CLASSIFICATION OF COMPANY LIFE CYCLE STAGES: AN AUTOMOTIVE INDUSTRY IN THE CZECH REPUBLIC

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Abstract: *Company life cycle models have been the focus of researchers' attention for decades, resulting in numerous definitions and determination of stages. Managers are striving to make appropriate strategic decisions at the right time to maximize opportunities linked to various life cycle stages. Assessing a company's life cycle and determining the stage of the cycle allows us to predict a company's future development and to prevent crises or even the company's early termination. In recent years, there has been increased interest in the life cycle assessment of products. However, as a corporate life cycle is longer than that of a product, it still definitely deserves attention – mainly in the field of quantitative criteria. The aim of this paper is to propose quantitative variables to determine a company's life cycle following two requirements: (1) the variables are derived from publicly available financial statements; and (2) the classification method is suitable for a large sample size including non-listed companies in the stock exchange. Our study shows that our three variables (capital expenditures, return on equity, and sales growth) are suitable for stage classification for each firm-year under the condition of following several steps: counting industry quintiles and/or definition of boundaries, score assignment to stages, designing composite score and sample selection. Based on descriptive statistics of each life cycle stage it is possible to assess the variables used in the context of the further strategic direction of the company. To determine the persistence of enterprises in the defined stages, a transition matrix for the four future years was performed, which showed that companies in the growth and maturity stages will be sustained in these two phases in the vast majority of cases. Finally, we discuss the limitations of the study and further research directions.*

Keywords: *Asset turnover, automotive industry, company life cycle, financial indicators, return on equity, sales growth.*

JEL Classification: *C23, M11, M21, M41.*

APA Style Citation: Slavíčková, J., & Slavíček, O. (2022). Classification of Company Life Cycle Stages: An Automotive Industry in the Czech Republic. *E&M Economics and Management, 25*(4), 85–99. https://doi.org/10.15240/tul/001/2022-4-006

Introduction

The life cycle of companies is a popular topic among researchers and managers, as it provides guidance for strategic decisions according to the current life stage of the organization. Each stage of a company's life cycle imposes its own set of features and needs, including employees, leadership styles, structure, decision making, information processing, and approach to innovation (Miller & Friesen, 1984). The popularity of this topic brings with it a large number of approaches to determine a life cycle stage and, at the same time, different numbers of stages (from three to ten) in the presented models. A model with three phases is represented by Smith et al. (1985);

four phases by Quinn and Cameron (1983), Pashley and Philippatos (1990); five phases by Miller and Friesen (1984), Lester et al. (2003); eight phases by Torbert (1974); and ten phases by Adizes (1979). Authors from the last decade are listed in the chapter Theoretical Background. Models with a higher number of stages tend to represent a decomposition of general phases into specific development periods, while models with a lower number of phases focus on identifying the most general stages. Irrespective of the number of life cycle stages, most economists describe the course of company development in a similar way. In general, an organization goes through the stages of birth (existence, start-up), growth (survival), maturity (stagnation, success), revival (rebirth, renewal), and decline.

It is also possible that not all businesses will go through the phases defined in previous studies, i.e., from birth, through growth and maturity, to recovery and decline, as there are already studies that provide evidence of a non-deterministic sequence of life cycle phases (Dickinson, 2011; Lester et al., 2003; Miller & Friesen, 1984; Tichy, 1980). This implies that the cycle phases do not always follow a strict sequence, but rather there are often fluctuations, upheavals, and revivals. Therefore, there is no need to classify a firm into a large number of phases, as some have very similar financial characteristics (e.g., growth and revival, consolidation and maturity) (Jaafar & Halim, 2016).

Limitations are seen especially in indicators designed for life cycle classification. The majority of studies present qualitative variables, mostly in combination with quantitative data. If there is a need to process a large amount of data, it is almost impossible to obtain the necessary information, especially from non-listed companies. From the very early studies on company life cycle, there is one recurring quantitative criterion, which we find unsuitable – the age of the organization. As already mentioned, an enterprise may go through life cycle stages in a different order. As a result, age has insufficient explanatory value, as some businesses mature faster and others slower than the average (Mueller & Yun, 1998; Saravia, 2013). Consequently, young growing enterprises may be classified as mature businesses, and vice versa.

The basis of firm life cycle theory suggests that changes in the company's life cycle stages have a significant impact on investment and financing decisions as well as operating performance. Accounting performance measurements have been the most commonly examined indicators for assessing a company's financial health. Therefore, the paper is focused on financial proxy variables available from the financial statements.

It is challenging to assess the life cycle stage at the company level since each business is composed of numerous overlapping but unique product life cycle phases. Furthermore, businesses may compete in a variety of industries and provide a wide range of products (Dickinson, 2011). It is therefore also necessary to consider the specificities of the sector and at the same time to distinguish between manufacturing enterprises versus enterprises offering services.

Furthermore, it is necessary to point out the importance of the automotive industry in the context of the Czech Republic, as this industry is the subject of this study. In general, the manufacturing industry is crucial for the Czech economy in terms of GDP, employment, development of new technologies (top-level research and development centres of vehicle manufacturers), and investment. The automotive industry accounts for more than 9% of GDP, 26% of manufacturing, and 24% of Czech exports (Czechinvest, 2021). Moreover, the automotive industry has a history of more than a century in the Czech Republic.

In recent years, there have been several frequent topics affecting the entire automotive sector. In the long term, this is Industry 4.0, European Green Deal, and more recent mobility trends such as autonomous and electric vehicles. All these aspects have a huge impact on strategy of companies, development of new technologies, focus on performance, retention of quality skilled employees, and, at the same time, automation of processes. When it comes to the push to increase efficiency and profitability of production while declining costs in Czech manufacturing industry, the focus is primarily on new sophisticated methodologies and approaches (Hedvičáková & Král, 2021).

As of 2019, it is not only this sector that is facing the challenge of the COVID-19 pandemic, which has caused global passenger car production to fall by 5.7% compared to the previous year, with a decline of 17.1% in 2020 (ACEA, 2022). Although the decline was halted in 2021, the automotive industry faced a global shortage of production components, especially chips. In addition, the turn of 2021/2022 saw huge increases in energy and gas prices, putting continuous pressure on all parts of the customer-supply chain. Last but not least, the whole world is currently grappling with the impact of the ongoing war conflict in Ukraine from February 2022 onwards. Company representatives are forced to address critical issues in the supply and price/demand factors.

The paper proceeds as follows. The next section reviews the literature, section 2 describes the research methodology and section 3 discusses our findings. Last section concludes.

1. Theoretical Background

As excellent summaries of existing life cycle models have already been presented in the past, e.g., Lester et al. (2003), Phelps et al. (2007), Jirásek and Bílek (2018), Habib and Hasan (2018), we focus on approaches presented since the year 2010 (Tab. 1). Various multi-stage life cycle models differ in terms of the number of stages, indicators, and characteristics that each stage represents. At this point, we are not talking about bringing out new unique models to the corporate life cycle theory, but rather individual authors leaning towards the previously described models with the addition of a new perspective on context, adjusting descriptors, or linking financial and non-financial areas. In Tab. 1, we provide a literature review comparing selected approaches of individual authors in the direction of stages definition and the indicators used to identify them.

Most of the recent studies of the organizational life cycle topic refer to models presented by Miller and Friesen (1983), Anthony and Ramesh (1992), Lester et al. (2003), DeAngelo et al. (2006), and also Dickinson (2011). Those indicators that are possible to use with a sample of only listed companies, are eliminated from this study as the required data (such as cash flow statement, dividend payout ratio, market to book ratio) cannot be obtained for other firms non-listed in the stock exchange.

As is clear from Tab. 1, the AGE indicator has continued to be used in the last decade too to determine the life cycle phase of a company. But as mentioned in the introduction part, this indicator is not suitable as a life cycle proxy as some companies mature faster than others, and also the company's life cycle is of non-sequential nature (Jaafar & Halim, 2016; Saravia, 2013). Dickinson (2011) further explains that this is due to the fact that the business represents a portfolio of multiple products, each of which could potentially be at a different stage of the life cycle. Other changes are brought about by product innovation, expansion into new markets, structural changes, etc.

The capital expenditures (CE) ratio is a common life cycle proxy variable (Anthony & Ramesh, 1992; Hastuti et al., 2017; Salehnejad & Shahiazar, 2014) due to its possible indications of new investment opportunities. The primary goal of capital expenditures is to meet market demands and expand the business. The more company invests, the

Tab. 1: Last decade of company life cycle approaches – Part 1

Authors	Stages	Indicators
Owen and Yawson (2010)	Young Mature Old	ROE (return on equity) = net income before extraordinary items/equity LIQ (liquidity) = cash and marketable securities/total assets LEV (leverage) = total debt/total assets GRO (sales growth) = annual growth in total sales Based on DeAngelo et al. (2006).
Dickinson (2011)	Introduction Growth Maturity Shake-Out Decline	CFO (cash flow from operating) CFI (cash flow from investing) CFF (cash flow from financing)

Tab. 1: Last decade of company life cycle approaches – Part 2

Authors	Stages	Indicators
Salehnejad and Shahiazar (2014)	Growth Mature Decline	AGE (age of the company) SG (sales growth) = [1 − ($Sales_{it}$/$Sales_{it}$ − 1)] * 100 CE (capital expenditures) = cap. exp./market value of equity DP (dividend payout ratio) Based on Anthony and Ramesh (1992).
Souza et al. (2015)	Existence Survival Success Renewal Decline	Set of questions Based on Lester et al. (2003).
Tam and Grey (2016)	Inception High growth Maturity	Set of questions Based on Smith et al. (1985).
Jaafar and Halim (2016)	Growth Mature Decline	MBA (market to book value of assets) CE (capital expenditures) = capital expenditures/book value of net property & equipment SG (sales growth) = $(S_t - S_{t-1})/S_{t-1}$ Modified model based on Anthony and Ramesh (1992).
Primc and Čater (2016)	Birth Growth Maturity Revival Decline	Modified set of questions Based on Miller and Friesen (1983).
Konečný and Zinecker (2017)	Introduction Growth Stabilization Decline	ROE = earnings after taxes/equity Model works with 7 variables representing measurements of profitability (ROE), beta coefficients, cost of equity, and risk.
Hastuti et al. (2017)	Growth Maturity Stagnant	DP_t (dividend payout) SG_t (sales growth) = $(S_t - S_{t-1})/S_{t-1}$ * 100 CEV_t (capital expenditure value) = (CE_t/$value_t$) * 100 AGE_t (age of the company) Based on Anthony and Ramesh (1992).
Akbar et al. (2019)	Introduction Growth Mature Decline Shake-out	CFO, CFI, CFF Independent variable: RE/TA = retained earnings/total assets + control variables Based on Dickinson (2011) and DeAngelo et al. (2006).
Shaheen et al. (2020)	Introductory Growth Maturity Decline	Independent variable: RE/TA = retained earnings/total assets Control variables: size, growth, profitability, leverage Based on DeAngelo et al. (2006), and O'Connor and Byrne (2015).

Source: own

more acquires investment opportunities (Jaafar & Halim, 2016).

Return of equity (ROE) measures the extent to which a firm is self-financing or reliant on external capital (Hasan, 2015). Indicator ROE as a proxy for life cycle identification is supported by a wide range of studies, e.g., DeAngelo et al. (2006), Owen and Yawson (2010), Brockman and Unlu (2011), O'Connor and Byrne (2015), Konečný and Zinecker (2017). DeAngelo (2006) focuses on the distinction between the growth and maturity phases. His study shows that a high ROE value indicates a company is in the maturity phase with decreasing investment activities. On the other hand, low ROE values tend to point towards young and growing companies. Other authors (Akbar et al. 2019; O'Connor & Byrne, 2015) divide the sample of firms using median ROE values into two halves. Firms with ROE values above the median are classified as mature, while firms with positive ROE values below the median are growing firms. Other companies, i.e., companies below the median and at the same time with the ROE ratio equal to zero or with a negative ROE, are classified as declining. We offer another approach following the previous findings. It is also possible to determine a company life cycle stage according to the MPO (2021) methodology, also applying the values of the risk-free rate (r_f) and alternative cost of capital (r_e). This procedure will be explained in the following chapter of the Research Methodology. It is necessary to consider also calculations with negative equity or negative earnings, as these cases strongly affect the predictive value of the ROE itself, which could in certain situations incorrectly classify the company's situation as prosperous.

Sales growth (SG) rate is used to measure a company's recession or expansion. Research shows that sales growth is one of the most widely used variables in previous studies of the same focus (e.g., Lester et al., 2003; Miller & Friesen, 1984; Primc & Čater, 2016) despite the difference in the method used for life cycle determination. The use of this indicator is based on assumption that firms in the growth phase usually have higher sales growth values than firms in the later stages of the life cycle. Mature companies usually have a lower value of this indicator while keeping the same market share, and in the case of disinterest in the product on offer, there is already a steeper decline (Jaafar & Halim, 2016).

Following the defined condition of this paper, that (1) the variables are derived from publicly available financial statements; and (2) the classification method is suitable for a large sample size including non-listed companies in the stock exchange, and considering the discussion about suitable indicators for organizational life cycle classification; authors agreed on three variables with strong literature support: capital expenditures, sales growth, and return on equity.

2. Research Methodology

This study used a sample of manufacturing companies operating in the automotive industry in the Czech Republic for the purposes of life cycle assessment. The reason for analysing this sector is that the automotive industry in the Czech Republic contributes substantially to the overall development of the economy and greatly affects the national trade balance. Data were obtained from the MagnusWeb database for the period 2010–2019 for CZ NACE C MANUFACTURING, specifically CZ NACE C29's manufacture of motor vehicles, trailers, and semi-trailers. This division contains the following subdivisions:

- CZ NACE C291 Manufacture of motor vehicles;
- CZ NACE C292 Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers; and
- CZ NACE C293 Manufacture of parts and accessories for motor vehicles.

As of 31. 12. 2019, 1,098 economic entities, both registered in CZ NACE 29 were recorded in the Eurostat database (Eurostat, 2022). This number includes both active and inactive economic entities. Active units are those that have reported turnover or employees at any time during the period under review and are therefore alive in that period. In addition, not all listed units are registered in the commercial register, which in terms of further analysis means that they are excluded as their financial statements are not available. The result of this sorting is the original sample that consists of 277 companies reporting the classification of their business activities in one of the above-mentioned categories in the year 2019. This sample includes legal and natural persons registered in the commercial register (with available financial statements) and at the same time it is entities that were classified as active in 2019.

The data necessary to assess the industry ROE indicator are not available for 2020 at the moment of paper processing; hence this year is excluded from the study. The database MagnusWeb collects data from financial statements, so these are data commonly available from the Commercial Register administered by the Ministry of Justice of the Czech Republic.

Regarding the size of the companies, we examined a staff headcount: 20% of the firms employ 1 to 9 employees, 22% have 9 to 49 employees, 23% have 50 to 249 employees, and 35% have 250 or more employees. The structure of companies in turnover terms is as follows: 38% of the firms reported turnover of below EUR 2 million; 20% reported turnover of between EUR 2 million and EUR 10 million; 19% between EUR 10 million and EUR 50 million; and 23% EUR 50 million or more.

The individual steps of the firm-year selection and life cycle stage classification process following the refined model of Jaafar and Halim (2016) are described in subchapters 2.1–2.2.

2.1 Firm-Year Calculation (Panel Data) and a Score Assignment

Based on the literature review and previous own research, the following indicators are assigned for analysis:

1. CE (capital expenditures) = change in property, plant, and equipment/value; where value = total assets − total liabilities;
2. ROE (return on equity) = earnings after taxes/equity;
3. SG (sales growth) = $sales_t/sales_{t-1}$.

Once we clarify what indicators are chosen to be included in the analysis, we calculate the indicators for each company and each year. This firm-year observation organized as panel data is a specific type of observation that combines cross-sectional and time-structured data. Thus, panel data allow us to enlarge the data set, reduce collinearity within the explanatory variables and allow for testing more complex econometric models (Fíglová, 2007).

As Jaafar and Halim (2016) state, industries have unique operating structures that cause financial ratios to cluster by industry grouping. Black (1998) points out that industries also have their life cycle that affects the company's life cycle. Therefore, as mentioned above, only companies from one industry (specifically the automotive industry) were selected for this analysis.

When all indicators for each firm-year are calculated, these are to be assigned with a particular score. For this purpose, each phase is assigned a score (1 to 5) that will be added to the composite score in the next step of the process. For the CE indicator, scores are assigned using calculated industry quintiles, where 1 = growth, 2 = growth/mature, 3 = mature, 4 = mature/decline, 5 = decline (Tab. 2). Score values of 1–5 for the indicators ROE and SG are assigned according to predefined boundaries based on prior research (Slavíčková & Myšková, 2017).

We suggest that for ROE instead of using quintiles as indicator CE, we use the categorization of companies in accordance with the modified MPO (2021) methodology as follows:

- Companies with ROE greater than the risk-free rate and at the same time is lower than the alternative cost of capital (r_f < ROE ≤ r_e) – classified as in the **growth phase (score 1)**;
- Companies that create economic value added, i.e., their ROE is greater than the alternative cost of capital (ROE > r_e) – classified as in the **maturity phase (score 3)**;
- Companies with ROE lower than the risk-free rate (ROE ≤ r_f) – classified as in **decline phase (score 5)**. In the decline stage companies with negative earnings or negative total equity are also included.

Tab. 2: Scores assigned to the company life cycle

Industry quintiles	CE
0–20%	5
21–40%	4
41–60%	3
61–80%	2
81–100%	1

Source: own

In this case, it is necessary to consider whether it is already insolvent or at risk of insolvency.

This procedure is much more accurate because it compares the ROE with the values of the alternative cost to equity (r_e) in a given CZ NACE C industry and at the same time with the risk-free rate of return (r_f). The relationship between these variables is based on the calculation of economic value added, where EVA = (ROE − r_e) * equity, and also $r_e = r_f$ + RP. This approach is based on the INFA methodology by Neumaierová and Neumaier (2014).

MPO (2021) calculates the industry ROE as follows: ROE = EAT/equity. The alternative cost to equity (r_e) represents the return on equity that could be achieved by investing in an alternative investment opportunity of equal risk. The value of r_e is calculated as a weighted arithmetic mean for the selected industry:
$r_{e\ industry} = \Sigma(r_{e\ company} * \text{equity}_{company})/\Sigma \text{equity}_{company}$.
The indicator r_e is first calculated for individual enterprises. This calculation is done automatically for most enterprises, but for the most important enterprises their individual specificities are taken into account. The risk-free rate of return (r_f) is defined as the profitability of 10-year Czech government bonds. Risk premium (RP) consists of risk premiums for financial structure, financial stability, business risk, and company size. All required data were adapted from Ministry of Industry and Trade (MPO, 2021) documents (Tab. 3).

As in the case of ROE, a company life cycle stage can be classified using values of sales growth (SG) according to predetermined boundaries as follows (Slavíčková & Myšková, 2017):

- 1.05 ≤ SG – a company classified as in the **growth phase (score 1)**;
- 0.9 ≤ SG < 1.05 – a company classified as in the **maturity phase (score 3)**, the sales can grow slightly or even decline unless it shows a long-term trend;
- SG < 0.9 – a company classified as in the **decline phase (score 5)**.

These boundaries have been verified on a sample of automotive firms and the possibility of including firms with negative SG in the maturity phase has been pointed out, provided that it is not a deep decline and at the same time a long-term trend. This argument is based on the fact that a firm in the maturity phase maintains a similar level of sales and its level, therefore, oscillates around a similar value. To reach more accurate phase classification, it is hence preferable to use predefined boundaries for a given business area instead of general industry quintiles.

Tab. 3: Values of selected indicators for the manufacturing industry (NACE C)

Year\Indicator	ROE_{ind} (%)	r_e (%)	r_f (%)	RP (%)
2010	11.49	13.07	3.71	9.36
2011	10.85	13.45	3.79	9.66
2012	12.12	12.43	2.31	10.12
2013	10.37	11.86	2.26	9.60
2014	14.31	9.84	1.58	8.26
2015	15.16	9.61	0.58	9.03
2016	16.38	8.69	0.43	8.26
2017	14.75	9.53	0.98	8.55
2018	12.45	11.30	1.98	9.32
2019	12.00	11.33	1.55	9.78

Source: own based on MPO (2021)

Note: ROE_{ind} = return on equity calculated for the automotive industry; r_e = alternative cost to equity; r_f = risk-free rate of return; RP = risk premium (refers to the excess return that investing provides over a risk-free rate).

2.2 Composite Score Calculation and Sample Selection

By summing up individual scores of variables calculated for each year for each company, we receive a composite score. This is assigned to a life cycle stage according to Tab. 4. The range of the composite score depends on the number of indicators used for the analysis. Having three indicators, the range would be 3–15; if we have four indicators, the range will go up to 4–20. The number of stages follows previous studies (Anthony & Ramesh, 1992; DeAngelo et al., 2006; Jaafar & Halim, 2016; Jenkins et al., 2004), where authors also include transition stages such as growth/maturity, maturity/decline in order to clearly define the fundamental phases corrected for boundary values.

At this moment we acquire a large number of firm-year data that undergoes the sample selection process (Tab. 5). First, we remove firm-years with missing data required for calculation. Second, firm-years situated in transition stages, i.e., growth/maturity and maturity/decline, will be excluded as well in order to increase the homogeneity of the remaining categories. For a better overview, we use data from these transition phases in subsequent sections of our study, but the main focus is on the fundamental phases.

As a result, we receive a total of 1,392 firm-year observations that are clearly assigned to the growth, maturity, or decline stage.

Tab. 4: Company life cycle classification based on the composite score

Company life cycle stage	Composite score (3)
Growth	3–6
Growth/mature	7
Mature	8–11
Mature/decline	12
Decline	13–15

Source: Jaafar and Halim (2016), Anthony and Ramesh (1992)

Tab. 5: Data selection process

Step of a process	Number of firm-year observations
Original number of firm-year observations	2,038
Less: Missing data	− 302
Less: Firm-years in transition stages	− 344
Firm-year observations in growth, maturity & decline stages	= 1,392

Source: own

3. Research Results

The initial sample of 277 companies from the automotive manufacturing industry, 1,392 firm-year observations (respectively 1,736 including transition stages), three indicators (CE, ROE, SG), and data from financial statements between 2010 and 2019 were inputs for our analysis. Our sample undergoes a descriptive, correlation, and transition analysis.

3.1 Descriptive Analysis

Descriptive statistics are given in Tab. 6 for the firm-year observations in each life cycle stage, including transition stages. Mature companies are characterized by stability, whereas firms in the decline stage are more in a temporary situation that is likely to change in the near future. It can therefore be assumed that the most numerous (least numerous) group will be companies in the mature (decline) stage. This assumption can be confirmed based on Tab. 6, where firm-years in the mature (decline) stage represent more than 50% (less than 7%) as a proportion of all observations.All profitability indicators have their highest median values in the growth and mature group, with steep declines in the later phases. The same trend can be observed for the ATO indicator, where it applies that the higher the ATO ratio is, the more efficient a company is at generating sales from its assets. A high leverage and/or D/E ratio generally indicates that a company has been aggressive in financing its growth with debt. Compared to other industries it might be a deterrent case, however, it is the nature of the industry that needs to be considered. Companies that require large capital expenditures, such as manufacturing businesses especially in the automotive industry, may require more loans than those in other sectors of the economy. Relatively high values of current liquidity (1.38–1.72) in growth and maturity stages indicate a strong financial platform; whereas the decline stage is burdened with a lower value of LIQ (0.86).

Tab. 6: Descriptive statistics – Part 1

		Growth	Growth/mature	Mature	Mature/decline	Decline
n		410	275	870	69	112
Percentage of total *n* (%)		23.62	15.84	50.12	3.97	6.45
CE	Mean (SD)	−0.257 (2.8430)	−0.416 (2.9937)	0.126 (3.1389)	0.024 (0.0646)	0.636 (1.3766)
	Median (P10; P90)	−0.03 (−0.24; 0.05)	0 (−0.77; 0.26)	0.05 (−0.10; 0.52)	0.02 (−0.06; 0.12)	0.2 (0.00; 1.63)
SG	Mean (SD)	1.218 (0.4458)	3.498 (34.9378)	2.186 (26.7824)	0.834 (0.1976)	0.728 (0.2555)
	Median (P10; P90)	1.13 (0.98; 1.47)	1.1 (0.91; 1.73)	1.03 (0.81; 1.51)	0.88 (0.61; 1.02)	0.8 (0.30; 1.00)
ROE	Mean (SD)	206.683 (3700.733)	−4.064 (155.7585)	41.020 (1571.825)	−7.835 (36.9766)	−31.240 (65.6148)
	Median (P10; P90)	10.16 (2.86; 41.38)	10.59 (−13.10; 36.04)	12.82 (−24.36; 41.27)	0.29 (−29.84; 20.88)	−5.24 (−109.70; 3.52)
ROA	Mean (SD)	7.372 (7.1413)	5.842 (16.3055)	4.590 (17.0171)	−1.380 (12.9164)	−10.623 (30.6008)
	Median (P10; P90)	5.31 (1.32; 16.02)	3.91 (−4.49; 17.71)	4.35 (−7.94; 18.26)	0.27 (−12.47; 11.31)	−2.96 (−33.16; 9.77)
ROS	Mean (SD)	4.989 (5.6901)	3.367 (8.8076)	1.078 (28.4898)	0.265 (9.4751)	−11.629 (53.3698)
	Median (P10; P90)	3.3 (0.68; 10.99)	2.58 (−2.64; 11.90)	2.83 (−6.34; 13.80)	0.31 (−7.34; 8.05)	−2.58 (−40.04; 9.28)
ATO	Mean (SD)	1.935 (1.1141)	2.265 (2.8237)	1.834 (1.2354)	1.685 (1.4429)	1.521 (1.2894)
	Median (P10; P90)	1.76 (0.84; 3.29)	1.74 (0.75; 3.75)	1.54 (0.67; 3.26)	1.29 (0.49; 3.38)	1.32 (0.19; 2.96)
FINLEV	Mean (SD)	7.870 (85.1237)	−1.164 (62.4275)	5.418 (75.6994)	1.914 (4.6544)	1.085 (9.6851)
	Median (P10; P90)	1.89 (1.18; 6.09)	2.03 (1.05; 6.72)	2.07 (17.20; 93.19)	1.53 (−1.29; 4.40)	1.23 (−4.74; 8.06)
LEV	Mean (SD)	47.352 (25.4103)	59.706 (31.4006)	60.389 (38.6348)	61.554 (55.7888)	100.310 (88.8295)
	Median (P10; P90)	45.71 (14.22; 82.95)	63.66 (17.57; 96.47)	57.99 (8.79; 637.66)	49.69 (11.27; 152.18)	83.13 (14.10; 187.03)

Tab. 6: Descriptive statistics – Part 2

		Growth	Growth/mature	Mature	Mature/decline	Decline
D/E	Mean (SD)	683.849 (8511.684)	−217.751 (6241.643)	442.542 (7530.267)	90.594 (464.9688)	7.055 (968.4714)
	Median (P10; P90)	86.17 (17.13; 506.25)	102.9 (4.76; 571.81)	106.18 (1.09; 7.62)	52.86 (−227.00; 339.84)	22.93 (−574.00; 685.26)
LIQ	Mean (SD)	3.374 (5.9298)	5.008 (36.2948)	3.059 (9.3026)	6.080 (27.9704)	1.816 (28.3849)
	Median (P10; P90)	1.72 (0.70; 6.56)	1.27 (0.56; 6.44)	1.38 (0.50; 5.45)	1.37 (0.49; 7.80)	0.86 (0.32; 6.19)
SIZE	Mean (SD)	19.116 (2.2359)	19.169 (2.6424)	19.117 (2.4309)	18.194 (2.1552)	17.343 (3.0164)
	Median (P10; P90)	19.03 (16.24; 21.58)	19.41 (15.52; 22.06)	19.36 (15.85; 21.87)	18.22 (15.47; 21.17)	17.52 (12.95; 21.07)

Source: own

Note: n = total number of firm-year observation; CE (capital expenditures) = change in PP&E/(total assets − total liabilities); SG (sales growth) = $sales_t/sales_{t-1}$; ROE (return on equity) = net earnings/total equity; ROA (return on assets) = net earnings/total assets; ROS (return on sales) = net earnings/total sales; ATO (asset turnover) = total sales/total assets; FINLEV (financial leverage) = total assets/total equity; LEV (leverage) = total debt/total assets; D/E (debt/equity ratio) = total debt/total equity; LIQ (current liquidity) = current assets/current liabilities; SIZE = natural log of total assets; SD = standard deviation; P10 = 10th percentile; P90 = 90th percentile.

3.2 Correlation Analysis

In order to assess the interdependence (linear) between the values of the composite scores in the individual groups (growth, mature, decline) and the values of the individual variables (ROE, ROA, etc.), the values of the individual correlation coefficients were calculated, and significance tests were performed for these coefficients. The results are presented in the following Pearson's correlation matrix exhibited in Tab. 7. A positive value of the correlation coefficient shows that as the value of the composite score in a given group (growth, mature, decline) increases, the value of the corresponding individual variable also increases. A negative value of the correlation coefficient indicates that as the value of the composite score increases, the value of the individual variable decreases. Correlations cannot be calculated for transition stages as one of the variables (composite score) entering the correlation has zero variability, i.e., it takes one specific value. This decision was made on the basis of a large number of observations in individual phases (growth – 410, mature – 870, decline – 112), when the values of the Pearson and Spearman correlation coefficient are already significantly different.

Both ROE and SG variables show a desirable negative correlation with growth and decline stages. Other profitability indicators, namely ROA and ROS, show a negative correlation with the mature and decline phase. However, there is a positive correlation with the growth phase, but this correlation is of low intensity and low significance level. Leverage exhibits a positive correlation with mature and decline stages.

Tab. 7 shows that there is a linear relationship between the value of the composite score in the growth group and the variables ROA, ROS, and LEV, while for ROA and ROS, the value of these indicators increases as the value of the composite score increases. The opposite is true for the LEV variable, i.e., as the composite score value increases, the value of the LEV variable decreases. In the mature group there is a linear relationship with the variables ROA, ROS, LEV, and SIZE. Compared to the growth group, the relationship is negative for ROA and ROS and positive for LEV. The SIZE variable, which in the growth group, did not show a linear relationship with the value of the composite score, is positively correlated here. In the decline group, there is a negative correlation relationship with SG and ATO variables and a positive correlation relationship with CE variable. For the other pairs, a linear relationship was not proven.

3.3 Transition Analysis

Furthermore, we examine the transition of firm-year observations from one cycle stage to another in five subsequent years. With the

Tab. 7: Correlation matrix

	Growth	Mature	Decline
CE	0.036	−0.010	0.252**
SG	−0.067	0.051	−0.230*
ROE	−0.009	0.040	−0.159
ROA	0.249**	−0.220**	−0.009
ROS	0.180**	−0.184**	−0.068
ATO	0.008	−0.066	−0.324**
FINLEV	−0.022	0.027	−0.031
LEV	−0.104*	0.167**	0.007
D/E	−0.022	0.028	−0.029
LIQ	0.043	-0.007	-0.148
SIZE	0.068	-0.096**	0.117

Source: own

Note: Test of significance of the correlation coefficient based on *t*-distribution; *$p < 0.05$; **$p < 0.01$.

condition of five strictly subsequent periods, our sample reduces from 277 companies to 192 companies (i.e., 960 firm-years). Using the transition matrix (Tab. 8), we observe how many companies will be in what stage in the future period. Bold data represent the proportion of companies that remain in the same stage as in the year *t*. We can confirm the findings of previous studies (Akbar et. al., 2019; Dickinson, 2011) that most companies remain in a stage of maturity (46.24%) one year after initial classification on year *t*. Moreover, the proportion of 'stayers' in this stage remains the highest in every subsequent year (reaching 47.31% in year *t* + 4).

Several more findings deserve attention. Firms in the growth phase exhibit a high persistence in the first future year *t* + 1, when its value was 36.17%. However, this value declined steeply with the following years, in

Tab. 8: Transition matrix – Part 1

Stage at year *t*	Stage in future period	*t* + 1 (%)	*t* + 2 (%)	*t* + 3 (%)	*t* + 4 (%)
Growth 24.48%	**Growth**	**36.17**	**31.91**	**29.79**	**23.40**
	Growth/mature	25.53	19.15	12.77	14.89
	Mature	36.17	48.94	48.94	55.32
	Mature/decline	2.13		6.38	4.26
	Decline			2.13	2.13
Growth/mature 20.31%	Growth	25.64	28.21	12.82	25.64
	Growth/mature	**15.38**	**17.95**	**20.51**	**10.26**
	Mature	56.41	46.15	58.97	51.28
	Mature/decline		2.56		5.13
	Decline	2.56	5.13	7.69	7.69

Tab. 8: Transition matrix – Part 2

Stage at year *t*	Stage in future period	*t* + 1 (%)	*t* + 2 (%)	*t* + 3 (%)	*t* + 4 (%)
Mature 48.44%	Growth	35.48	31.18	12.90	13.98
	Growth/mature	9.68	7.53	19.35	23.66
	Mature	**46.24**	**52.69**	**55.91**	**47.31**
	Mature/decline	4.30	3.23	4.30	5.38
	Decline	4.30	5.38	7.53	9.68
Mature/decline 1.56%	Growth	33.33		84.00	
	Growth/mature				
	Mature	66.67	100.00	66.67	66.67
	Mature/decline			**33.33**	
	Decline				33.33
Decline 5.21%	Growth	10.00	40.00	30.00	20.00
	Growth/mature	20.00			
	Mature	50.00	40.00	50.00	50.00
	Mature/decline	10.00	10.00		
	Decline	**10.00**	**10.00**	**20.00**	**30.00**

Source: own

year *t* + 4 this value reached already 23.40%, while at the same time it is possible to trace the increased number of firms that have moved to the maturity phase (up to 55.32%). In addition to the stability of the maturity stage, there is also a high ratio of transitions to the growth stage in the first years and a sharp decrease in transitions to the growth stage in year *t* + 4. On the other hand, also a significant increase in transitions to the decline stage can be observed (from 4.30% in year *t* + 1 to 9.68% in year *t* + 4). The decline stage is characterized by a low proportion of 'stayers' in the first subsequent year *t* + 1 (10%) and a gradually increasing value up to 30% in year *t* + 4. Nevertheless, there is a tendency for firms to fight for a better position in case of unfavourable results, which is reflected in most cases in the transition to the maturity and growth phases. As expected, the transition stages (growth/mature and mature/decline) represent mainly a 'transfer station' to the fundamental stages in the following years. We can conclude that the transition between growth and maturity phases and backward (if not staying) is desirable for the firm. Dickinson (2011) recommends the firm maintain a position between the growth and maturity phases where the reward-risk relationship is optimized, which we cannot but agree with.

Conclusions

This paper introduces three financial indicators for life cycle classification that could be commonly retrieved from financial statements, including those from firms that are not listed on the stock exchange. This fact significantly simplifies obtaining inputs for the analysis. Moreover, we could analyse the large sample size using firm-year observations (panel data). A composite score allows us to assign a score to each indicator value, which further arranges the firm-year into individual phases. This is very useful if previous studies have not sufficiently supported the stage classification based on the calculated indicator values. However, simply adding a score to the composite score can lead to misclassification of a phase, so we recommend that weights be added to the individual descriptors and/or score assignment is based on predefined boundaries rather than industry quintiles; hence this is the next step for refining a life cycle stage classification process.

Based on the descriptive, correlation, and transition analysis, we can conclude, that mature and growth phases follow a predictable pattern. These stages are relatively stable; transitions of firm-years are observed mostly within stages of growth and maturity in both the forward and backward directions. Stage decline can therefore be seen as a kind of transition station that serves as a reminder and a steppingstone for the company to use resources more efficiently and to revise strategic plans in order to move back to phases with more positive results, where the reward-risk relationship is optimized.

The question arises as to which variant of accounting earnings is the most appropriate for calculating ROE. The authors presented in Tab. 1 calculate ROE with earnings after taxes (EAT), and the authors of this paper follow their approach. However, using earnings before taxes (EBT) could significantly affect the results due to, for example, exemptions effects. Earnings before interest and taxes (EBIT) may seem to be the most appropriate output characteristic, as this variable is not affected by the amount of interest to the creditor, nor by the amount to the government, i.e., taxes. However, interest expenses are an item that can only be obtained with a one-year lag since its correct value is determined after various refinements given by company audits. According to MPOs (2020) procedure, it is possible to identify EBIT with the operating earnings; this identification commits an acceptable error. As part of further research, we recommend paying attention to this topic. Furthermore, it would be advisable to compare the calculated values with the r_e and r_f values found for CZ NACE 29, not the overall CZ NACE C, in the ROE classification of the firm, if this value is available in future years. This step would make the classification of the firm into the correct phase more precise.

Further, on closer inspection of the results, we see significant differences in the classification of the firm into the phase according to the different indicators, especially from the CE perspective, and thus this point will be the subject of further research by the authors.From a company's point of view, it is clear which challenging parts should be focused on. It is also advisable to use current data for life cycle classification on an industry level. As stated previously, an industry can affect a company's life cycle, and therefore the extent to which industry influences the life cycle should be explored.

Acknowledgments: *Supported by grant No. SGS_2021_012 "Sustainable Competitiveness of Companies and Organizational Change Management, with an Emphasis on Business Ethics."*

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