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COMPILATION OF AN OVERALL EFFICIENCY MATRIX FOR BANKING INDUSTRY

Master’s thesis

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I hereby declare that I have compiled the thesis independently
and all works, important standpoints and data by other authors
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ABSTRACT

The systemic importance and essential role in economic growth require the efficiency levels of a bank to be analysed by using multiple indicators. One of the methods of measuring the efficiency level is the efficiency matrix concept described for the first time in 1977 by Estonian academician Uno Mereste.

The main objective of this thesis is to further develop the overall efficiency matrix to make it more structured and usable at the level of a company in the banking industry.

In this thesis, the efficiency matrix concept has been introduced and the structural differences of financial statements between banks and regular companies have been analysed by the author to adjust the overall efficiency matrix for use in the banking industry. The author compiles the bank's overall efficiency matrix by involving six quantitative indicators: average equity for the period, average assets for the period, operating expenses, net interest income, total income and profit before tax. The biggest commercial banks in Estonia, to be exact, Swedbank AS and SEB Pank AS have been selected for testing the compiled bank's overall efficiency matrix. The data for testing is taken from publicly available annual reports of selected banks.

The analysis of the overall efficiency matrix has been made for Swedbank AS and a comparison has been done with SEB Pank AS based on the figures in 2015–2019. The results of the analysis reflect that the level of the overall efficiency of Swedbank AS slightly increased by 1% during the given period. Swedbank AS was the most overall efficient in 2016 and 2018, 104% and 103%, respectively, while the least overall efficient year was 2019 with 97%. Unlikely, SEB Pank AS was the most overall efficient with 107% in 2019 and reduced the gap with its competitor from 124% to 113% according to benchmark indices. Overall, Swedbank AS looks more reliable and durable for economic crisis compared to SEB Pank AS. It is mainly because of the proportion of net interest income to total income during the period analysed.

The bank's overall efficiency matrix compiled in this thesis may be used by different user groups who are willing to examine the overall efficiency of a commercial bank with its competitors and analyse the differences in efficiency levels.

Keywords: financial statement analysis, commercial banks, overall efficiency, efficiency matrix

INTRODUCTION

Efficiency is the identification of the best possible use of given resources. It requires achieving a peak level of performance by utilizing the minimum amount of inputs. This means that whether invested amount within the company is sufficiently profitable and whether the company generates the best possible amount of profit. Additionally, it's vital to work out whether enough cash is being earned from business activities to be used for future investments, the repayment of loans, or the distribution of dividends. Managers have to recognize both the company's specific fields or points where it absolutely was inefficient as well as the company's ranking compared to its competitors.

The efficiency of a company is measured using its financial data on the specific periods and developing particular financial ratios. Financial ratio analysis is one of the most common ways of analysing the company. There are various types of ratios depending on the group of users who analyse the financial statements. Measuring specific aspects of the company such as managerial performance, business performance, the capacity to cover short-term and long-term liabilities as well as dividends, and different other predictions for the future of a company can be achieved by analysing financial ratios. Other methods of measuring performance of a company are also developed so far. The usage of multiple indicators is an essential aspect of the performance analysis which makes the picture more accurate and easier to analyse.

One of the methods of analysing the efficiency of a company is the overall efficiency matrix which was developed in Estonia at the beginning of the 1980s. It was known and used among former Soviet republics, as well as some European countries. Further developments have been made to the matrix modelling until 2018 when the overall efficiency matrix found its structured form for regular companies.

Unlike regular companies, the primary role of banks is to act as intermediaries, accepting deposits from capital providers and providing capital in the forms of loans and borrowers. The systemic importance of banks is that the overall health of the economy depends on their smooth functioning. Systemic risk reflects a risk of failure of financial services caused by one of the chains in the financial system and has the possibility to disrupt the economy as a whole. After the global crisis governments experienced the problem of systemic risk which caused a serious amount of money for countries around the world. Systemic importance makes financial institutions to be heavily regulated by the government. The failure of returning customers' deposits could have harmful results across the economy. Even the expectation that a bank might not be able to honor its deposits could cause depositors to withdraw their money from the bank, and a large sudden withdrawal of deposits could cause an actual failure of the economy.

The research problem addressed in this master's thesis is that measuring the overall efficiency of a commercial bank requires further development of the overall efficiency matrix to make it more structured and usable at the level of a company in the banking industry. Moreover, this thesis illustrates the possibility of analysing the overall efficiency at the company level in the banking industry based only on companies' annual reports which are publicly available.

Aim of the thesis is to compile the overall efficiency matrix for the banking industry and test the usability of it.

Hereby author defines following research tasks to achieve the aim of the thesis:

1. To analyse the differences of the structure of financial statements between banks and regular companies
2. To introduce the efficiency matrix concept
3. Proposition of quantitative indicators available from publicly available sources for providing industry-specific measure of bank overall efficiency
4. Incorporation of industry-specific quantitative indicators into overall efficiency matrix concept and demonstration of applicability of the overall efficiency matrix.

This master's thesis provides an improvement of usability of the overall efficiency matrix. It has been completed in the compilation of an updated overall efficiency matrix for a company in the banking industry which means that field-specific financial indicators influencing the formulation of efficiency have also been proposed. Furthermore, this thesis may be used by different users (including analysts, owners, and investors) who are interested in examining the efficiency levels of a company with its competitors and analysing the differences in efficiency levels.

The author of this thesis implements the compiled overall efficiency matrix to measure and compare the overall efficiency of the largest banks in Estonia, to be exact, SEB Estonia (SEB Pank AS) and Swedbank Estonia (Swedbank AS). Swedbank Estonia has been chosen as the main bank to be analysed and SEB Estonia as the bank to be compared. The empirical part uses annual audit reports of banks which are usually publicly available and serve to provide users financial statements and company-related information fundamental for decision making.

This master's thesis consists of three chapters. The first chapter is a theoretical framework of efficiency analysis, overall efficiency matrix, and bank financial information. The second chapter provides an analysis of financial statements which includes accounting principles and specifics of banks in terms of financial data and proposing important financial indicators for banks. Furthermore, the overall efficiency matrix for the banking industry is developed. In the last chapter, an empirical example is presented about the analysis of efficiency based on the financial indicators of Swedbank Estonia and SEB Estonia.

I would like to express my deepest gratitude to my supervisor Professor Paavo Siimann for his guidance, advice and encouragement. Without his persistent help, the goal of this thesis would not have been realized. Additionally, I am grateful to my family and friends who encouraged me and helped me to maintain my motivation throughout the time of my research. I also thank Tallinn University of Technology for supporting me to pursue my studies here in Tallinn.

1. THEORETICAL FRAMEWORK

1.1. Overview of efficiency analysis

The word "efficiency" comes from the word "efficient" which meant "the power to accomplish something" (Harper, 2018) and refers to the quality or degree of being efficient. In economy efficiency is defined as choosing the options and adopting the processes that generate the best outcome at the least cost. Here, the cost does not refer to only financial aspect of the business but also the time and employee resources. Most of the people confuse the effectiveness and efficiency as both describe the performance of the company, but they have a very important difference from each other. According to Drucker (1963), the company can increase its profit by "doing the right things" but still be inefficient by not "doing the things right". Being effective not every time is equal to being efficient. In management, we can consider efficiency as the study of the optimized use of internal factors of the firm. On the other hand, the effectiveness concept summarizes the yield of factors and the reach of goal, without considering the manner and the resources optimized use.

As a backbone of the financial systems, efficiency of a bank has to be regularly monitored by the management and the government. In the last century, several methods of measuring the efficiency of a bank were introduced. According to Wozniewska (2008), there are three main classifications of measuring the efficiency – the traditional method, the parametric methods and the non-parametric method. The traditional method is based on financial indices of financial statements while the parametric methods refer to mainly knowledge of production function. The non-parametric methods differ from others as those methods do not require such knowledge.

In the end of 1970's, CAMEL approach was developed by the Uniform Financial Institutions Rating System to measure the overall performance of the commercial banks. Later in 1995, Federal Reserve added one more component ("S" – Sensitivity) to the rating system which formulated CAMELS system. These components are:

1. Capital adequacy
2. Assets
3. Management Capability

4. Earnings
5. Liquidity
6. Sensitivity

Sarker (2005) demonstrated that evaluating the performance of a bank with CAMELS system requires information from various sources such as financial statements, funding sources, macroeconomic information, budget and cash flow projection, staffing and business operations.

Data envelopment analysis (DEA) is the most popular non-parametric measure of efficiency by Charnes, Cooper, & Rhodes (1978) who defines the efficiency with more than one input and output. DEA method considers that the maximum that could have been produced is obtained by observing the most productive units. This approach provides an objectively determined numerical efficiency value using multiple inputs and outputs, and this is why Berger & Humphrey (1997) suggest that it is particularly valuable in assessing and informing government policy regarding financial institutions. Thus, it was recommended that DEA replaces the traditional method of measuring banking efficiency mentioned previously.

The DEA-model introduced by Banker et al. (1984) presented the transformation of the output that caused by the changes in the input. Constant and variable return scale models mainly are used for overall scale and technical efficiencies of the company. The use of two-stage DEA-models have been started starting from the end of the 1990s. Here, an output variable of the first frontier will be applied as an input variable into the second frontier. Nowadays, this model became one of the popular nonparametric efficiency measurement methods.

Financial ratio analysis is the traditional method of measuring the efficiency. Ratios obtained from financial statements are broadly used by both scientists and stakeholders for different reasons. Depending on the users, the reasons can be making prediction on bankruptcy, analysis of stock exchange qualities, field-specific analysis, etc.

Due to the large number of financial ratios used in financial statements, it needs to be classified into groups. In last century, many methods of classification of financial ratios were introduced and each of them had different experiences and examples to base on. Since 1920s, the first discussions were started to list the ratios into the groups using empirical, deductive and inductive approaches. One of the early papers where the empirical approach was used to classify the ratios was “Some Empirical Bases of Financial Ratio analysis” by James O. Horrigan (1965). He created five categories for financial ratios:

1. Short-term liquidity ratios
2. Long-term solvency ratios
3. Turnover ratios

4. Profit margin ratios
5. Return on Investment ratios

Horrigan sorted liquidity ratios into two different categories, short-term liquidity category and long-term solvency category. Moreover, based on Du Pont's model, he divided profitability ratios into assets turnover, profit margin and return on investment ratios.

In his book about financial statement analysis Lev (1974) classified ratios into four groups; profitability ratios, liquidity ratios, financial leverage ratios and efficiency ratios. This classification is one of traditional and most popular approaches which allows analysts easily understand the economic condition of the company.

When it comes to deductive approach, mathematical relationship is used to split the ratios into certain groups. Du Pont's triangle model is one of the best-known examples for this method which was published in 1919 (Salmi & Martikainen, 1994). This system demonstrates relationship and effect of asset turnover and net profit margin:

$$ROA = \frac{Net\ profit}{Total\ assets} = \frac{Net\ sales}{Total\ assets} \times \frac{Net\ profit}{Net\ sales}$$

Based on the same technique, financial leverage, assets turnover and profit margin are usually taken into account to compute the return of equity:

$$ROE = \frac{Net\ profit}{Average\ Equity} = \frac{Average\ assets}{Average\ Equity} \times \frac{Net\ sales}{Average\ assets} \times \frac{Net\ profit}{Net\ sales}$$

Overall, the deductive approach explains the difference in the indicators of the main ratios by identifying further differences in the lower levels. Based on this approach, a parallel can be drawn to an overall efficiency matrix where all the elements are interlinked and systemic.

The inductive approach of classifying the ratios requires statistical techniques. The aim of this approach is to make compact list of ratios out of numerous ratios which are covering different fields of companies' activities. The main characteristic of the inductive approach is an empirical principle of grouping ratios (Salmi & Martikainen, 1994).

One of the examples for this approach is multiple discriminant analysis (MDA) which is suitable for several finance problems with nonmetric dependent variable. The purpose of MDA is to acquire a model to get a single qualitative variable from one or more independent variable(s) by implementing statistical decision rule. It also illustrates which of the variables has contributed the most to the group discrimination.

Before inputting the variables to MDA stage, it is essential to decrease the high correlation among them and factor analysis is used to group and find patterns in initial data. Interpretation of factor analysis considers the number of diverse factors, relationship between factors and the significance of the factor for being interpreted in particular analysis. These factor patterns have capacity to explain the maximum amount of information contained in original data.

Pinches, Mingo, & Caruthers (1973) performed a research on ratio classifications based on financial ratios of 221 companies which was one of the first attempts of using factor analysis in financial ratio classifications. Pinches et al. classified financial ratios in seven factors:

1. Return on investment
2. Capital turnover
3. Inventory turnover
4. Financial leverage
5. Receivables turnover
6. Short-term liquidity
7. Cash position

Inspired by Pinches et al., Johnson (1979) continued the research and added eighth factor of growth ratios which measures the current year relative to former year for asset items as well as sales. Later Hutchinson, Meric, & Meric (1988) introduced six main components for 127 small companies which were quoted on UK Unlisted Securities market. For each component, the ratio with the highest factor loadings was published (Table 1.1). It can also be concluded that factor analysis is mainly used to classify ratios using statistical methods.

Table 1.1. Principle components and the financial ratios representing the best every component.

Principle component (factor)	**Ratio**
Indebtedness and Liquidity	Equity to Total assets
Profitability	Earnings before interest and tax to Total assets
Growth rate	Annual average sales growth rate (two-year average for the period t–5 and t–3)
Assets structure	Current assets to Total assets
Assets turnover	Sales to Total Assets
Accounts receivable level	Accounts receivable to Sales

Source: (Hutchinson, Meric, & Meric, 1988)

The compilation of the efficiency matrix has similarities with deductive classification where technical relationships are used for ratio classification. Additionally, statistical methods (mainly factor analysis) can be used to decide which ratios are the most meaningful in explaining the financial data chosen by the analyst and bearing this in mind when selecting quantitative indicators for the efficiency matrix.

After analysing hundreds of research papers Siimann (2018) provided the list of most popular ratios by categories used in the scientific research (Table 1.2.). According to the table, liquidity and business failure prediction have been the most interesting fields in financial statement analysis.

Table 1.2. Number of popular ratios split by categories.

Category	**Number of ratios**
Liquidity	14
Assets usage	10
Investment profitability	10
Assets structure	9
Solvency	7
Sales profitability	3
Labour usage	1
Cost to Sales	1

Source: (Siimann, 2018)

In order to assess an overall efficiency of a company, Professor Anatoli Sheremet (Шеремет, 1974) introduced the instruction of the complex analysis of economic activities. This methodology provided 13 consecutive phases of complex analysis starting from first phase of creating basis for the subsequent in-depth analysis of financial indicators till the 13th phase of an overall evaluation of the work in a company provided.

In the second half of the 1970s and in the 1980s, Sheremet's complex analysis methodology was developed further by the Estonian academician Mereste. Since a complex may be random in nature, Mereste supplemented complex analysis with the principle of systemicity (Mereste 1984 referenced in Siimann 2018, 35). The objective of system integrated analysis is to analyse the various facets of the activities of a company systemically and comprehensively and to provide an overall evaluation of the efficiency of the economic activities of a company. In the next subchapter, methodology of an overall efficiency matrix developed by Mereste is touched more deeply.

1.2. Overview of an overall efficiency matrix

The concept of the efficiency matrix was well-known in Estonia at the end of 1970s. The use of this concept spread out to Soviet countries and even to some countries in the eastern Europe. Siimann (2018) in his research paper mentioned four different periods of the efficiency matrix concept, namely, development, composition, rapid growth and rebirth of the efficiency matrix.

The matrix approach to measure the efficiency of economic activities of a manufacturing company was presented for the first time by Mereste at the Faculty of Economics of the Tallinn Polytechnic Institute. According to that, Mereste suggested to take the main quantitative indicators of a company activities and consolidate the relationship between them into a matrix form (Mereste, 1977 referenced in Siimann 2018, 38). At that time, he did not include the visual form of the efficiency matrix.

In the composition period of efficiency matrix, Mereste introduced the structured efficiency matrix where all elements under main diagonal increase as efficiency rises (Figure 1.). This model presented by Mereste was widely accepted by researchers and made way for new debates about the dynamic and static ranking problem. There was a gap to rank years based on the changes in economic efficiency as the matrix concept of calculating the efficiency does not present efficiency as one indicator. As a result, Mereste (1980 referenced in Siimann 2018, 38) suggested overall efficiency index which merges the elements of the efficiency matrix. The arithmetic mean of growth indices of efficiency matrix elements was calculated to get the overall efficiency index. However, Root (1981) mentioned that indices characterising change in efficiency are multiples and it is appropriate to use geometric mean to calculate overall efficiency index. Overall, despite the difficulties of calculating the geometric mean it was accepted that geometric mean has more benefits than arithmetic mean while measuring the overall efficiency index. As for arithmetic mean the location of the elements matters while for geometric mean it does not matter if the element is under or on top of the main diagonal of efficiency matrix. Siimann (2018) pointed out that overall efficiency index based on geometric mean has limitations as it requires the elements of index matrix to be positive values. As not all the companies are generating profit, arithmetic mean could be used if the efficiency matrix contains negative elements.

Later in the composition period, Vensel (1984, referenced in Siimann 2018, 46) developed an efficiency vector indicator of manufacturing based on the concept of efficiency matrix. He pointed out three factors which are essential for efficiency vector indicator methodology:

- the elements of the diagonal of an efficiency matrix equal 1,
- elements located symmetrically in relation to the main diagonal (qualitative indicators) are reverse values of one another,
- an efficiency matrix consists of linearly dependent column and row vectors.

Based on these properties, Vensel (1984, referenced in Siimann 2018, 46) developed the efficiency vector with a single qualitative indicator to analyse the efficiency of a business entity. In this case, he mentioned that numerator should be a performance indicator and denominator is a resource-type quantitative indicator.

Quantitative factor	Profit (P)	Total cost of manufacturing and services (TCMS, T)	Cost of finished goods produced (CFGP, G)	Manufacturing costs (MC, M)	Tangible fixed assets (TFA, F)	Number of employees (A)
Profit (P)	11 1	12 $\frac{T}{P}$ TCMS to Profit	13 $\frac{G}{P}$ CFGP to Profit	14 $\frac{M}{P}$ MC to Profit	15 $\frac{F}{P}$ TFA to Profit	16 $\frac{A}{P}$ Employees to Profit
Total cost of manufacturing and services (TCMS, T)	21 $\frac{P}{T}$ Profit to TCMS	22 1	23 $\frac{G}{T}$ CFGP to TCMS	24 $\frac{M}{T}$ MC to TCMS	25 $\frac{F}{T}$ TFA to TCMS	26 $\frac{A}{T}$ Employees to TCMS
Cost of finished goods produced (CFGP, G)	31 $\frac{P}{G}$ Profit to CFGP	32 $\frac{T}{G}$ TCMS to CFGP	33 1	34 $\frac{M}{G}$ MC to CFGP	35 $\frac{F}{G}$ TFA to CFGP	36 $\frac{A}{G}$ Employees to CFGP
Manufacturing costs (MC, M)	41 $\frac{P}{M}$ Profit to MC	42 $\frac{T}{M}$ TCMS to MC	43 $\frac{G}{M}$ CFGP to MC	44 1	45 $\frac{F}{M}$ TFA to MC	46 $\frac{A}{M}$ Employees to MC
Tangible fixed assets (TFA, F)	51 $\frac{P}{F}$ Profit to TFA	52 $\frac{T}{F}$ TCMS to TFA	53 $\frac{G}{F}$ CFGP to TFA	54 $\frac{M}{F}$ MC to TFA	55 1	56 $\frac{A}{F}$ Employees to TFA
Number of employees (A)	61 $\frac{P}{A}$ Profit per employee	62 $\frac{T}{A}$ TCMS per employee	63 $\frac{G}{A}$ CFGP per employee	64 $\frac{M}{A}$ MC per employee	65 $\frac{F}{A}$ TFA per employee	66 1

Figure 1. Structured efficiency matrix of a machine factory or shipyard.
Source: (Mereste 1981, referenced in Siimann 2018, 41)

In the rapid development period, introduction of efficiency field concept was one of the important events. Mereste (1984, referenced in Siimann 2018, 47) took five key quantitative indicators for overall evaluation of economic activities of a manufacturing and introduced the concept of efficiency field. The followings are the indicators:

1. profit
2. cost of manufacturing
3. cost of materials
4. fixed assets
5. number of employees

The main logic was that company is multi-faceted economic factor and its efficiency cannot be analysed with only two or three ratios. In order to analyse the efficiency of an entity at least five indicators which cover the whole manufacturing process should be considered.

Vensel (1985, referenced in Siimann 2018, 49) presented the efficiency matrix to measure the efficiency of the use of labour with seven quantitative indicators:

1. average number of employees,

2. man-days used,
3. man-hours used,
4. cost of employees' annual pay,
5. cost of employees' daily pay,
6. cost of employees' hourly pay,
7. cost of finished goods.

As it was 7x7 efficiency matrix, it had 42 qualitative indicators and Vensel highlighted only 21 of them by omitting the reverse efficiency field. In order to compare the base and reporting periods, he developed based efficiency field, reporting efficiency field and index matrix. Moreover, Vensel pointed out that the main important factor is the interlinking of all elements of efficiency matrix. It means that each element of the first column equal multiplication of the elements under the main diagonal. Consideration of the same approach on Figure 1. will give the following result:

$$\frac{P}{A} = \frac{F}{A} \times \frac{M}{F} \times \frac{G}{M} \times \frac{T}{G} \times \frac{P}{T}$$

where $\frac{P}{A}$ – profit per employee,

$\frac{F}{A}$ – tangible fixed assets per employee,

$\frac{M}{F}$ – manufacturing costs to tangible fixed assets,

$\frac{G}{M}$ – cost of finished goods produced to manufacturing costs,

$\frac{T}{G}$ – total cost of manufacturing and services to cost of finished goods

produced,

$\frac{P}{T}$ – profit to total cost of manufacturing and services.

In its period of rapid development, concept of efficiency matrix was utilized by several researchers to analyse the different fields of a company. In order to analyse the dynamic and fulfilment of the budget, Root (1987, referenced in Siimann 2018, 52) composed a new efficiency matrix with six indicators where two of them were output indicators, profit and sales, four of them were input indicators, cost of raw materials and indirect materials, direct labour expenses and man-hours.

Another researcher, Tosso (1990, referenced in Siimann 2018, 55) used the efficiency matrix to analyse the working efficiency. He pointed out that the efficiency matrix is sufficient to discover the volume of working efficiency, but it is not effective for management. It is vital to note that working efficiency can be affected not only by economic factors but also social and psychophysiological factors which is hard to track in efficiency matrix.

The concept of efficiency had its peak level of utilization in the period between 1984 and 1990. During those years, the concept started to spread among Soviet republics as well as German Democratic Republic and even Japan.

The rebirth of efficiency matrix concept started since 2000s which followed the absence of any research or further development of the matrix modelling for several years. Vensel (2001, referenced in Siimann 2018, 56) formulated an efficiency matrix to measure the performance of commercial banks in the period of 1994–1999. It was the first time when the efficiency matrix was used to analyse the efficiency of financial institution. As the quantitative indicators Vensel chose the following indicators in order of finality:

1. Total assets
2. Equity
3. Income generating assets (receivables from customers and other commercial banks, and securities)
4. Interest income
5. Net interest income
6. Profit before taxes
7. Net profit

The first English-language review papers on matrix analysis methodology were published by Startseva and Alver (2011) and Siimann (2011) which was pursued at Tallinn University of Technology.

The efficiency matrix was a main tool in the analysis of the change in profit per employee published by Siimann and Alver (2015). In their research paper, Estonia's small and medium-sized information technology and telecommunications companies were analysed between the years of 2009 and 2013.

Siimann (2018) in his doctoral thesis, increased the number of the groups of financial indicators involved in the efficiency matrix from the previous three to six, also including a capital group, and divided performance indicators into income, profit and cash flow indicators. Company's overall efficiency matrix was constructed, involving eight quantitative indicators: average capital for the period, average number of employees for the period, average assets for the period, operating expenses, sales revenue, EBIT, net operating cash flow and free cash flow (Figure 2.). Moreover, Siimann proposed two extra groups of overall efficiency indicators, benchmark index of company's overall efficiency and growth index of company's overall efficiency. Implementation of the overall efficiency matrix developed by Siimann demonstrated that the analysis the overall efficiency of a company requires only publicly available financial statements, no other data is needed.

Quantitative factor	Free cash flow (F)	Net operating cash flow (R)	EBIT (P)	Sales (S)	Operating expenses (O)	Average Assets (A)	Average number of employees (E)	Average Capital (C)
Free cash flow (F)	11 1	12 R/F Op. cash flow to Free cash flow	13 P/F EBIT to Free cash flow	14 S/F Sales to Free cash flow	15 O/F Op. expenses to Free cash flow	16 A/F Assets to Free cash flow	17 E/F No of employees to Free cash flow	18 C/F Capital to Free cash flow
Net operating cash flow (R)	21 F/R CM **Free cash flow to Op. cash flow**	22 1	23 P/R EBIT to Op. cash flow	24 S/R Sales to Op. cash flow	25 O/R Op. expenses to Op. cash flow	26 A/R Assets to Op. cash flow	27 E/R No of employees to Op. cash flow	28 C/R Capital to Op. cash flow
EBIT (P)	31 F/P Free cash flow to EBIT	32 R/P PCM **Op. cash flow to EBIT**	33 1	34 S/P Sales to EBIT	35 O/P Op. expenses to EBIT	36 A/P Assets to EBIT	37 E/P No of employees to EBIT	38 C/P Capital to EBIT
Sales (S)	41 F/S Free cash flow to Sales	42 R/S ICM Op. cash flow to Sales	43 P/S IPM **EBIT to Sales**	44 1	45 O/S Op. expenses to Sales	46 A/S Assets to Sales	47 E/S No of employees to Sales	48 C/S Capital to Sales
Operating expenses (O)	51 F/O Free cash flow to Op. expenses	52 R/O ECM Op. cash flow to Op. expenses	53 P/O EPM EBIT to Op. expenses	54 S/O EIM **Sales to Op. expenses**	55 1	56 A/O Assets to Op. expenses	57 E/O No of employees to Op. expenses	58 C/O Capital to Op. expenses
Average Assets (A)	61 F/A Free cash flow to Assets	62 R/A RCM Op. cash flow to Assets	63 P/A RPM EBIT to Assets	64 S/A RIM Sales to Assets	65 O/A REM **Op. expenses to Assets**	66 1	67 E/A No of employees to Assets	68 C/A Capital to Assets
Average number of employees (E)	71 F/E Free cash flow to No of employees	72 R/E Op. cash flow to No of employees	73 P/E EBIT to No of employees	74 S/E Sales to No of employees	75 O/E Op. expenses to No of employees	76 A/E RM **Assets to No of employees**	77 1	78 C/E Capital to No of employees
Average Capital (C)	81 F/C Free cash flow to Capital	82 R/C KCM Op. cash flow to Capital	83 P/C KPM EBIT to Capital	84 S/C KIM Sales to Capital	85 O/C KEM Op. expenses to Capital	86 A/C Assets to Capital	87 E/C KRM **No of employees Capital**	88 1

Figure 2. The company's overall efficiency matrix
Source: (Siimann, 2018)

From what has been discussed above, it can be concluded that the efficiency matrix is a convenient tool to analyse efficiency as a multi-faceted phenomenon. At the same time, it highlights the importance of generalising efficiency by allowing to investigate the changes in indicators to compare departments internally or several companies in the same field.

1.3. Specifics of banks' financial statements

The aim of the financial statements is to demonstrate the overall financial performance of a company. As the elements of financial statements are different for non-banks and banks, it requires specific approach to analyse them. This difference comes from the nature of the activities of banks and manufacturing and service companies. In this paper, statement of financial position and income statement will be taken for analysis of commercial banks.

Commercial banks are financial institutions that intermediate between those who own money (i.e., savers or depositors) and those who want money (i.e., borrowers). Banks collect deposits from savers and offer interest and other attractive factors that give customers better option to use their funds. Financial intermediation by providing deposits with low denomination, low risk and significant liquidity is essential role that banks play in economy.

The core accounting equation of assets equal to liabilities and equity is same for banks and regular companies. However, the components of each category in bank balance sheet are quite distinct. One of the unique aspects of bank balance sheet is that all the figures are the average amounts. In this way, balance sheet provides more accurate info about financial health of a bank (Table 1.3).

Cash assets of commercial banks include deposits at the Central Bank (primarily to meet legal reserve requirements), deposits at the other banks (for clearing purposes and also to compensate the other banks for providing services), and cash items in the process of collection. All of these four categories of assets have one common feature: They earn no interest. A principal function of the commercial banking industry is to offer transaction accounts to the public and to administer the payment system. This basic function has been historically reflected in the large amount of demand and other transactions deposits at commercial banks. To offer these services, individual banks must cooperate with other banks on the clearing and processing of checks. The role of commercial banks as an outlet for savings of individuals and businesses is also reflected in the balance sheet of the industry.

Another main group of bank asset is investment securities. Generally, securities on bank balance sheet are more or less totally debt. The reason behind it is that banks are not allowed to own equity securities. There are strict regulations that push banks not to be investors but focus on being lenders.

Loans, the least liquid of banking assets and the major source of risk, comprise the major asset category for most banking institutions as well as the primary source of bank earnings. It can be categorized as loans to credit institutions and loans to public. Reflecting the traditional orientation of commercial banks toward business lending, the greatest portion of credit extension at these banks is in the form of loans to businesses for acquiring inventory, carrying accounts receivable, and purchasing new equipment and real estate. Substantial amounts of credit are also extended by commercial banks to other financial institutions, principally to securities firms and to sales and personal finance companies. Indeed, most small sales and personal finance companies obtain the bulk of their funds from commercial banks.

Table 1.3. Banks' statement of financial position.

Statement of financial position					
	Notes	Year		Notes	Year
Assets			**Liabilities**		
Cash and cash equivalents		xx	Amount owed to credit institutions		xx
Treasury bills		xx	Deposits and borrowings		xx
Loans to customers		xx	Securities		xx
Bonds		xx	Derivative financial liabilities		xx
Securities		xx	Accrued expenses		xx
Derivative financial assets		xx	Prepaid income		xx
Tangible assets		xx	Provisions		xx
Intangible assets		xx	Current tax liabilities		xx
Deferred tax assets		xx	Deferred tax liabilities		xx
Other assets		xx			
Prepaid expenses		xx	**Total liabilities**		**xx**
Accrued income		xx			
			Equity		
			Equity of parent company		xx
			Share capital		xx
			Other equity		xx
			Retained earnings		xx
			Profit for the year		xx
			Total equity		**xx**
Total assets		**xx**	**Total liabilities and equity**		**xx**

Source: (by author)

Equity represents a small but vitally important part of the balance sheet of commercial banks. In a market-based economy in which banks seek to make a profit for their owners, equity is the tangible representation of this private ownership. However, that equity finances a small portion of the assets of a bank. Fundamentally, banks are highly leveraged business organizations. As such, during periods of prosperity, bank earnings increase dramatically, while periods of economic decline are magnified into dramatic reductions in bank earnings, erosion in the capital account, and the failure of large numbers of banks.

Taking a risk is an essential problem in the banking industry, and it has become a main topic of the banking studies. Even pre-defined set of regulations and strict auditing of commercial banks to ensure that all these requirements are met do not make the commercial banks risk-free because of the nature of their activities (Jin, Kanagaretnam, Lobo, & Mathieu, 2013). Banks earn profits by accepting risk because of the nature of their activities. The management of commercial banks should come up with different strategies in terms of risk characteristics to increase the income for their shareholders. Banks must recognize that there are different types of risk and that the impact of a particular investment strategy on shareholders depends of the impact of the total risk of the organization. That total risk is composed of six components (Fraser, Gup, & Kolari, 1995):

1. Credit risk
2. Interest rate risk
3. Liquidity risk
4. Operational risk
5. Capital risk
6. Fraud risk

Credit risk is the general risk that causes serious problems to bank management. Banks may fail because of the mismanagement, fraud or many other reasons but the crucial one is bad loans.

When it comes to the income statement of the commercial banks (Table 1.4), it presents all major categories of revenue and expenditures, the net profit or loss for the period, and the amount of cash dividends declared, measures a firm’s financial performance over a period of time, such as a year or a quarter or a month. The income statement and the balance sheet are integrally related, and both should be evaluated when assessing bank performance.

Interest income is generated by loans that are the largest asset category for most bank balance sheets, and interest and fees on loans are the primary sources of bank income. This class of revenue, which has all year-to-date interest and fees on loans, is reported on the top on the income statement. Income from lease funding is year-to-date financial gain derived from lease funding receivables. The analyst should notice that financial gain reported on loans and leases is accrued, which means that it is recognized over the period of the loan rather than when cash is actually received. A bank can recognize this income for at least 90 days before the loan goes on nonaccrual status (IFRS 9, 2018).

Other interest income includes income on interest-bearing securities and derivatives that reduce the risks involved in bank’s operations.

Interest expense is the main type of expense for most banks. Interest expense is allocated into six categories: interest paid on time deposits; interest on other deposits; interest expense on purchased funds and securities sold under agreements to repurchase; interest on note balances and on other borrowed money; interest on mortgage debt and capital leases on bank premises, fixed assets, and other real estate owned; and interest on subordinated notes and debentures. Net interest income on a tax-equivalent basis is total interest income less total interest expense. The relationship between net interest income–the amount by which interest received exceeds interest paid–and total assets is an important analytical tool in assessing a bank’s ability to generate profits with the help of the management of interest generating assets and interest-bearing liabilities.

Table 1.4. Banks' financial statement of profit and loss.

Statement of profit and loss		
	Notes	Year
Interest income		xx
Interest expense		xx
Net interest income		**xx**
Non-interest income		xx
Gain from securities		xx
Commission income		xx
Other income		xx
Net non-interest income		**xx**
Personnel expenses		xx
Administrative expenses		xx
Depreciation and amortisation		xx
Impairments		xx
Provision for credit related commitments		xx
Other operating expenses		xx
Net operating expenses		**xx**
Profir before tax		**xx**
Tax expense		xx
Profit for the year		**xx**

Source: (by author)

Other income usually is not a big portion on the income statement of commercial banks. Depending on the size of the bank it can be generated by extra services provided within the group companies and other operating income.

Other expenses in banking industry are generally considered as administrative expenses such as expenses for premises, rents, short/term leases, advertising, public relations and other operating expenses.

2. COMPILATION AND ANALYSIS OF AN OVERALL EFFICIENCY MATRIX

The second section of the thesis focuses on developing a bank's overall efficiency matrix, which may be used in practice for analysing the overall performance based on the publicly available annual reports. Additionally, the properties of a matrix model are analysed.

2.1. Compilation of bank's overall efficiency matrix

Based on the relationship between row and column vectors in an overall efficiency matrix, it can be said that all elements of the matrix are related. At the same time, the main characteristic is the symmetric value of each elements in respect of the main diagonal. As a consequence, the square matrix consists of two triangular matrices that are mirror images of each other. In his research Siimann (2018) agreed with Vensel (1985, referenced in Siimann 2018, 67) on two different fields of square matrix which are distributed along the main diagonal, namely, efficiency field and reverse efficiency field. All elements under the main diagonal is the efficiency triangular field. On the contrary, the remaining half of the square matrix, to be exact, combination of the elements that are above the main diagonal create the reverse efficiency triangular field.

While drafting the efficiency matrix it is important to clarify the purpose of the analysis as long as the selection of the quantitative indicators has a significant effect on the result of the analysis. Depending on what exactly one needs to analyse, the company as a whole or just a specific part of a company, the selection of quantitative indicators will differ. Mainly the focus of analysis will be on the efficiency field as the relationships between the elements need to be investigated and analysed. However, as a part of the matrix itself, the reverse efficiency field should also be included in the efficiency analysis.

Selecting the qualitative indicators impacts on the result of the efficiency matrix concept and needs to be considered more carefully. Luur (1982) divided the quantitative indicators into two categories, input and output indicators which created three different areas inside the efficiency matrix (Figure 3.):

- Triangular output matrix (OM) refers to the efficiency of last outcome of economic activities. Its elements demonstrate the portion between the output indicators.
- Triangular input matrix (IM) refers to the efficiency of utilizing the resources. Its elements present the portion between the input indicators.
- Triangular input-output matrix (IOM), the elements of which are used to analyse connection between the input and output indicators. This relationship can also be called as intensity ratios.

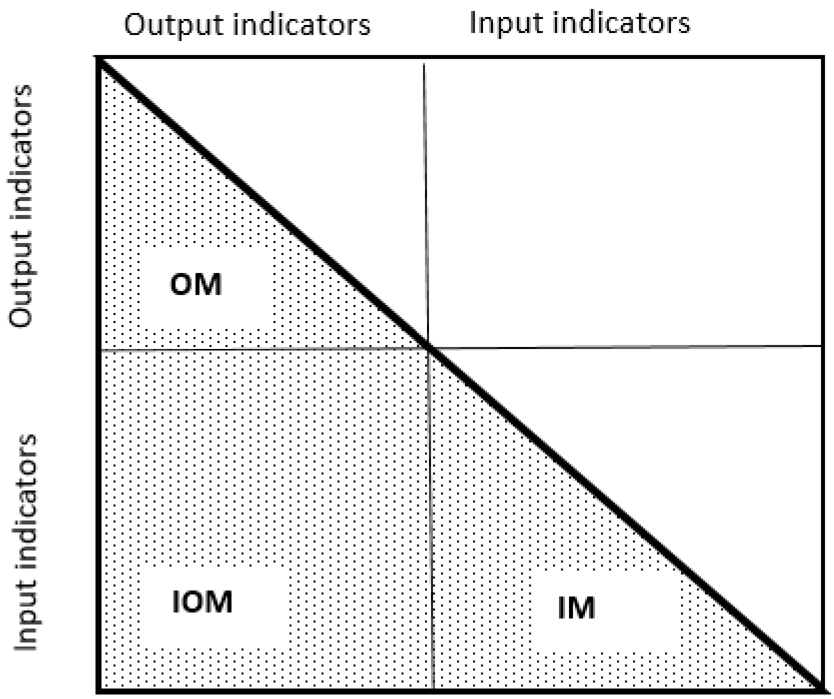

Figure 3. Division of efficiency field into three submatrices.
Source: (Лууp, 1982)

While enhancing the efficiency matrix, Vensel (1985, referenced in Siimann 2018, 69) proposed to split the quantitative indicators into four groups, one output indicator and three input indicators:

- indicators reflecting the manufacturing process (for example, number of the goods manufactured, gross profit, sales revenue, etc.),
- indicators demonstrating the use of labour (for example, number of employees, training expenses, etc.),
- indicators presenting the utilization of tangible fixed assets (for example, investments in non-current assets, etc.),
- indicators reflecting the utilization of current assets (for example, cost of inventories and material used, etc.).

Siimann (2018) suggested to select the quantitative indicators according to the business activities which are operating activities, investment activities and financing activities. Considering the time-based occurrence of these activities, it is logical to start with financing activities when company gets its equity contribution from the shareholder(s). As soon as company has enough funds, the next activities are investment activities when company, for example, acquires tangible item of non-current assets. When it comes to operating activities, they are the last ones as those activities refer to earning income and generating cash inflows.

Siimann (2018) in his doctoral thesis "*Usage of Efficiency Matrix in the Analysis of Financial Statements*" provided novel approach for selecting quantitative indicators of efficiency matrix, which is following below time-based indicators:

CAPITAL ⇨ RESOURCES ⇨ EXPENSES ⇨ INCOME ⇨ PROFIT ⇨ CASH FLOW

As noted already, the most important remark in an overall efficiency matrix is that the quantitative indicators should be ranked in an economically meaningful order (one that considers the sequence of the operations). Vensel thought that it should be applicable if the sequence of the operations is followed (1985). Based on the scheme, it may be concluded that, as the level of finality of a quantitative indicator increases, its rate of growth must not decrease compared to previous indicators (Siimann, 2018). This is referred to as the intensity development principle.

Although previous researches were done for mainly regular companies, it does not deny the fact that it can be adjusted for other companies with different nature of activities. If intensity development principle is followed and field specific indicators are chosen, then the overall efficiency matrix may be applicable for other sort of economic entities.

Author of this thesis thinks that the same principle is adaptable for banking industry. Although the business strategy and way of generating money is different, there are several mutual characteristics of a regular company and a bank. The shareholders of both a regular company and a bank are interested earning profits and both entities are obliged to report their annual figures and publish it in certain structure. Their financial statements are similar with slight difference which is based on the nature of each. Following economically meaningful order among financial indicators that are publicly available can show you the overall efficiency level of a regular company and it may be effective for banks as well. It is important to adjust the same principle for banking industry because of its nature. The scope of the same financial indicator may have individual importance for each type of a business, for example, high value of total assets are not a sign of a strength for a regular company, even more it is sign of a mismanagement but for a bank, total assets are a sign of a healthy future.

Another question is how to select and rank quantitative indicators between input and output indicators and at the same time to follow the intensity development principle. For example:

- Capital indicators can be owners' equity and loan capital. However, banks do not have loan capital which means that owners' equity should be selected as a capital indicator.
- Resource indicators has two groups: employees and assets. Siimann (2018) used both of them for regular companies. However, for banks number of employees does not play an essential role in generating income and profit. It makes sense to select assets as resource indicator. Compared to regular companies, having a high volume of assets represents strength of banks. It makes sense to focus on few major asset groups rather than involving assets with limited share and rank them in order of their decreasing share.
- Expense group has also similar approach as asset. While ranking the expenses, focus should be on two or three major categories of expenses and skip those that have limited share. Banks have 3 main expense categories which are interest expense and non-interest expense and operating expense. Author of this thesis proposes to select operating expenses to measure the efficiency of a bank in controlling its expenditures in operating activities.
- For income group it has slightly different approach that focuses on order of increasing shares. It means that the first selected income indicator is preferred to be more stable than other income indicators and has lower share than the second selected income indicator.
- Analysis of profit indicators requires to be included in the overall efficiency matrix. According to the intensity development, it makes sense to select gross profit first and then follow with other profit indicators such as EBITDA, operating profit, and net profit. Net profit has higher growth rate than gross profit and other profit indicators.
- Cash flow indicators should also be included into the efficiency matrix as those are the important parts of analysis of the banks. Banks should have enough cash and cash equivalents to survive the economic crisis. It also refers to liquidity which is the measure of cash and cash equivalents banks have available to quickly pay bills and meet short-term business and financial obligations.

Accordingly, to get a more comprehensive analysis result, Siimann (2018) suggested to divide efficiency field into 21 submatrices, six of which are triangular matrices and 15 quadrilateral matrices (Figure 4). Triangular matrices characterise proportions between the various parts of one group of quantitative indicators. He also explained quadrilateral matrices that characterise proportions between various parts of two groups of quantitative indicators. This approach helped to analyse the financial ratios in the field elements of the overall efficiency matrix and understand the changes and the reason behind these changes.

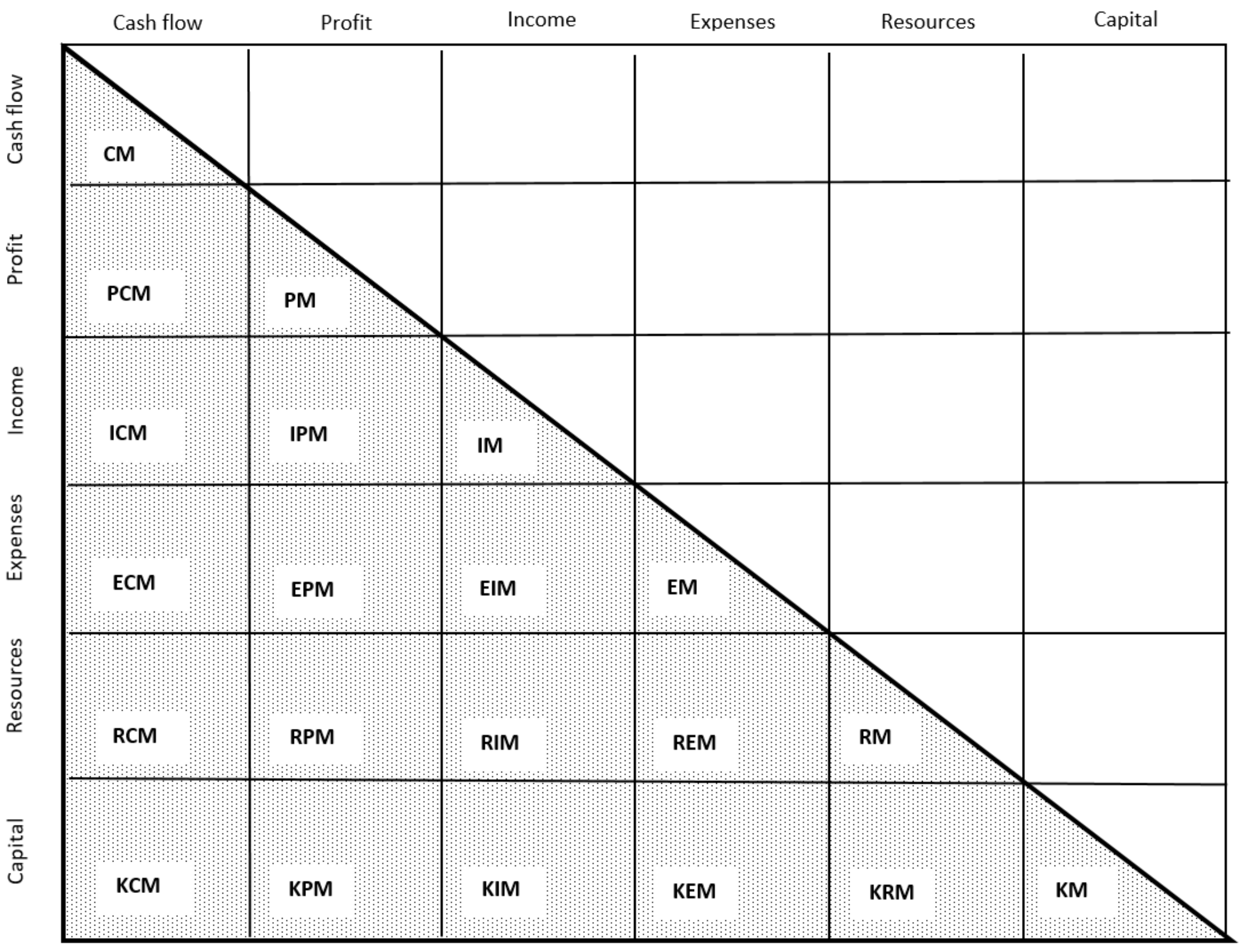

Figure 4. Division of efficiency field into 21 submatrices.
Source: (Siimann, 2018)

All 21 submatrices appear in a single efficiency matrix only if all six groups of quantitative indicators are involved and at least two indicators from every group are represented. If one indicator is involved from a group of quantitative indicators, no triangular matrices characterising the proportions of the relevant group are formed (Siimann, 2018).

For the analysis of the overall efficiency level of banks, the author of this thesis proposes a bank's overall efficiency matrix (Table 2.1). Following assumptions will be the fundamentals of this matrix model:

1) information used is taken only from publicly available annual reports,
2) consideration is given to the order where raising capital makes allows to purchase and invest resources that, through expenses, generated income, profit, and cash,

3) selected indicators are applicable for the banks in the same sector,

4) a matrix model involves an even number of quantitative indicators, thereby enabling the dynamic analysis and the comparative analysis of efficiency levels in a manner where the result of the analysis is affected by all the quantitative indicators.

Based on the assumptions above, eight quantitative indicators are involved in an overall efficiency matrix and are presented in the following order of their finality:

— average equity (C),

— average assets (A),

— operating expenses (O),

— net interest income (I),

— total income (R),

— profit before tax (P).

Table 2.1. The bank's overall efficiency matrix.

Indicators	Profit before tax (P)	Total Income (R)	Net interest income (I)	Operating expenses (O)	Average Assets (A)	Average Equity (C)
Profit before tax (P)	11 1	12	13	14	15	16
Total Income (R)	21 $\frac{P}{R}$ IPM	22 1	23	24	25	26
Net interest income (I)	31 $\frac{P}{I}$ IPM	32 $\frac{R}{I}$ IM	33 1	34	35	36
Operating expense (O)	41 $\frac{P}{O}$ EPM	42 $\frac{R}{O}$ EIM	43 $\frac{I}{O}$ EIM	44 1	45	46
Average Assets (A)	51 $\frac{P}{A}$ RPM	52 $\frac{R}{A}$ RIM	53 $\frac{I}{A}$ RIM	54 $\frac{O}{A}$ REM	55 1	56
Average Equity (C)	61 $\frac{P}{C}$ KPM	62 $\frac{R}{C}$ KIM	63 $\frac{I}{C}$ KIM	64 $\frac{O}{C}$ KEM	65 $\frac{A}{C}$ KRM	66 1

Source: (by author)

The first quantitative indicator of the bank's overall efficiency matrix is average equity which consists of owners' capital, capital from issued shares, reserves and retained earnings. Average equity is very essential in banking sector as it is considered as a backup to cover creditors if a bank's assets are liquidated. Split of equity might be different for each bank so involving an average equity as a quantitative indicator avoids structural difference between banks.

The second quantitative indicator is related to resource indicator. Average amount is calculated based on the figures at the beginning and the end of the financial year. In this way, it makes sense to compare this indicator with other periodic indicator such as income. Moreover, a high amount of assets presents the strength of the banks compared to the regular companies where the same figures will probably be associated with mismanagement.

In case of expense indicators, operating expense indicator is selected for analysis. The reason is that control of this expense category is fully up to the bank itself. Interest expense depends on the interest income as latter is naturally occurring within a bank grow. However, non-interest expenses, such as staff costs or administrative expenses as well as commission expenses, can be controlled by the bank.

When it comes to income indicators, two types of income are included to the matrix model: net interest income and total income. In terms of net interest income, it is the main source of income for commercial banks and that is the reason why it should be involved to efficiency measure. Furthermore, total income has been selected as the second income indicator because it reflects the income earned from operating activities of a bank including other non-interest incomes. In modern world each bank should have other source of income to survive crisis and economic difficulties when the volume of interest income reduces.

In terms of profit indicators, it is most relevant to select profit before tax as it will eliminate the differences between banks with non-identical capital structure. At the same time, it helps not to consider country specific tax rates.

The author of this thesis has not selected a cash indicator based on the cash flow statement of a bank. The majority of net operating cash flow for the banks is impacted by the changes in loans and deposits. Additionally, because of the nature of commercial banks interest income and interest received as well as interest expense and interest paid happen in the same period. Compared to banks, regular companies have sales revenue and net cash which can be reported in different operating periods and that is why it is necessary to measure the net cash flow for regular companies. However, the author of this thesis thinks that it is not so important to include a cash indicator in the bank's overall efficiency matrix as the main portion of cash generated by banks is already considered in the income statement. It may lead to incorrect measurement of efficiency of a bank if cash indicator is selected with profit and asset indicators.

In conclusion: raising capital enables banks to invest or purchase assets which, result in operating expenses and thereby create the preconditions for earning income and profit.

The bank's overall efficiency matrix is an aggregate model to link indicators related to efficiency in a structured way. As a result, the efficiency field consolidates all the elements that should grow as efficiency rises and reverse efficiency field elements that should decrease as efficiency rises. Hereinafter, this thesis focuses mainly on efficiency field elements. The efficiency field of the bank's overall efficiency matrix presents 11 submatrices. An overview of the qualitative indicators (or, financial ratios) in these submatrices is demonstrated in Table 2.2.

In an overall efficiency matrix for banks, the group of cash indicators is eliminated from the overall efficiency matrix for banks and five remaining group of quantitative indicators are used. The reason behind it is mainly because of the nature of the banks' activities and at the same time to increase the comparability between banks by avoiding structural differences and promote the usage of an overall efficiency matrix. Moreover, two indicators are selected for resource and income groups and according to the opinion of the author of this thesis, the overall performance of banks mostly depends on these two groups of quantitative indicators. It is possible to select two indicators per group, however, it may lead to more detailed analysis rather than measuring an overall efficiency level.

Table 2.2. Interpretation of the efficiency field elements of bank's overall efficiency matrix.

Submatrix	Efficiency field element	Interpretation of efficiency field element
Income matrix (IM)	Total income to Net interest income	Demonstrates how much total income earned for each euro of net interest income.
Income-Profit matrix (IPM)	Profit before tax to Total income	Demonstrates how much profit the bank is earning compared to total income.
	Profit before tax to Net interest income	Demonstrates how much profit the bank is earning compared to net interest income.
Expense-Profit matrix (EPM)	Profit before tax to Operating expenses	Demonstrates how much profit the bank is earning compared to operating expenses. It is called the efficiency of expense usage.
Resource-Profit matrix (RPM)	Profit before tax to Average assets	Demonstrates the level of gross profit the bank is earning compared to average assets.

Capital-Profit matrix (KPM)	Profit before tax to Average equity	Demonstrates the amount of profit earned before tax by a bank compared to average equity.
Expense-Income matrix (EIM)	Total income to Operating expenses	Demonstrates how much revenue the bank is earning compared to operating expenses.
	Net interest income to Operating expenses	Demonstrates the level of net interest income the bank is earning compared to operating expenses.
Resource-Income matrix (RIM)	Total income to Average assets	Demonstrates how much total income the bank is earning compared to average assets.
	Net interest income to Average assets	Demonstrates the net amount of income generated from interest the bank is earning compared to average assets.
Capital-Income matrix (KIM)	Total income to Average equity	Demonstrates how much total income the bank is earning compared to average equity.
	Net interest income to Average equity	Demonstrates how much net interest income the bank is earning compared to average equity.
Resource-Expense matrix (REM)	Operating expenses to Average assets	Demonstrates how much operating expense the bank is spending compared to average assets.
Capital-Expense matrix (KEM)	Operating expenses to Average equity	Demonstrates how much operating expenses the bank is spending compared to average equity.
Capital-Resource matrix (KRM)	Average assets to Average equity	Demonstrates how much the bank invested into assets compared to average equity.

Source: (by author)

In conclusion, the overall efficiency matrix for banks has several advantages such as more structured and systemic way of analysis, adaptability of matrix based on chosen quantitative indicators, opportunity of analysing the financial ratios. Possibility to calculate the overall efficiency indices should also be considered as an advantage in terms of detailed analysis. It is easy to apply for multiple banks as it was developed in a way to avoid structural difference. Moreover, potential automation also can be the further development of the bank's overall efficiency matrix.

This subchapter focused on the creation of bank's overall efficiency matrix. As a result, compared to previous research, the author of this thesis:

— compiled a bank's overall efficiency matrix model, which includes 11 submatrices,
— has selected field specific input indicators,
— has selected field specific output indicators,
— explained the reason behind of choosing certain quantitative indicators,
— prepared interpretations of all 15 efficiency field elements of bank's overall efficiency matrix.

The bank's overall efficiency matrix compiled in this subchapter should be considered as a continuous work of the company's overall efficiency matrix compiled in previous researches. The author of this thesis adjusted the company's overall efficiency matrix and compiled an industry-specific efficiency matrix with relevant quantitative indicators which may be an effective tool to measure the overall efficiency of commercial banks.

2.2. Analysis of an overall efficiency indicators

As revealed by previous researches, the use of one or a few ratios never provides a full answer about the level of efficiency of a bank as a multi-faceted qualitative phenomenon. The matrix model represents the key financial ratios on the principle of full systemicity which provides adequate field of relationship among them. It is essential to note that qualitative indicators in one row or column of a matrix are not enough to solve the analysis tasks, all elements of an efficiency field need to be considered. Admittedly, using more than eight quantitative indicators will provide better picture and more financial ratios to analyse and evaluate the efficiency levels and the reasons behind the changes.

As revealed by the foregoing, the matrix concept of economic efficiency denies the possibility of reflecting the level of the economic efficiency of a bank in a single figure. In reality, a further problem often needs to be solved when efficiency is measured: ranking economic entities based on their efficiency. This cannot be done using an efficiency matrix, since one bank may prove better based on the value of one matrix element, the second/third bank based on the second/third matrix element, etc.

Efficiency matrix is mostly relevant to analyse the internal aspects of a bank. However, it is important for management to rank a bank based on its efficiency level and discover which bank has a higher level of efficiency and which one a lower level of efficiency. To be able to develop ranking lists, one needs to know an indicator expressed as a single number measuring either the static ranking problem or dynamic ranking problem.

The author of this paper agrees with Siimann (2018) that, the most accurate overall efficiency indicator may be calculated by applying the geometric mean and by using the indices of all the efficiency field elements. Based on the previous researches, the main reason behind it is that the index matrix is calculated on the basis of an efficiency matrix of which the indices are multiples. As every quantitative indicator is considered in the calculation of the geometric mean, the author of this thesis highlights the opinion of Root (1981) and Siimann (2018) that an efficiency matrix has to involve an even number of quantitative indicators.

2.2.1. Static ranking based on the bank's overall efficiency matrix

Solving a static ranking problem reflects to solving the problem of the complex comparative analysis of the efficiency of an economic entity. The overall indicator calculated in the course of it is referred to by Siimann (2018) as the benchmark index of company's overall efficiency (BICOE). The first thing to do is to decide which standards to adopt as the benchmark. For this, the following are suitable in comparative analysis carried out at the level of the bank:

1) data of analysed bank,
2) market leader data,
3) average indicators of all the banks in the same field.

Additionally, it is possible that the benchmark index of company's overall efficiency gets negative values. That is the reason why the calculation of a benchmark index of company's overall efficiency is subject for mature banks with positive profit and cash flow group indicators. Otherwise, making loss and having negative free cash flow make obtaining an efficiency index technically impossible.

Siimann (2018) provided two ways of calculating BICOE and one them is based on the growth indices of all the elements of an efficiency field. Every element of comparative efficiency matrix c_{ij} is the quotient of the elements of the efficiency fields for the same period of a company analysed and of the company selected as the benchmark (Table 2.3). As soon as the elements are calculated, the next step is to calculate a benchmark index of company's overall efficiency (BICOE):

$$BICOE = \sqrt[\frac{n^2-n}{2}]{\prod c_{ij}^{\frac{A}{0}}}$$

where $c_{ij}^{\frac{A}{0}}$ – all efficiency field elements of comparative matrix,

n – number of quantitative indicators in the model.

Banks need to be sorted based on the value of BICOE in descending order where the higher efficiency levels are in front and lower efficiency levels are in the back. Based on the indicator, the efficiency level of the bank can be analysed. If the value of the specific element c_{ij} exceeds one, it means that bank is efficient in terms of this indicator. It also can be said that if the value of specific element c_{ij} is below one, then the efficiency level is low.

The next step as soon as the analysis phase is completed is the proposal of actions to increase the efficiency. For that bank need to set objectives of achieving best or mean level in the reference group.

Table 2.3. Efficiency matrix of comparative coefficients (based on bank's overall efficiency matrix)

QI	P	R	I	O	A	C
P	1					
R	c_{21}	1				
I	c_{31}	c_{32}	1			
O	c_{41}	c_{42}	c_{43}	1		
A	c_{51}	c_{52}	c_{53}	c_{54}	1	
C	c_{61}	c_{62}	c_{63}	c_{64}	c_{65}	1

Source: (by author)

When it comes to another way of calculating BICOE, it can be achieved without developing the bank's overall efficiency matrix (Siimann, 2018). The author of this thesis decided not to focus on this method as the main topic is the compilation and usage of the bank's overall efficiency matrix. The calculation of the second method does not require to develop the efficiency matrix which does not fit with the topic of this thesis. Additionally, unlike the first approach, second one does not provide detailed information to analyse the specific elements of the overall efficiency matrix and the position of a bank on the ranking list.

2.2.2. Dynamic ranking based on the bank's overall efficiency matrix

The solution of the dynamic ranking problem clarifies the changes and how these changes happened compared to the reference period. The base period can be chosen freely, it can be a previous month, quarter, year, or even five years ago. The overall indicator calculated in the course of it is referred to by Siimann (2018) as the growth index of company's overall efficiency (GICOE). He suggested two different ways of calculating the overall efficiency indicator to rank the efficiency levels of banks. One of them requires developing the overall efficiency matrix and another one does not. The author of this thesis sticks to the main topic of the thesis and does not focus on the second method which does not require a matrix model.

Like BICOE, the calculation of GICOE is also based on the growth indices of all elements on an efficiency field. Every element of efficiency index matrix i_{ij} is the quotient of the elements of the efficiency fields for the given period of a bank analysed and the base period (Table 2.4). As soon as the elements are calculated, the next step is to calculate a growth index of company's overall efficiency (GICOE):

$$GICOE = \sqrt[\frac{n^2-n}{2}]{\prod i_{ij}^{\frac{t_k}{t_0}}}$$

where $i_{ij}^{\frac{t_k}{t_0}}$ – all index matrix efficiency field elements,

n – number of quantitative indicators in the model.

Banks need to be sorted based on the value of GICOE in descending order where the better growth rate levels are on the top of the list and lower levels are on the bottom. By analysing the elements of an index matrix, ascertain the main reasons why the company analysed has placed in this position specifically on the ranking list of change in efficiency levels. The more the value of the specific element i_{ij} exceeds one, the more the indicator considered has contributed to the growth of efficiency. And vice versa: the more the value of the specific element is i_{ij} below one, the more the indicator considered has affected the decline in the level of efficiency. In the end of analysis, one needs to set objectives and develop list of actions to increase the efficiency and reduce areas lagging behind.

Table 2.4. Index matrix (based on bank's overall efficiency matrix)

QI	P	R	I	O	A	C
P	1					
R	i_{21}	1				
I	i_{31}	i_{32}	1			
O	i_{41}	i_{42}	i_{43}	1		
A	i_{51}	i_{52}	i_{53}	i_{54}	1	
C	i_{61}	i_{62}	i_{63}	i_{64}	i_{65}	1

Source: (by author)

It is essential to note some limitations when using data from annual reports for benchmarking and ranking purposes. Firstly, there is a time lag of the financial data as it depends on the country. In some countries, it might be obliged for banks to publish their annual reports up to 12 months after the end of the fiscal year (Siimann, 2011). Secondly, banks publish only a limited amount of data which might be a challenge for implementation. Thirdly, some banks can choose the fiscal year which leads to the differences in figures. Fourthly, there might be differences among banks in terms of the structure of financial statements. It also may have naming issues while developing the overall efficiency matrix for banks with a structural difference. However, the bank's overall efficiency matrix has a very common form that can be implemented for the majority of the banks which use IFRS in their financial reporting.

3. ANALYSIS OF BANKS' EFFICIENCY LEVEL

The purpose of this chapter is to show the use of the bank's overall efficiency matrix using the example of an actually operating banks. Swedbank AS has been selected as the bank to be analysed, and SEB Pank AS as the bank to be compared. The period analysed is 2015–2019.

3.1. Introduction of banks and overview of initial data

Swedbank AS (hereinafter referred to as "Swedbank") is a credit institution in the form of public liability company domiciled in Estonia. The principal activity of Swedbank is accepting deposits and other repayable funds from non-professional market participants and is lending out such funds. In addition, Swedbank has the right to provide other financial services such as leasing and factoring services, life insurance services, property insurance services and IT services.

During the period analysed, the value of total assets in the bank grew from 9,690 to 11,721 million euros. A bit of fluctuation has been recognized in the average amount of total equity during the same period while total income and net interest income has experienced steady rise. Moreover, profit before tax has dropped slightly to 249 million euros in 2019 after its peak level of 261 million euros in 2018.

Based on annual reports published by Swedbank, highlights of the period analysed were as follows:

- In 2019, Swedbank launched pension program for employees. Clifford Chance was hired to conduct investigation of historical shortcomings in exposure to money laundering scandal which was popular in media. Swedbank had experienced a noticeable increase in all types of income and it was mainly supported by net interest income and net insurance income (Swedbank AS, 2019).
- In 2018, net insurance income increased by 15 million euros (30%) compared to previous year making up to 64,7 million euros. Lending volume and deposit volume also had experienced significant increase by 7,2% and 9,4% respectively (Swedbank AS, 2018).
- In 2017, economic growth was strong in Estonia which also had positive impact on Swedbank. Smart ID was launched, and a digital mobile app used for identification and

authorisation. The number of active mobile bank users nearly doubled to 250 thousand. As a result, operating profit increased by 8% and reached 234 million euros (Swedbank AS, 2017).

- In 2016, new version of the Internet Bank has been launched. Swedbank has experienced not a significant increase in total income and net interest income, however, strong market position has been maintained. Moreover, deposit volumes increased by 6% year over year supported by both corporate and private segment (Swedbank AS, 2016).
- In 2015, sales of Swedbank's core products such as mortgages, credit cards, insurance and consumer loans rose by 11% which resulted with an increase of 3% in the volume of total income. Additionally, the deposits by non-financial sector companies and households were up by 15,8% and 7,4% respectively (Swedbank AS, 2015).

Compilation of an overall efficiency matrix for the company requires source data, obtained from Swedbank's annual reports (Appendix 1), and their annual growth indices and compound annual growth rate (CAGR) have been set out in Table 3.1.

Table 3.1. Initial data and their dynamics for compilation of Swedbank's overall efficiency matrix.

Year/ QI (in mln €)	Profit before tax (P)	Total Income (R)	Net interest income (I)	Operating expenses (O)	Average Assets (A)	Average Equity (C)
2019	249	407	218	156	11,459	1,755
2018	261	383	211	136	10,882	1,732
2017	234	367	199	136	10,401	1,674
2016	218	355	196	131	9,962	1,598
2015	213	344	188	127	9,505	1,794
2019/2018	0.95	1.06	1.03	1.14	1.05	1.01
2018/2017	1.12	1.04	1.06	1.00	1.05	1.03
2017/2016	1.08	1.04	1.02	1.04	1.04	1.05
2016/2015	1.02	1.03	1.04	1.03	1.05	0.89
CAGR 2019/2015	1.04	1.04	1.04	1.05	1.05	0.99

Source: (by author)

Analysis of initial data suggests that the compound annual growth rate for all initial indicators is above one which means that the figures for all indicators has experienced an increase during the given period. According to the compound annual growth rate, almost all indicators has witnessed slight increase by around 4% per year on average in the period analysed while growth rate for only average equity was 1% less. Operating expenses increased by 14% in 2019 reaching 156 million euros which is the peak level in five years period. Overall, the level of average assets rose steadily from 9,505 million euros in 2015 to 11,459 million euros in 2019. This indicator is actually a sign of strength for Swedbank and also has positive impact on continuing increase in total income and net interest income.

SEB Pank AS (hereinafter referred to as “SEB”) is a credit institution in the form of public liability company in Estonia. SEB is subsidiary company of one of the leading financial group in Nordic countries and Baltic countries. The main activity of SEB is banking services, but it also provides leasing, asset management and data communication services.

During the period analysed, the total assets for the bank kept increasing from 5,183 to 6,864 million euros. A bit of fluctuation has been recognized in the amount of total income during the same period while net interest income has experienced steady rise from 79 to 122 million euros.

Based on annual reports published by SEB, highlights of the period analysed were as follows:

- In 2019, all-time highest increase of 2,500 clients over the year in private client segment for whom SEB is the home bank, transformation to more secure and contemporary authentication solutions which were popular among 32% of all clients (SEB Pank AS, 2019).
- In 2018, largest lending transaction in the history of SEB, 200 million euros were provided for the large corporation in the renewable energy sector and for the acquisition of the district-heating company. Overall, large corporate customer portfolio has experienced an increase by 11% which is one of the notable highlights (SEB Pank AS, 2018).
- In 2017, despite the fact that corporate credit portfolio had witnessed slight decline in several quarters, the figures bounced back till the end of the year. The reason of the reduction was explained in a way that Estonian companies invested more in tangible assets. Moreover, SEB introduced a number of digital novelties for private customers which also had a positive impact on business (SEB Pank AS, 2017).
- In 2016, significant increase was recognized in the volume of deposits by 10% which is largely consistent with the overall increase of total household deposits in the economy. The loan portfolio of corporate clients climbed by 7% while large corporations’ deposits grew by 29% (SEB Pank AS, 2016).
- In 2015, the biggest highlight was experienced in private customers’ loan portfolio which is an increase by 5%. Moreover, market share of SEB also has witnessed a slight increase by 5% and made up to 23% (SEB Pank AS, 2015).

Creation of an overall efficiency matrix for the company requires source data, obtained from SEB's annual reports, and their annual growth indices and compound annual growth rate (CAGR) have been set out in Appendix 1 in Tables 3 to 5.

3.2. Analysis of banks' overall efficiency matrix

A bank's overall efficiency matrix is created in Table 2.1 and the initial data for the bank being analysed in Table 3.1. The author of this thesis focuses on the presentation of an efficiency field and builds a combined matrix where every element includes six qualitative indicators:

- value of the relevant ratio in 2015, 2016, 2017, 2018 and 2019 (five indicators),
- growth index for the value of the relevant ratio compared to the previous year (four indicators),
- compound annual growth for the relevant ratio (one indicator).

Overall efficiency matrix of Swedbank is presented in Table 3.2.

Author of this thesis divided the analysis of the information presented in the efficiency matrix into three phases:

1) analysis of the efficiency level of the company in terms of submatrices for efficiency,
2) calculation and analysis of benchmark index of company's overall efficiency (BICOE),
3) calculation and analysis of growth index of company's overall efficiency (GICOE).

Phase 1: Analysis of the efficiency level of the bank in the terms of submatrices for efficiency.

Analysis was done based on interpretation of efficiency field elements and results are demonstrated on Table 3.3. There are 15 qualitative indicators in the efficiency field of the overall efficiency matrix of the bank whose values increase as efficiency rises.

In the case of Swedbank, the value of 6 indicators of the efficiency field increased, that of 4 remained stable, and the value of 5 qualitative indicators decreased during the period analysed. In four cases out of six, an increase is efficiency was experienced in income indicators. The intensity of capital usage ratio and average assets to average equity ratio also improved. There was not any significant decrease in efficiency for five declined indicators, but it needs to be noted that it was mainly because of operating expenses. During the period analysed, the value of operating expense was stable except the last year. A remarkable increase in 2019, changed the efficiency chart for the bank. As the control of the level of operating expenses mainly depends on the bank itself, in the case of the right cost management decisions, it will create the preconditions for increasing efficiency in the future. Furthermore, decrease in profit before tax in 2019 lead to decline in growth rate of ratio profit before tax to average assets. As a result, efficiency of return on asset ratio decreased by 1% during the given period.

Table 3.2. The overall efficiency matrix of Swedbank.

Year/ QI (in mln l)		Profit before tax (P)	Total Income (R)	Net interest income (I)	Operating expenses (O)	Average Assets (A)	Average Equity (C)
P		1					
R	2019	0.612					
	2018	0.683					
	2017	0.638					
	2016	0.614					
	2015	0.618	1				
	2019/2018	0.90					
	2018/2017	1.07					
	2017/2016	1.04					
	2016/2015	0.99					
	CAGR 2019/2015	1.00					
I	2019	1.143	1.866				
	2018	1.240	1.815				
	2017	1.178	1.846				
	2016	1.110	1.810				
	2015	1.130	1.826	1			
	2019/2018	0.92	1.03				
	2018/2017	1.05	0.98				
	2017/2016	1.06	1.02				
	2016/2015	0.98	0.99				
	CAGR 2019/2015	1.00	1.01				
O	2019	1.600	2.612	1.400			
	2018	1.921	2.812	1.549			
	2017	1.723	2.699	1.463			
	2016	1.658	2.702	1.493			
	2015	1.672	2.704	1.480	1		
	2019/2018	0.83	0.93	0.90			
	2018/2017	1.11	1.04	1.06			
	2017/2016	1.04	1.00	0.98			
	2016/2015	0.99	1.00	1.01			
	CAGR 2019/2015	0.99	0.99	0.99			
A	2019	0.022	0.035	0.019	0.014		
	2018	0.024	0.035	0.019	0.013		
	2017	0.023	0.035	0.019	0.013		
	2016	0.022	0.036	0.020	0.013		
	2015	0.022	0.036	0.020	0.013	1	
	2019/2018	0.91	1.01	0.98	1.09		
	2018/2017	1.07	1.00	1.01	0.96		
	2017/2016	1.03	0.99	0.97	0.99		
	2016/2015	0.98	0.98	0.99	0.98		
	CAGR 2019/2015	0.99	1.00	0.99	1.00		
C	2019	0.142	0.232	0.124	0.089	6.529	
	2018	0.151	0.221	0.122	0.079	6.283	
	2017	0.140	0.219	0.119	0.081	6.215	
	2016	0.136	0.222	0.123	0.082	6.234	
	2015	0.119	0.192	0.105	0.071	5.299	1
	2019/2018	0.94	1.05	1.02	1.13	1.04	
	2018/2017	1.08	1.01	1.02	0.97	1.01	
	2017/2016	1.03	0.99	0.97	0.99	1.00	
	2016/2015	1.15	1.16	1.17	1.16	1.18	
	CAGR 2019/2015	1.05	1.05	1.04	1.06	1.05	

Source: (by author)

Another thing that needs to be noted while analysing the elements of the efficiency field is that in 2018 the value of 12 out of 15 elements of the efficiency field were growing. The biggest contribution to the increasing efficiency in the year under review was made by credit recoveries and insurance income resulting significant cash inflow from operating activities.

The efficiency level of four efficiency field indicators out of 15 remained stable during the period analysed (indicators Total income to Average assets, Profit before tax to Total income, Profit before tax to Net interest income and Operating expenses to Average assets). The fluctuation over five years period end up with balanced figure in the end of period. Ratios related to profit before tax grew in 2017 and 2018 while ratios linked to average assets rose in 2019.

Table 3.3. Analysis of the efficiency field elements of Swedbank's overall efficiency matrix.

Submatrix	Efficiency field element	Interpretation of efficiency field element
Income matrix (IM)	Total income to Net interest income	Efficiency **increased** a bit (CAGR 1.01): all ratios are around 1.8 which means that the bank has continuous and reliable source of income besides net interest income. It makes the bank more resistant in case of economic and financial crises. In 2016, a lower result is indicating net insurance income level which almost remained same.
Income-Profit matrix (IPM)	Profit before tax to Total income	Efficiency **stable** (CAGR 1.00): in 2019, ratio decreased dramatically from its peak level of 0.68 in 2018 analysed to 0.61. The reason is an increase in the volume of operating expenses, mainly in staff costs which were around 10 million euros more than previous year.
	Profit before tax to Net interest income	Efficiency **stable** (CAGR 1.00): in 2018, ratio plummeted to 1.24 times while others were stable at 1.1 during the period analysed. Overall, profitability of operating and financial activities remained same compared to net interest income.
Expense-Profit matrix (EPM)	Profit before tax to Operating expenses	Efficiency **decreased** slightly (CAGR 0.99): each euro invested to operating expenses earned average 1.71 euro as profit. The highest point was in 2018 because of a significant increase in net insurance income by 30%.

Resource-Profit matrix (RPM)	Profit before tax to Average assets	Efficiency **decreased** slightly (CAGR 0.99): return on assets was 2.2%, only in 2018, it increased to 2.4% which did not improve the overall result.
Capital-Profit matrix (KPM)	Profit before tax to Average equity	Efficiency **increased** (CAGR 1.05): return on equity increased from 11% in 2015 to 14% in 2019.
Expense-Income matrix (EIM)	Total income to Operating expenses	Efficiency **decreased** a bit (CAGR 0.99): ratio decreased from 2.7 in 2015 to 2.6 in 2019. Although total income was 2.8 times higher in 2018 compared to operating expenses, it did not increase the efficiency.
	Net interest income to Operating expenses	Efficiency **decreased** slightly (CAGR 0.99): the lowest ratio was in 2019 with 1.4 and the highest 1.55 in 2018. The level of net interest income compared to operating expenses fluctuated during the period analysed.
Resource-Income matrix (RIM)	Total income to Average assets	Efficiency **stable** (CAGR 1.00): assets turnover ratio is very stable and almost fixed in 3% in the given period.
	Net interest income to Average assets	Efficiency **decreased** a bit (CAGR 0.99): in 2015 and 2016 the ratio was 2% but later it started to drop slightly which resulted with decrease in efficiency by 1%.
Capital-Income matrix (KIM)	Total income to Average equity	Efficiency **increased** (CAGR 1.05): capital turnover ratio was 19% in 2015 which increased to its peak level of 23% in 2019.
	Net interest income to Average equity	Efficiency **increased** (CAGR 1.04): lowest ratio was experienced in 2015 with 0.1 and later it stabilized in 0.12 in 2018 and 2019.
Resource-Expense matrix (REM)	Operating expenses to Average assets	Efficiency **stable** (CAGR 1.00): intensity of asset usage ratio is almost equal to each other which is around 0.01 times.
Capital-Expense matrix (KEM)	Operating expenses to Average equity	Efficiency **increased** (CAGR 1.06): intensity of capital usage ratio increased from 0.07 times in 2015 to 0.09 times in 2019.

Capital-Resource matrix (KRM)	Average assets to Average equity	Efficiency **increased** (CAGR 1.05): average value of assets was 5.3 times higher than average value of equity in 2015 which increased to 6.5 times in the end of given period.

Source: (by author)

Phase 2: Calculation and analysis of benchmark index of company's overall efficiency (BICOE).

It makes sense to consider market leader in analysis and compare it to competitor and that is the reason why Swedbank is the bank to be analysed and SEB as the bank to be compared. SEB's overall efficiency matrix is set out in Appendix 1 (Table 6). SEB has been considered as base bank in this comparative analysis which means that calculation is done by dividing the figures of Swedbank to the figures of SEB. To calculate the BICOE, it is required first to obtain the comparative efficiency matrix. Each element of the comparative efficiency matrix (Table 3.4) is the division of the elements of the overall efficiency matrix of Swedbank and SEB where the figures of Swedbank are the numerator and the figures of SEB are the denominator.

By using the formula of BICOE, the benchmark indices of the overall efficiency of Swedbank and SEB are presented in Table 3.5. Based on these indices it can be said that overall efficiency level in Swedbank was higher than its competitor's overall efficiency during the period analysed. The least difference between rival companies was experienced in 2019 when the overall efficiency in Swedbank was only 13% higher than SEB's.

Compared to SEB, Swedbank is more reliable and strong endurance for the economic crisis. It can be seen in the proportion of net interest income compared to total income during the period analysed. This ratio clearly indicates that Swedbank's other sources of income can be a backup during the economic crisis to cover the bank's expenses especially when the level of net interest income experiences a dramatic fall.

In 2019, Swedbank has witnessed a decrease in the level of overall efficiency compared to SEB but still kept its dominant position by 13% higher than its competitor. The main reason for the reduction in the BICOE of Swedbank and SEB is due to the operating expenses and impairment allowances. Although write-offs in 2019 have been significantly lower compared to 2018, the total amount of credit impairment by the general public was 30 times higher which consequently reduced the amount of net interest income and profit before tax. When it comes to the operating expenses, an increase in staff costs and general administrative expenses had also a negative impact on the benchmark index in 2019.

Table 3.4. Comparative efficiency matrix of Swedbank and SEB.

Year/ QI (in mln I)		Profit before tax (P)	Total Income (R)	Net interest income (I)	Operating expenses (O)	Average Assets (A)	Average Equity (C)
P		1					
R	2019	0.905					
	2018	1.091					
	2017	1.003					
	2016	1.027					
	2015	1.048	1				
	2019/2018	0.83					
	2018/2017	1.09					
	2017/2016	0.98					
	2016/2015	0.98					
	CAGR 2019/2015	0.96					
I	2019	1.184	1.309				
	2018	1.380	1.265				
	2017	1.146	1.142				
	2016	1.026	0.999				
	2015	1.152	1.099	1			
	2019/2018	0.86	1.04				
	2018/2017	1.20	1.11				
	2017/2016	1.12	1.14				
	2016/2015	0.89	0.91				
	CAGR 2019/2015	1.01	1.04				
O	2019	0.816	0.901	0.689			
	2018	1.129	1.035	0.819			
	2017	1.079	1.075	0.941			
	2016	1.142	1.112	1.113			
	2015	1.245	1.189	1.082	1		
	2019/2018	0.72	0.87	0.84			
	2018/2017	1.05	0.96	0.87			
	2017/2016	0.94	0.97	0.85			
	2016/2015	0.92	0.94	1.03			
	CAGR 2019/2015	0.90	0.93	0.89			
A	2019	1.242	1.372	1.048	1.522		
	2018	1.558	1.428	1.129	1.379		
	2017	1.444	1.439	1.260	1.339		
	2016	1.340	1.305	1.306	1.173		
	2015	1.510	1.441	1.311	1.212	1	
	2019/2018	0.80	0.96	0.93	1.10		
	2018/2017	1.08	0.99	0.90	1.03		
	2017/2016	1.08	1.10	0.96	1.14		
	2016/2015	0.89	0.91	1.00	0.97		
	CAGR 2019/2015	0.95	0.99	0.95	1.06		
C	2019	1.270	1.404	1.072	1.558	1.023	
	2018	1.602	1.468	1.161	1.419	1.029	
	2017	1.530	1.525	1.335	1.419	1.059	
	2016	1.455	1.418	1.418	1.274	1.086	
	2015	1.373	1.310	1.192	1.102	0.909	1
	2019/2018	0.79	0.96	0.92	1.10	0.99	
	2018/2017	1.05	0.96	0.87	1.00	0.97	
	2017/2016	1.05	1.08	0.94	1.11	0.98	
	2016/2015	1.06	1.08	1.19	1.16	1.19	
	CAGR 2019/2015	0.98	1.02	0.97	1.09	1.03	

Source: (by author)

Moreover, it should also be admitted that SEB has experienced significant growth in almost all elements of the overall efficiency matrix in 2019 which helped to reduce the gap in the efficiency race with its competitor.

In 2019, Swedbank has witnessed a decrease in the level of overall efficiency compared to SEB but still kept its dominant position by 13% higher than its competitor. The main reason for the reduction in the BICOE of Swedbank and SEB is due to the operating expenses and impairment allowances. Although write-offs in 2019 have been significantly lower compared to 2018, the total amount of credit impairment by the general public was 30 times higher which consequently reduced the amount of net interest income and profit before tax. When it comes to the operating expenses, an increase in staff costs and general administrative expenses had also a negative impact on the benchmark index in 2019. Moreover, it should also be admitted that SEB has experienced significant growth in almost all elements of the overall efficiency matrix in 2019 which helped to reduce the gap in the efficiency race with its competitor.

Table 3.5. Benchmark indices of overall efficiency of Swedbank and SEB.

Year	BICOE
2019	113%
2018	124%
2017	123%
2016	120%
2015	120%

Source: (by author)

In spite of Swedbank's overall higher efficiency level compared to SEB, the comparative efficiency matrix of Swedbank and SEB (Table 3.5) suggests that Swedbank could increase its total income level by increasing net interest income, thereby, increase its profit before tax. Moreover, cost control on the level of salary and wages would also have a positive impact on overall efficiency.

<u>Phase 3:</u> Calculation and analysis of growth index of company's overall efficiency (GICOE).

The index matrix needed for completing a dynamic ranking problem is already included in Swedbank's overall efficiency matrix created in Table 3.2. By using the formula of GICOE, growth indices for Swedbank's overall efficiency (Table 3.6) have been obtained.

Table 3.6. Growth indices of Swedbank's overall efficiency.

Year	GICOE
2019/2018	97%
2018/2017	103%
2017/2016	101%
2016/2015	104%
CAGR 2019/2015	101%

Source: (by author)

Based on the analysis of the growth indices of Swedbank's overall efficiency it can be concluded that Swedbank's overall efficiency level grew 1% per year on average from 2015 to 2019. The level of efficiency increased each year, however, in 2019, it dropped by 3% which was the only decline during the period analysed. The causes for change in the elements of the efficiency field are analysed in the first phase (Table 3.3).

It is worthy to note that the reflection of the highlights happened during the period analysed for each bank can be recognized while analysing the banks' overall efficiency matrix. The increase in the value of salaries and board fees and social insurance charges reflected to the value of operating expenses in 2019 in Swedbank. Moreover, the changes in the depreciation value of right-of-use assets and the value of the expenses for premises also resulted with an increase in the value of operating expenses. It can be seen in the analysis of expense-income matrices and expense-profit matrix. As the total income and net interest income of Swedbank did not grow significantly in 2019, GICOE percentage in the same period dropped to 97%. However, in 2018, Swedbank has experienced growth in almost all indicators which also reflected to overall efficiency matrix. In 2017, Swedbank's overall efficiency increased only by 1% and it is interesting to note that the main reason of this increase was the non-interest income. To be exact, the amount of net insurance income rose significantly in 2018 while the net interest income increased just slightly. This helped Swedbank not to face a decline in its level of overall efficiency.

This chapter demonstrated the usage of the bank's overall efficiency matrix using the example of a real operating bank. In using this approach, more comprehensive case studies and diagnostics can be performed using either publicly available or internal financial and non-financial data.

CONCLUSION

The research problem addressed in the master's thesis is that further development of the overall efficiency matrix was required for implementation in the measuring of the overall efficiency of commercial banks. It was required to select field-specific quantitative indicators and made the overall efficiency matrix structured and usable at the level of a company in the banking industry. In this case, it is possible both to analyse the formation of the efficiency level of a bank and to compare its efficiency level to the indicators of other banks or of the same bank for previous periods. The efficiency matrix concept, described by the Estonian academician Uno Mereste for the first time in 1977, was well known in Estonia and Russia from the 1970s to the 1990s and, to a lesser extent, in the 2000s.

The main objective of this thesis was to compile the overall efficiency matrix for the banking industry and test the usability of it based on publicly available financial information of Swedbank Estonia (Swedbank AS) and SEB Estonia (SEB Pank AS).

As a result of four research tasks defined for the accomplishment of the objective of the master's thesis, several important conclusions and results, summarised below, were reached.

Task 1: To analyse the differences of the structure of financial statements between banks and regular companies.

Thesis provided the main differences of financial statements of a regular company and a bank. Mainly they came from the nature of the activities of banks and manufacturing and service companies. Although the core accounting equation of assets equal to liabilities and equity was same for banks and regular companies, the components of each category in bank balance sheet were quite distinct. The major categories of bank assets, equity and income statement were touched in this thesis. One of the main differences is the interpretation of high value of assets in balance sheet in a bank and a regular company. For banks, it is strength, however, for regular companies it may be a sign of mismanagement. Another difference is that net interest income is the main source of income for a bank and in order to be efficient and resistant bank needs to keep balance between the level of net interest income and non-interest income. Risk-taking is also one of the things that makes banks different from regular companies. It is an important issue in the banking industry. Banks accept risk in order to earn profits. The principal risk that has caused problems bank management is credit or default risk. Although banks fail for many reasons, the principal one is bad loans.

Task 2: To introduce the efficiency matrix concept.

The master's thesis introduced that in recent decades many methodologies have been developed for the calculation and analysis of both efficiency and of change happened during period analysed. Estonian academician Uno Mereste supplemented complex analysis with the principle of systemicity, since comprised within the concept of a system is the requirement of integrity, which a complex need not include. Later, a system integrated analysis was proposed based on the theory of index numbers. The financial indicators for one company for one period are sufficient to develop an efficiency matrix but the statistical analysis of parameters require financial information from a greater number of either companies or periods. This means that system integrated analysis may be used, for example, to explain how profit is affected by change in net interest income, total income and operating expense. At the same time, system integrated analysis cannot be used to analyse the impact of training events, employee motivation, management culture and other effects on change in profit.

Concept of efficiency matrix was first introduced by Mereste in 1977 and in 1981 he presented the visual form of the structured efficiency matrix. The period 1980–1984 is known as the composition of overall efficiency indicators. During this period, Mereste defined the need of solving dynamic ranking problem and static ranking problem and proposed methods of calculating them. This period was followed by rapid development of the concept of efficiency matrix which continued till 1990. In 1990s, it became not so popular tool for measuring the efficiency among researchers. Finally, in 2001, Vensel presented a 7x7 efficiency matrix to analyse the performance of Estonian commercial banks which became a trigger for rebirth of efficiency matrix concept. The first English-language review papers about the methodology of matrix analysis were published in 2011 by Startseva, Alver and Siimann. Later, Siimann and Alver continued to use efficiency matrix to analyse changes in profit per employee in 2015. Later in 2018, Siimann published his doctoral thesis where he compiled the company's overall efficiency matrix.

Author of this thesis inspired by Siimann, continued to adjust the company's overall efficiency matrix for use in banking industry by following the principals that efficiency matrix concept.

Task 3: Proposition of quantitative indicators available from publicly available sources for providing industry-specific measure of bank's overall efficiency.

Based on the bank activities and their comprehensive reflection, the author of this thesis decreased the number of the groups of financial indicators involved in the previous company's overall efficiency matrix from six to five by eliminating the cash flow group.

As part of this thesis, a bank's overall efficiency matrix was constructed, involving six quantitative indicators: average equity for the period, average assets for the period, operating expenses, net interest income, total income and profit before tax.

The bank's overall efficiency matrix is based on the following assumptions:

1) only information contained in publicly available annual reports is used,
2) consideration is given to the order in which quantitative indicators are involved in the matrix model: raising capital makes it possible to invest in resources that, through expenses, are transformed into income and profit,
3) financial information readily comparable between banks is used,
4) a matrix model involves an even number of quantitative indicators, thereby enabling dynamic analysis and comparative analysis of efficiency levels in a manner where the result of the analysis is affected by all the quantitative indicators.

Task 4: Incorporation of industry-specific quantitative indicators into overall efficiency matrix concept and demonstration of applicability of the overall efficiency matrix.

Based on the financial indicators of an actual bank (Swedbank AS), the author of this thesis created a numerical example of the bank's overall efficiency matrix, analysed the level of efficiency by comparison to the nearest competitor (SEB Pank AS) and the previous period. Based on the calculations, analysis was done, and efficiency field indicators were mentioned to which a bank should focus on, increasing their values in order to raise its level of efficiency going forward.

The main advantages of the usage of the bank's efficiency matrix:

- systemicity (to have the indicators from various facets of bank in one model),
- simplicity (data required can be easily taken from publicly available annual reports),
- indices (possibility to calculate the overall efficiency indices),
- applicability (applicable for all commercial banks using IFRS).

This master's thesis made both a theoretical and empirical contribution to further development of the efficiency matrix. The author of the thesis considers thesis aim to be fulfilled and hopes that it will encourage the usage of the efficiency matrix concept to analyse the overall efficiency in banks in future.

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APPENDICES

Appendix 1. Initial data for efficiency matrix compilation and analysis

Initial data of Swedbank AS:

Table 1. Balance sheet data of Swedbank.

Indicator (mln €)	2019	2018	2017	2016	2015	2014
Total Assets	11,721	11,196	10,568	10,233	9,690	9,319
Total Equity	1,757	1,753	1,711	1,636	1,560	2,027

Source: (Swedbank AS, 2019); (Swedbank AS, 2018); (Swedbank AS, 2017); (Swedbank AS, 2016); (Swedbank AS, 2015).

Table 2. Initial data for matrix compilation of Swedbank.

Indicator (mln €)	2019	2018	2017	2016	2015
Average equity	1,755	1,732	1,674	1,598	1,794
Average assets	11,459	10,882	10,401	9,962	9,505
Operating expenses	156	136	136	131	127
Net interest income	218	211	199	196	188
Total income	407	383	367	355	344
Profit before tax	249	261	234	218	213

Source: (Swedbank AS, 2019); (Swedbank AS, 2018); (Swedbank AS, 2017); (Swedbank AS, 2016); (Swedbank AS, 2015); author's calculations.

Initial data of SEB Pank AS:

Table 3. Balance sheet data of SEB.

Indicator (mln €)	2019	2018	2017	2016	2015	2014
Total Assets	6,864	6,558	6,124	5,775	5,234	5,183
Total Equity	1,070	1,034	1,043	986	932	855

Source: (SEB Pank AS, 2019); (SEB Pank AS, 2018); (SEB Pank AS, 2017); (SEB Pank AS, 2016); (SEB Pank AS, 2015).

Table 4. Initial data for matrix compilation of SEB.

Indicator (mln €)	2019	2018	2017	2016	2015
Average equity	1,052	1,038	1,014	959	894
Average assets	6,711	6,341	5,950	5,505	5,208
Operating expenses	60	58	58	62	58
Net interest income	122	109	90	83	79
Total income	174	156	146	150	131
Profit before tax	118	98	93	90	77

Source: (SEB Pank AS, 2019); (SEB Pank AS, 2018); (SEB Pank AS, 2017); (SEB Pank AS, 2016); (SEB Pank AS, 2015); author's calculations.

Table 5. Initial data and its dynamics for the compilation of SEB's overall efficiency matrix.

Year/ QI (in mln €)	Profit before tax (P)	Total Income (R)	Net interest income (I)	Operating expenses (O)	Average Assets (A)	Average Equity (C)
2019	118	174	122	60	6,711	1,052
2018	98	156	109	58	6,341	1,038
2017	93	146	90	58	5,950	1,014
2016	90	150	83	62	5,505	959
2015	77	131	79	58	5,208	894
2019/2018	1.20	1.11	1.12	1.04	1.06	1.01
2018/2017	1.05	1.07	1.20	0.99	1.07	1.02
2017/2016	1.03	0.97	1.09	0.94	1.08	1.06
2016/2015	1.16	1.15	1.05	1.07	1.06	1.07
CAGR 2019/2015	1.11	1.07	1.12	1.01	1.07	1.04

Source: (by author)

Table 6. The overall efficiency matrix of SEB.

Year/ QI (in mln I)	Profit before tax (P)	Total Income (R)	Net interest income (I)	Operating expenses (O)	Average Assets (A)	Average Equity (C)
P	1					
R 2019	0.677					
2018	0.626					
2017	0.636					
2016	0.598					
2015	0.590	1				
2019/2018	1.08					
2018/2017	0.98					
2017/2016	1.06					
2016/2015	1.01					
CAGR 2019/2015	1.03					
I 2019	0.965	1.425				
2018	0.899	1.436				
2017	1.028	1.616				
2016	1.082	1.811				
2015	0.981	1.662	1			
2019/2018	1.07	0.99				
2018/2017	0.87	0.89				
2017/2016	0.95	0.89				
2016/2015	1.10	1.09				
CAGR 2019/2015	1.00	0.96				
O 2019	1.962	2.898	2.033			
2018	1.701	2.717	1.892			
2017	1.597	2.511	1.554			
2016	1.451	2.429	1.341			
2015	1.343	2.275	1.369	1		
2019/2018	1.15	1.07	1.07			
2018/2017	1.06	1.08	1.22			
2017/2016	1.10	1.03	1.16			
2016/2015	1.08	1.07	0.98			
CAGR 2019/2015	1.10	1.06	1.10			
A 2019	0.018	0.026	0.018	0.009		
2018	0.015	0.025	0.017	0.009		
2017	0.016	0.025	0.015	0.010		
2016	0.016	0.027	0.015	0.011		
2015	0.015	0.025	0.015	0.011	1	
2019/2018	1.14	1.05	1.06	0.98		
2018/2017	0.99	1.00	1.13	0.93		
2017/2016	0.96	0.90	1.01	0.87		
2016/2015	1.10	1.09	1.00	1.02		
CAGR 2019/2015	1.04	1.01	1.05	0.95		
C 2019	0.112	0.165	0.116	0.057	6.382	
2018	0.094	0.150	0.105	0.055	6.109	
2017	0.092	0.144	0.089	0.057	5.866	
2016	0.094	0.156	0.086	0.064	5.739	
2015	0.086	0.146	0.088	0.064	5.829	1
2019/2018	1.19	1.10	1.11	1.03	1.04	
2018/2017	1.03	1.05	1.18	0.97	1.04	
2017/2016	0.98	0.92	1.03	0.89	1.02	
2016/2015	1.08	1.07	0.98	1.00	0.98	
CAGR 2019/2015	1.07	1.03	1.07	0.97	1.02	

Source: (by author)

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