment should also be maintained on domestic market. If a customer purchases some of this equipment, he might need maintenance or spare parts in the future or become satisfied user of equipment from brands ABC distributes and might come back to buy another. I propose to seek and look after long-

term partnerships in product group of specialized equipment. Such partnerships can provide sustainable revenue streams which would improve firm's financial performance.

## **4.2 Liquidity**

Both difference indicators and liquidity ratios demonstrate sufficient liquidity of ABC, ltd. Only drawback is in low level of cash and I recommend increasing its value, because majority of current assets are in form of inventories and receivables, which can't be turned into cash instantly. More cash could therefore help ABC avoid for example feed for late payments, although the company does not seem to have any overdue obligations. As interval measure interprets cash resources to possibly fuel company's consumption for just about a day, to increase its value is a reasonable decision in pursuit of financial stability of the company. Improvement in inventory and receivables management could free cash that is tied to these types of assets. According to statistical analysis liquidity will dwindle and therefore ABC should try to allocate more resources in their liquidity, unless current liabilities will decrease.

## **4.3 Efficiency**

ABC, ltd. acquired fixed assets in value of tens of million CZK during 2016 and 2017, but is not using this property efficiently, because sales have not risen as assets did, worsening asset turnover values. As the company should now have unused capacity, best thing it can do is to realize more sales, which was described in revenues chapter.

Inventory management does not show any anomalies in its evolution; however, it would be good to try improving its values. That is difficult, because ABC prides itself with wide assortment, which is necessity in this niche, and it also reflects in worse inventory turnover. I recommend to research which products are bestsellers and which are sold only occasionally and keep adequate amounts of stocked. Even if the bestsellers would be sold out in one or two weeks, ordering more often to copy demand precisely usually saves costs. Boosting sales would as well improve time required to sell entire inventory.

Receivables management is doing good, and I recommend ABC, ltd. to continue their efforts in this manner.

#### **4.4 Financial leverage**

It was described earlier that ABC is doing great considering debt repayment. If we look at the balance sheet of monitored period, we can see that since total liabilities rose up to 76 million CZK in 2017, ABC was able to repay 10 million CZK in 2018 and another 13 million CZK in 2019.

It is understandable, that ABC prioritizes debt repayment, as debt is always connected with some additional financial expenses on interests. In this case, however, my point of view is that too many resources are wasted on repayment, which could be used elsewhere. As debt ratio was 25.8 % in 2015, it was the right decision to choose external sources of financing for upcoming investments. Highest debt ratio 53,1% in 2017 is still on reasonable level and should not cause any troubles.

That is why I propose ABC. Ltd, to rearrange debt repayment for their outstanding liabilities of 53,5 million CZK in 2019 to lower amount repaid each annum. Doing so will enable ABC to use freed cash in all areas where it is required, for marketing, which is necessary to increase sales volume, cash reserve present at company's bank account to achieve better stability with more instant assets at hand, and foremost the money that are kept in the company will result in increase in financial profit, which is area where ABC is struggling the most. Lower annual repayment of long-term debt will also decrease amount of current liabilities, as it is partially formed by long term loans value repaid in that year.

For example, if only 10% from outstanding long-term debt amount (in 2019) were repaid in 2020, that would allocate few additional millions CZK that could be split into other areas. As ABC repaid approximately 11 million CZK of long-term debt in 2018 and almost 7 million in 2019, with outstanding long-term debt of 19 million CZK, 10% would mean under 2 millions repaid in 2020, which also indicates possible increase in resources by 4-8 million. That would be enough to increase liquid assets of high liquidity while increasing current liabilities by the same amount, improving both NWC and current ratio. More money would also be left for profit, where even a few million CZK would mean avoiding red numbers in case sales won't be increased.



## **4.5 Profitability**

We are already aware that rentability is quite troublesome area of company's financial health. To prevent ABC, ltd. going loss, there a few things that can be done about fading profits.

First approach is increasing sales volume, which was assessed in chapter 4.1. Other approach is to cut costs. Costs have been quite increasing since 2015, considering mainly increased personal expenses, which are wages, insurance contributions etc. and depreciation, as ABC acquired lots of fixed equipment, which is now amortizing. These 2 expenditures were main driver behind decrease in operating profit in years 2017 to 2019. Good news is that ABC, ltd. is currently undertaking project to implement a system of economic monitoring for decreasing costs connected to administration and infrastructure. I totally approve this project as after acquisition of new assets it is required to learn to use these assets the most efficiently. However, I also recommend taking a better look at HR, trying to evaluate necessity of hiring employees in present moment and near future, to avoid unduly number of employees which become more of a burden than valuable asset, because they cannot contribute to operations for there's too little job for such workforce. Although statistical analysis predicted loss for 2020, I think a delicate balance between expenses and income have been controlled by ABC throughout past years, but as there is no need to risk and suggested proposals ought to help the company to improve its financial health, which would ultimately take shape in form of Z-score's predicted improvement.

## CONCLUSION

My bachelor thesis was devoted to assessment and evaluation of financial situation of selected company using mathematical and statistical methods, namely selected financial indicators and ratios, time series and regression analysis. Recommendations for improvement of financial situation were then proposed based on outcomes of analyses. Sources for elaboration of financial analyses were financial statements of selected company from fiscal year 2015 to 2019.

Thesis is divided into 3 main parts. First part contains theoretical basis which is later used in analytical part. Selected methods of financial analysis for evaluation of various aspects of financial health of a company were explained as well as statistical theory. Second is analytical part, devoted to introduction of selected company ABC and their results in financial and statistical analysis. Those are interpreted by tables and graphs and evaluated in the end of chapter. In last part of my bachelor's thesis, I propose measures and changes that could be implemented to improve financial situation and health of the company.

Most important observations and connected suggestions are in areas of revenue, cash balance, utilization of inputs, debt repayment and profits. ABC is recommended to find new revenue sources using its e-shop and actively search for B2B customers in specialized niche. More resources should be allocated in most liquid cash assets, which could be done by reasonable inventory management. Company got bulkier in recent years and should strive to demonstrate that by corresponding results, thus use the assets more efficiently. Also, the firm should not worry to keep some part of assets financed externally and rather use income to further increase turnover and income than to repay obligations.

Financial health of ABC in recent years stagnated, but as the predictions are optimistic in most cases and there are logical connections between achieved values and recent development of the company, I believe this fluctuation in company's performance will, possibly with help of my suggestions, turn out into successful growth and achievement of ABC's goals.

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## Appendix 1: Balance sheets over period 2015-2019

Appendix 1: Balance sheets over period 2015-2019 (source: own elaboration according to 14)

<b>Balance sheet</b>					
<b>Year</b>	<b>2015/2016</b>	<b>2016/2017</b>	<b>2017/2018</b>	<b>2018/2019</b>	<b>2019/2020</b>
<b>Total assets</b>	<b>79 600</b>	<b>130 306</b>	<b>143 796</b>	<b>138 615</b>	<b>125 717</b>
<b>Fixed assets</b>	<b>31 740</b>	<b>86 647</b>	<b>91 992</b>	<b>87 198</b>	<b>82 285</b>
Intangible assets			55	60	447
Land	6 492	7 158	7 158	7 158	7 158
Buildings	17 277	59 825	59 224	58 059	56 141
Movable and other assets	7 971	19 664	25 555	21 921	18 539
<b>Current assets</b>	<b>47 832</b>	<b>43 659</b>	<b>51 804</b>	<b>51 371</b>	<b>43 404</b>
Inventories	32 298	27 331	32 619	35 717	30 412
Trade and other receivables	14 675	16 084	18 948	15 486	12 553
Cash	859	244	237	168	439
Accruals	28	0	0	46	28
<b>Total equity &amp; liabilities</b>	<b>79 600</b>	<b>130 306</b>	<b>143 796</b>	<b>138 615</b>	<b>125 717</b>
<b>Owners equity</b>	<b>59 043</b>	<b>66 684</b>	<b>67 428</b>	<b>72 152</b>	<b>72 212</b>
Share capital	1 000	1 000	1 000	1 000	1 000
Reserve funds	100	106	146	134	124
Previous years' retained earnings	48 500	57 903	65 539	66 573	70 979
Current year's retained earnings	9 443	7 675	743	4 445	109
<b>Total liabilities</b>	<b>20 557</b>	<b>63 622</b>	<b>76 365</b>	<b>66 463</b>	<b>53 505</b>
Long-term liabilities	10 870	42 893	36 919	25 903	19 079
Current liabilities	9 687	20 729	39 446	40 560	34 426
Accruals			3		



## Appendix 2: Profit/loss statements over period 2015-2019

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<b>Profit/Loss statement</b>					
<b>Year</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
Sales of products and services	956	806	956	1 016	976
Sales of goods	120 594	120 658	134 631	139 399	121 969
Cost of materials and energy	97 148	98 203	110 999	109 529	95 517
Personal expenses	9 353	10 063	15 062	17 865	19 168
Depreciation	1 749	2 396	7 163	5 754	6 123
Other operating income	538	14	165	866	245
Other operating expenses	1 336	344	336	580	375
<b>Operating profit</b>	<b>12 502</b>	<b>10 472</b>	<b>2 192</b>	<b>7 553</b>	<b>2 007</b>
Financial income	113	19	188	224	279
Financial expenses	889	1 042	1 514	1 924	2 160
>of which interest expenses are	613	762	1 018	1 405	1 616
<b>Financial profit</b>	<b>-776</b>	<b>-1 023</b>	<b>-1 326</b>	<b>-1 700</b>	<b>-1 881</b>
<b>EBT</b>	<b>11 726</b>	<b>9 449</b>	<b>866</b>	<b>5 853</b>	<b>126</b>
Tax	2 283	1 774	123	1 408	17
<b>EAT</b>	<b>9 443</b>	<b>7 675</b>	<b>743</b>	<b>4 445</b>	<b>109</b>
<b>Total net revenue</b>	<b>122 201</b>	<b>121 497</b>	<b>135 940</b>	<b>141 505</b>	<b>123 469</b>