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The Impact of Working Capital Management on Profitability – A Comparative Analysis of German and Japanese Automotive Manufacturers

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Abstract

This study investigates the impact of Working Capital Management (WCM) on profitability by analyzing six years of quarterly data of German and Japanese automotive manufacturers. Descriptive statistics and independent t-tests reveal significant country differences. Japanese companies follow a more aggressive WCM policy, expressed by a significantly lower Cash Conversion Cycle (CCC) and a higher Return on Assets (ROA) than German firms. The results of the correlation analysis and Ordinary Least Squares regressions stress the importance of WCM. Managers of automotive manufacturers can improve ROA by lowering CCC, Days Sales Outstanding, and the share of current assets on total assets.

Keywords: Working Capital Management, Profitability, Cash Conversion Cycle, Days Inventory Outstanding, Days Sales Outstanding, Days Payable Outstanding, Return on Assets, Automotive Manufacturers, Japan, Germany, COVID-19 Pandemic

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1. Introduction

The automotive industry is one of the world´s largest industries by sales and includes a broad range of organizations and firms involved in the design, development, manufacturing, marketing, and selling of motor vehicles (Rae 2020). In 2020, the global market size comprised 85.32 million units and is expected to grow at a CAGR of 3.71% to 122.83 million units in 2030 (Research and Markets 2021). In 2021, Japanese and German original equipment manufacturers (OEMs) represented the major groups in the global top 15 ranking, demonstrating the importance of the two countries in the world market (Factory Warranty List 2022). German Volkswagen Group (VW) and Japanese Toyota Motor (Toyota) have been competing for the pole position in recent years. While VW was leading in terms of units sold from 2016 to 2019, Toyota took over in the COVID-19 pandemic impacted years of 2020 and 2021 (Tagesschau 2021).

The success of the Japanese automotive industry is often linked with just-in-time manufacturing or lean management approaches, which emerged from the Toyota Production System and focus on working capital management (WCM) (Herron and Hicks 2008). The importance of WCM is underlined by the fact that current assets typically represent over half of the total assets of manufacturing firms (Kumari and Anthuvan 2017). In the past years, the Cash Conversion Cycle (CCC) has gained popularity as a dynamic measure for WCM among researchers (Raheman and Nasr 2007; Eljelly 2004). This study contributes to the literature by enhancing the understanding of the impact of CCC on profitability, proxied by Return on Assets (ROA), by analyzing six years of quarterly data of German and Japanese OEMs.

This paper is structured as follows: Section 2 provides an overview of the automotive industry. Section 3 covers the theoretical key concepts used in this study, namely ROA and CCC. Section 4 reviews the current literature, and section 5 outlines the hypotheses and explains the methodology. Section 6 analyzes the data, presents the results, and discusses the findings.

Section 7 provides the conclusions, and section 8 closes this research with its limitations and suggestions for future research.

2. Industry Overview

The automotive industry is deeply embedded within society due to its political and economic value for leading economies and its significant direct dependence on final consumers[1]. Thus, this overview outlines macro-economic factors and competitive elements shaping the industry.

Legislations of leading economies to combat climate change drive the automotive industry´s transition to emission-free mobility, such as the European Union´s (EU) ban on fossil-fuel vehicles by 2035 or Japan´s (JP) target of net-zero greenhouse gas emissions by 2050 (METI). Due to its importance for major economies, the automotive industry has been repeatedly addressed by international politics. In the 1980s, JP imposed a Voluntary Export Restraint on its automotive exports to the U.S. due to American pressure (Ito and Krueger 1999). As a result, Japanese OEMs set up production facilities in the U.S., which allowed the country to regain the lead in global vehicle production from JP in 1994 (Rae 2020). Other examples of political involvement are China´s condition for foreign automakers to set up a 50/50 joint venture with a local player to enter the Chinese market (Rahman 2022) or Trump´s threat to impose tariffs on European cars in 2020. Moreover, VW and other global OEMs, such as the Chinese "big four" (SAIC Motor, Dongfeng, FAW, and Chang´an), are (partially) state-owned (Wikipedia). Legal factors influence the industry not only through emission requirements but also by different safety requirements or copyright laws, which benefit domestic players. Cars need to fulfill other safety tests in Europe than in the U.S., and Chinese copies of Western vehicles cannot be sold in the West (Tumminelli 2009; Moreno 2020).

Technological innovation drives the market, and vast research and development (R&D) investments are necessary to master the transition to emission-free vehicles. Software is gaining

[1] Appendix 2 provides a PESTEL analysis and a summary of Porter´s five forces for the automotive industry.

in importance as a key driver for OEMs to differentiate in various areas, in particular: autonomous driving, active safety, connectivity, and infotainment (Gao et al. 2016).

As acquiring a car is a great investment, the industry depends on economic developments. According to Euromonitor, the income disparity is expected to deteriorate or at least not improve in 72 out of 103 major economies between 2020 and 2040 (Hodgson 2021). Thus, OEMs need strategies for a polarized market with a shrinking middle class and a higher share of low-income consumers at the base of the pyramid. The COVID-19 pandemic has severely hit the automotive industry due to plummeting sales and supply chain disruptions. While in pre-pandemic 2019 around 80 million cars were sold worldwide, this figure dropped to 69 million in 2020 and ca. 70.5 million in 2021 (Menzel 2022). The recovery is lagging due to the semi-conductor shortage, which is expected to last beyond 2022 (Hyunjoo 2022). VW attributes the decrease of 8.1% in its 2021 passenger car sales to this shortage (VW 2022). Moreover, the Ukrainian war is adding further uncertainty and could further increase inflation levels and push already record-high prices even higher (Wayland 2022).

Social factors impact the automotive industry with the trends of urbanization and emission-free mobility resulting in fewer cars needed in urban areas. Yet, owning a car remains a symbol of social standing, and the rural regions continue to rely on automotive vehicles.

Regarding the competitive situation, OEMs are facing fierce competition and a strong peer group. The composition of the world´s top 10 remained unchanged from 2007 to 2017 (OICA 2007, 2017). OEMs are experiencing continuous consolidation pressure to achieve a competitive edge through economies of scale and negotiation power. A recent example is the Stellantis merger of Fiat Chrysler Automobiles and Group PSA in 2021.

Companies willing to enter the market are confronted with high entry barriers due to the vast monetary and human capital requirements to establish a competitive offering. The established players enjoy a strong market position and benefit from well-known brands and economies of scale. However, new EV players like Tesla demonstrate that modern capital markets can provide the necessary funds for a market entry.

The immense size of established OEMs leaves suppliers with limited negotiation power. The shift towards low carbon mobility intensifies the competition among suppliers since fewer parts are required for EV machines when compared with combustion engines. In contrast, buyers are enjoying a strong position thanks to low switching barriers and the opportunity to choose the option that best unites their preference of price and quality.

The threat of substitutes is moderate. While it is unlikely that any means of transportation might replace cars in the future, the number of automotive vehicles might decrease in urban areas due to a combination of other transportation solutions, such as e-scooters, trains, bicycles, or car-sharing. Nevertheless, cars will remain relevant as a symbol of social status and as a means of mobility in rural areas. Companies need to constantly innovate to ensure firm survival (March 1991), and the current industry transition poses the risk of missing a key moment. Tesla and BYD are famous examples of producers of electric cars, putting pressure on traditional brands. While most carmakers are focusing on battery-electric vehicles, Japanese Toyota and Honda, as well as South Korean Hyundai, continue to bank on hydrogen fuel cell vehicles to achieve carbon neutrality (Kang 2021).

3. Theoretical Background

To master the outlined challenges, Working Capital Management (WCM) can play a decisive role as it can have a direct impact on enterprise liquidity, solvency, and profitability (Peel and Wilson 1996; Shin and Soenen 1998). Working Capital Management (WCM) relates to the management of current assets and current liabilities (Filbeck and Krueger 2005). Organizations can minimize risk and improve their overall performance by properly managing WC (K. Smith 1980; Chang 2018). To evaluate performance, this study uses Return on Assets (ROA) as a proxy of profitability. ROA, calculated as $\frac{Operating\ Income\ LTM}{Average\ Total\ Assets\ LTM}$, reflects the operating profitgenerating capacity of a firm[2]. Breaking it down into its drivers allows to obtain a better understanding of the levers of operating profitability.

$$ROA_t = \underbrace{\left(\frac{Operating\ Income\ LTM}{Sales\ LTM}\right)}_{\textbf{Return on Sales}} x \underbrace{\left(\frac{Sales\ LTM}{Average\ Total\ Assets\ LTM}\right)}_{\textbf{Asset Turnover}} \quad [1]$$

While Asset Turnover (AT) measures the overall efficiency of using assets to generate sales, Return on Sales (ROS) demonstrates the efficiency of turning the generated sales into profits (Penman 2013, p. 365-79). As AT is incorporating WCM variables, it reflects the direct impact of WCM on ROA. ROS can be further split, leading to the following equation:

$$ROA_t = \underbrace{\left(\frac{EBIT\ LTM}{Gross\ Profit\ LTM}\right)}_{\textbf{Operating Risk}} x \underbrace{\left(\frac{Gross\ Profit\ LTM}{Sales\ \ LTM}\right)}_{\textbf{Gross Profit Margin}} x \underbrace{\left(\frac{Sales\ LTM}{Average\ Total\ Assets\ LTM}\right)}_{\textbf{Asset Turnover}} \quad [2]$$

Operating Risk (OR) measures the impact of fixed costs, and Gross Profit Margin (GPM) the effect of variable costs (Penman 2013, p. 365-79).

The core drivers of WCM are accounts receivable, inventories, and accounts payable (Högerle et al. 2020; Lin and Wang 2021). There are three major WCM policies describing different management of these drivers: aggressive, moderate, and conservative WCM (Weinraub and Visscher 1998; Nazir and Afza 2009).

Companies pursuing an aggressive WC policy aim for low accounts receivable and inventories and high accounts payable, resulting in increased overall profitability (Weinraub and Visscher 1998). Reducing accounts receivable allows firms to collect cash more quickly by, for example, providing discounts on early payments or renegotiating established deal terms (Popescu 2018). To reduce the capital bound in inventories, companies following an aggressive WC policy strive for low stocks by for example implementing lean management practices and just-in-time manufacturing (Högerle et al. 2020). Higher levels of accounts payable allow firms to assess the quality of the acquired products and represent a cheap and flexible source of

[2] LTM = Last twelve months, meaning the current and three prior quarters.

financing (Raheman and Nasr 2007). While an aggressive WC policy promises greater profitability, it is also bearing higher (liquidity) risk (Weinraub and Visscher 1998). Companies might lose out on sales if the trade credit policies are too tight, low inventories increase the risk of production stops due to stock-outs, and excessive accounts payable may result in losing discounts for early payments (Blinder and Maccini 1991; Deloof 2003; García-Teruel and Martínez-Solano 2007). Further, firms run the risk of insufficient funds for their daily operations and settling their short-term debts (Van-Horne and Wachowicz 2008).

In contrast to the aggressive WC policy, the conservative approach stresses higher liquidity levels at the cost of lower profitability (Gardner et al. 1986). More customer-friendly payment terms can help to increase sales (Smith 1987). Higher inventory levels help to ensure smooth operations and provide a safety cushion in case of supply chain issues (Gill et al. 2010). Clearing accounts payable early allows firms to benefit from cash discounts and improves business relationships with the respective suppliers. However, having a high net working capital (NWC)[3] leads to more capital being tied up in the operational cycle, lowering overall profitability due to opportunity costs (Lind et al. 2012). The moderate WC policy describes the midway between the aggressive and conservative approach.

Static and dynamic measures can be applied to evaluate WCM. Static measures are Current Ratio, Quick Ratio, and Cash Ratio[4]. While static ratios relate balance sheet items at a single moment in the past, the cash conversion cycle (CCC)[5] is a dynamic measure, combining data from both balance sheet and income statement (Gitman 1974; Atieh 2014). The shortcomings of the static measures have led researchers to advocate the CCC as a comprehensive measure of WCM (Raheman and Nasr 2007; Eljelly 2004). CCC measures the time (usually in days) from purchasing input materials until the inflow of cash from customers

[3] *Net Working Capital* is the excess of Current Assets over Current Liabilities.
[4] Current Ratio = Current Assets / Current Liabilities; Quick Ratio = (Current Assets – Inventories) / Current Liabilities, Cash Ratio = Cash and Equivalents / Current Liabilities
[5] CCC is also known as *Cash Flow Gap, Cash Flow Cycle* or *Net Cash Conversion Cycle* (Eljelly 2004).

(Lyngstadaas and Berg 2016; Pais and Gama 2015). CCC is the sum of Days Inventory Outstanding (DIO) and Days Sales Outstanding (DSO) less Days Payables Outstanding (DPO) (Deloof 2003). DIO is the average time inventories are held, DSO is the average time it takes to collect cash from customers, and DPO is the average time companies need to pay their suppliers (García-Teruel and Martínez-Solano 2007).

$$CCC_t = DIO_t + DSO_t - DPO_t \quad [3]$$

$$DIO_t = \frac{Average\ Inventories\ LTM}{COGS\ LTM}\ x\ 365 \quad [4]$$

$$DSO_t = \frac{Average\ Accounts\ Receivable\ LTM}{Sales\ LTM}\ x\ 365 \quad [5]$$

$$DPO_t = \frac{Average\ Accounts\ Payable\ LTM}{COGS\ LTM}\ x\ 365 \quad [6]$$

Consisting of the WCM drivers, a long CCC represents a conservative approach, while a short CCC refers to an aggressive WCM (Jose et al. 1996). Longer CCCs are typical for manufacturing industries (Uyar 2009). However, the success of the Japanese automotive industry is widely associated with the Toyota Production System, which forms the basis of lean management[6] and just-in-time manufacturing (Herron and Hicks 2008). Being the homeland of the also called “zero inventories” management suggests a more aggressive CCC policy of Japanese OEMs (Voss et al.1987). Since a more aggressive approach suggests higher profitability, the following is assumed:

Hypothesis 1 (H1): *DIO, DSO, DPO, CCC, ROA, ROS, AT, OR, and GPM are statistically significantly different between GER and JP.*

4. Literature Review

In recent years, the relationship between CCC and profitability has aroused great interest among scholars. Analyzing a large sample of listed U.S. firms from 1975-1994, Shin and Soenen (1998) found that managers can improve profitability by reducing the CCC to a reasonable

[6] *Just-in-time* definition by Voss et al. (1987, p.2): “an approach that ensures that the right quantities are purchased and made at the right time and quality and that there is no waste”.

minimum. This negative relationship was confirmed by other studies (Wang 2002; Enqvist et al. 2014; Yazdanfar and Öhman 2014; Chang 2018). In his landmark article, Deloof (2003) studied 1009 large Belgian non-financial firms from 1992 to 1996 and found a negative relationship between all three components of CCC and profitability, measured by Gross Operating Income (GOI) Margin[7]. However, the author stresses that it cannot be ruled out that a negative relation between CCC and profitability stems from profitability affecting CCC and not vice versa. While Deloof´s results for DIO and DSO are in line with theory, the author explains the result of DPO with less profitable firms waiting longer to pay their bills. Using ROA for profitability, similar results were found in studies of Spanish, Portuguese, and Norwegian small and medium-sized enterprises (SMEs) (García-Teruel and Martínez-Solano 2007; Pais and Gama 2015; Lyngstadaas and Berg 2016), and Indian automotive companies (Shajar 2017). Further proof was added in a study of Pakistani firms by Raheman and Nasr (2007), using Net Operating Profitability for profitability[8].

In line with the presented theory, Lazardis and Tryfonidis (2006) found a negative relationship between CCC and profitability, with DIO and DSO negatively impacting profitability and DPO being positively associated with GPM. These findings were supported by Viajayakumar´s (2011) study on Indian automotive companies from 1996-2009. In their research on listed German companies, Högerle et al. (2020) found a significant negative relationship between CCC, DIO, DSO, and Return on Capital Employed (ROCE)[9] as a measure of profitability, and a positive but not significant link between ROCE and DPO. Besides DPO, other studies found no significant association between DSO, DIO, and profitability. Chowdhurry et al. (2018) identified a significant negative relationship between CCC, DSO, and ROA, and a positive link between DPO and profitability. However, the relationship between

[7] Gross Operating Income Margin = (Sales – Cost of Sales) / (Total Assets – Financial Assets)
[8] Net Operating Profitability = (Operating Income + Depreciation) / (Total Assets – Financial Assets)
[9] ROCE= EBIT / Average (Capital Employed$_t$+ Capital Employed$_{t-1}$)

ROA and DIO was not found to be significant. Similarly, Yilmaz and Acar (2019) identified a negative relationship between CCC and GPM in their study on Omani companies, with DPO having a positive impact, whereas DIO and DSO were not significantly impacting GPM.

While the presented studies suggest a negative link between CCC and profitability, contrary results cannot be denied. In their research on U.S. American manufacturing firms, Gill et al. (2010) discovered a positive relationship between CCC and GOI. Regarding the components of the CCC, the authors identified a negative link between GOI and DSO, while the impact of DIO and DPO on GOI was not statistically significant. Examining firms listed on the Amman Stock Market in Jordan, Abuzayed (2012) found a positive relationship between GOI and CCC. The author explains the result with more profitable firms being less motivated to manage their WC (Abuzayed 2012). Regarding the CCC components, DPO was found to negatively impact GOI, while a higher DIO and DSO were contributing to profitability. According to Abuzayed (2012), higher inventories are linked with increasing sales, which again improves profitability. The author explains the positive relationship between DSO and GOI with the higher cash availability at profitable firms allowing for customer credits.

While the previous studies identified linear relations, other scholars found a profitability-optimizing level of CCC. Baños-Caballero et al. (2012) discovered a concave influence of CCC on GOI for Spanish SMEs. The results were supported for ROA, ROE, and ROCE in a study of 160 SMEs listed on the Alternative Investment Market (London SE) (Afrifa and Padachi 2016). Based on a sample of 745 European automotive companies from 24 countries and data from 2010-2019, Zaher and Illescas (2020) found an inverted (U) shape for the relation between CCC, and profitability proxied by ROA[10], with cash holdings having a moderating effect. According to the authors, companies holding more cash have a higher optimal CCC level than

[10] ROA= Net Income / Total Assets

more financially constrained firms. A higher cash holding can be used to finance operations, while a higher CCC increases profitability to an optimal level.

Based on the reviewed literature, no uniform conclusion can be drawn. While various studies found a negative relationship between CCC and profitability, contradictory results exist. Moreover, divergent outcomes were identified concerning the components of the CCC and their impact on profitability. Regarding the automotive industry, the number of studies on the relationship between CCC and profitability is limited. Furthermore, the presented studies combined different stages of the automotive value chain. However, it is reasonable to assume other profit-enhancing WC policies for automotive suppliers, manufacturers, and dealers. Therefore, this research contributes to the current literature by studying the relationship between CCC, DSO, DIO, DPO, and profitability proxied by ROA by directly comparing German and Japanese OEMs.

5. Methodology

5.1 Hypotheses Development

To understand the underlying data and check for country differences between German and Japanese OEMs in **H1**, univariate analysis is performed by comparing means and medians of key variables. Further robustness is added using independent sample t-tests. If Levene´s test for equality of variances shows a significant result in a t-test, the p-values are used, not assuming equal variances. The descriptive analysis is complemented by a common-sized analysis. Scaling income statement items to total sales and balance sheet components to total assets facilitates comparability and eliminates currency differences (Wahlen et al. 2015). In addition, the mean evolutions of CCC and ROA and their respective components are assessed, which might reveal insights about the impact of the COVID-19 pandemic on OEMs of both countries.

As noted in section 4, various scholars found a negative relationship between CCC and profitability (Wang 2002, Deloof 2003). Regarding the CCC components, a negative correlation between DIO, DSO, and profitability is assumed, while DPO is believed to positively impact profitability through extended supplier financing.

H2.1-2.4: *CCC (H2.1), DIO (H2.2), and DSO (H2.3) are negatively correlated with profitability, proxied by ROA, while DPO (H2.4) is positively associated with profitability in GER and JP.*

To measure the relationship, a correlation analysis is run using Spearman´s rho as a non-parametric method and the Pearson correlation coefficient as a parametric alternative.

As a next step, an Ordinary Least Squares (OLS) regression is performed to clarify the impact of CCC and its components on profitability. If H1 demonstrates significant differences between the two geographies, the sample will be split by country. It is assumed that:

H3: *CCC negatively impacts profitability, proxied by ROA (H3.1= GER, H3.2=JP).*

H4: *DIO negatively impacts profitability, proxied by ROA (H4.1 = GER, H4.2=JP).*

H5: *DSO negatively impacts profitability, proxied by ROA (H5.1 = GER, H5.2=JP).*

H6: *DPO positively impacts profitability, proxied by ROA (H6.1 = GER, H6.2=JP).*

5.2 Variables

ROA is used as dependent variable (Sing et al. 2017) and CCC and its components (DIO, DSO, DPO) as independent variables in the multivariate analysis. The following control variables were chosen: GDP growth (GDPGROW), interest rates (INTEREST), sales growth (SGROW), cash holdings (CASH_HOLDINGS), long term investments (LT_INVESTMENTS), long term debt (LT_DEBT), and firm size (SIZE). To consider macroeconomic factors, GDPGROW is used to account for cyclical changes and INTEREST to reflect the attractiveness of external financing (Smith 1987, Walker 1991, Michaelas et al. 1999). At the firm level, SGROW is the percentage increase of sales per quarter (Deloof 2003; Högerle et al. 2020), CASH_HOLDINGS is the ratio of cash and equivalents and total sales, LT_INVESTMENTS describes the ratio of non-current assets and total assets, LT_DEBT divides long term debt by total assets and SIZE is calculated by the natural logarithm of total assets (Lin and Wang 2021). Further, the following dummy variables are used: COUNTRY, ACCOUNTING, COVID, Q1, Q2, Q3. COUNTRY assumes 1 if the company is Japanese. ACCOUNTING equals 1 if international accounting standards are applied (IFRS). COVID describes the periods influenced by the COVID-19 pandemic[11], and Q1-Q3 are used to account for possible seasonality effects.

5.3 Research Models for Multivariate Analysis

To test H3-6, the following models are used[12]. If significant country differences are found in H1, the models will be run on a country basis. The error term ε_{it}, or residual, explains the deviation of the observed results from the values of the theoretical model. In line with Wooldridge (2016, p. 35-40), the model assumptions are linearity, a random distribution of errors, homoskedasticity, and neither multicollinearity nor autocorrelation[13].

I. $$ROA_{it} = \beta_0 + \alpha_1\ CCC_{it} + \beta_1\ SGROW_{it} + \beta_2\ CASH\_HOLDINGS_{it} + \beta_3\ LT\_INVESTMENTS_{it} + \beta_4\ LT\_DEBT_{it} + \beta_5\ SIZE_{it} + \beta_6\ GDPGROW_t + \beta_7\ INTEREST_t + \beta_8\ COUNTRY + \beta_9\ ACCOUNTING + \beta_{10}\ COVID + \beta_{11}\ Q1_t + \beta_{12}\ Q2_t + \beta_{13}\ Q3t + \varepsilon_{it} \quad [7]$$

II. $$ROA_{it} = \beta_0 + \alpha_1\ DSO_{it} + \beta_1\ SGROW_{it} + \beta_2\ CASH\_HOLDINGS_{it} + \beta_3\ LT\_INVESTMENTS_{it} + \beta_4\ LT\_DEBT_{it} + \beta_5\ SIZE_{it} + \beta_6\ GDPGROW_t + \beta_7\ INTEREST_t + \beta_8\ COUNTRY + \beta_9\ ACCOUNTING + \beta_{10}\ COVID + \beta_{11}\ Q1_t + \beta_{12}\ Q2_t + \beta_{13}\ Q3_t + \varepsilon_{it} \quad [8]$$

III. $$ROA_{it} = \beta_0 + \alpha_1\ DIO_{it} + \beta_1\ SGROW_{it} + \beta_2\ CASH\_HOLDINGS_{it} + \beta_3\ LT\_INVESTMENTS_{it} + \beta_4\ LT\_DEBT_{it} + \beta_5\ SIZE_{it} + \beta_6\ GDPGROW_t + \beta_7\ INTEREST_t + \beta_8\ COUNTRY + \beta_9\ ACCOUNTING + \beta_{10}\ COVID + \beta_{11}\ Q1_t + \beta_{12}\ Q2_t + \beta_{13}\ Q3_t + \varepsilon_{it} \quad [9]$$

IV. $$ROA_{it} = \beta_0 + \alpha_1\ DPO_{it} + \beta_1\ SGROW_{it} + \beta_2\ CASH\_HOLDINGS_{it} + \beta_3\ LT\_INVESTMENTS_{it} + \beta_4\ LT\_DEBT_{it} + \beta_5\ SIZE_{it} + \beta_6\ GDPGROW_t + \beta_7\ INTEREST_t + \beta_8\ COUNTRY + \beta_9\ ACCOUNTING + \beta_{10}\ COVID + \beta_{11}\ Q1_t + \beta_{12}\ Q2_t + \beta_{13}\ Q3_t + \varepsilon_{it} \quad [10]$$

5.4 Sample Selection

Quarterly data of German and Japanese OEMs were collected using Bloomberg Intelligence. Quarterly data allows for a better understanding of the general link between CCC and ROA through more granular results and enhances the understanding of the impact of the COVID-19 pandemic. Moreover, since the financial year of Japanese companies ends on March 31st vs. the

[11] A preliminary analysis of the historical sales development revealed that the sample companies were impacted by the pandemic from Q1 2020 onwards (Appendix 5).
[12] See Appendix 11 for an illustration of the regression models.
[13] See Appendix 12 for the tests that were applied to ensure the statistical validity of the models.

31st of December at German firms, using quarterly data allows to directly compare individual quarters and mitigates possible accounting adaptations at the financial year-end[14].

The query "BI AUTMG" returned an initial sample of 43 global automotive companies, with twelve coming from GER and JP. Data were retrieved for six years, with Q3 2021 being the most recent available quarter and Q4 2015 the starting point. The chosen period enhances the distinction between states of pre-crisis and crisis. Since Toyota took over Daihatsu in Q4 2016, the sample was reduced to eleven OEMs. To account for the effect of the economic cycle in the analysis, quarterly growth rates of real GDP per country were extracted from the OECD database in accordance with prior studies (Pais and Gama 2015; García-Teruel and Martínez-Solano 2007). Since companies can finance their operations using internal and external sources, 10-year government bond yields were extracted from Bloomberg for GER and JP (Myers and Majluf 1984). Long-term bonds are most sensitive to interest rate changes and indicate the attractiveness of external funding (Gallant e al. 2022). All financial data were extracted in USD.

This study uses IBM SPSS Statistics for statistical analyses. To detect outliers, box plots were created for ROA as well as the CCC and its components: DIO, DSO, and DPO (Appendix 3). In accordance with Hoaglin and Iglewicz (1987)[15], 12 outliers were identified. Two companies were excluded from further analysis due to extreme outliers.

The final sample consists of 216 data points of quarterly data of nine firms over six years (Appendix 4.2). Six firms are Japanese (144 data points) and three companies are German (72 data points). While this is a relatively small size of companies compared to other studies, incorporating quarterly data allows for a focused analysis of the relationship between CCC and ROA at OEMs from two leading automotive nations.

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[14] For the quarterly comparison, Japanese Q4 was converted into Q1, in accordance with the calendar year. Appendix 15 shows that pre-crisis, the CCC of both countries has been lowest at the end of their financial year.

[15] An inter quartile range (IQR) of 2.2 was added to the 75% quartile to determine the upper limit and subtracted from the 25% quartile for the lower bound of acceptable values.

6. Data Analysis

6.1 Univariate Analysis

When comparing the means and medians over the past six years, Japanese OEMs present higher ROAs and lower CCCs[16] than German ones. While Japanese companies reached an average ROA of 5.1%, German OEMs attained 4.2%. Japanese ROAs fluctuate more, which can be seen in a higher standard deviation of 3.2% vs. 1.2% at German OEMs. When comparing the median ROAs, both geographies are more similar, with 4.2% in GER and 4.9% in JP. Regarding AT, Japanese OEMs are clearly more efficient in using total assets to generate sales, with an average AT of 98.0% vs. 54.0% at the German OEMs. German OEMs partly compensate for a lower AT with a higher ROS of 7.6% compared to 5.5% at Japanese OEMs. Breaking down ROS into OR and GPM reveals that the higher ROS at German firms is mainly driven by a lower operating risk (OR GER: 39.8%, JP: 25.9%). A higher OR means that operating income is closer to GPM, implying relatively smaller fixed costs. A high share of fixed costs can cause severe difficulties during an economic turmoil as staff needs to be compensated regardless of a reduced order intake. The GPM is slightly higher in Japan (GER: 19.0%, JP: 20.9%). Being international players, the sample companies can source globally, which explains a similar level of GPM. While it takes Japanese OEMs on average 51 days from purchasing raw materials to cash inflow from their customers, German OEMs require 155 days. This difference is also reflected in the components of the CCC, with DSO (JP: 57, GER: 120) and DIO (JP: 51, GER: 77) being lower in the Japanese OEMs, and DPO (JP: 58, GER: 42) higher than in German OEMs. The statistically significant results of the independent t-tests confirm the country differences between the means of ROA and CCC and their breakdowns. Thus, **H1** cannot be rejected.

[16] See Appendix 6.4 – 6.5

Regarding liquidity and the capital structure, both geographies have a current ratio above 1 (GER: 1.1, JP: 1.4), meaning that current assets are sufficient to cover current liabilities[17]. Also, both German and Japanese OEMs hold excessive cash, with CASH_HOLDINGS being 16.7% at German OEMs and 20.1% at Japanese firms[18]. Holding excessive cash provides a safety cushion and facilitates capital-intensive investments to master the challenges outlined in the industry overview by fostering internal developments or acquiring knowledge externally (M&A). Regarding the cash equation, Japanese OEMs present positive net cash (2.0%) vs. negative net cash at German OEMs (-17.4%). Positive net cash means that companies can cover their working capital needs with their NWC and reflects the most conservative balance sheet structure (Stolowy et al. 2013, p. 537). Concerning leverage, Japanese OEMs have both a larger cash cushion as a percentage of total assets (JP: 19.7%, GER: 9.5%) and a lower total debt ratio (JP: 24.1% vs. 46.6%). Thus, while the WCM of Japanese OEMs is more aggressive, the overall capital structure mitigates this risk through lower net debt and positive net cash. Vice versa, the WCM of German OEMs is relatively more conservative, whereas the overall capital structure is riskier than that of their Japanese competitors. Both geographies show only marginal differences for GDPGROW and INTEREST. LT_INVESTMENTS represent 59.9% at German OEMs and 51.4% at Japanese OEMs. Regarding SIZE, German OEMs are larger (Log Total Assets GER: 5.5, JP: 4.7) and have grown less on average but at the same rate in terms of median (1.4% per quarter).

6.2 Univariate Analysis – Evolution over Time

Regarding the evolution of CCC (Figure 1) and ROA (Figure 2), similar trends can be observed in both countries, suggesting similar external factors shaping the industry. While a positive trend can be seen for the CCC of both countries over the periods under research, the contrary

[17] See Appendix 7.3 – 7.6
[18] According to Koller and Goedhart (2020, p. 492), CASH_HOLDINGS above 2% can be seen as excessive cash.

holds for the ROA development, indicating a negative relationship, which will be assessed in the correlation and regression analyses. In both Figure 1 and Figure 2, an external shock starting in 2020 is clearly observable, which can be associated with the COVID-19 pandemic.

Figure 1: Evolution of CCC (Days)

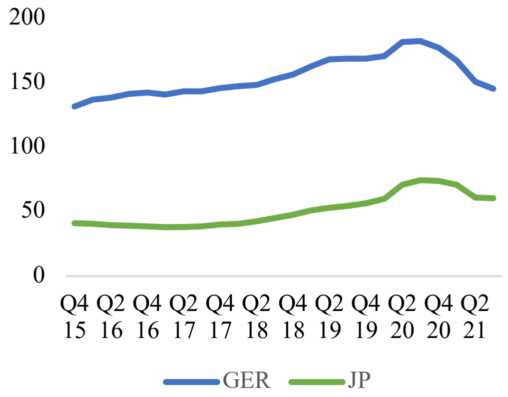
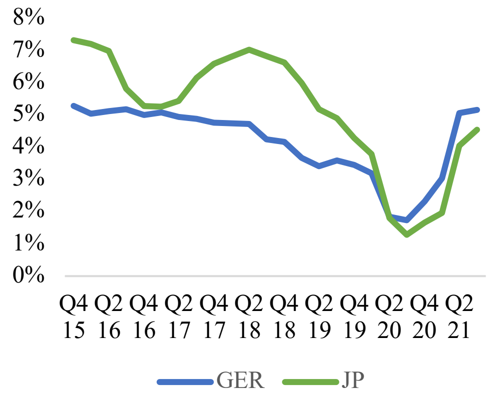


Figure 2: Evolution of ROA



Despite the similar trends, German and Japanese OEMs assume different levels on the y-axis, reflecting the identified country differences. On average, the German CCCs are 104 days above their Asian competitors. From 2018 to 2020, the average German CCC increased by 27 days to 178 days, while the Japanese CCC rose simultaneously by 26 days to 70 days. For 2021, a downward movement can be observed. DIO and DSO show a similar development as CCC[19]. Yet, the corridors between GER and JP differ (DSO 63 days, DIO 26 days). German OEMs take two months longer to collect the cash from their clients and store inventories, roughly one month longer than Japanese OEMs. DPO remained stable with a converging tendency during 2018. Japanese OEMs benefit from an extended supplier credit, with the corridor being on average 18 days higher than in GER. Contrary to DSO and DIO, no external shock is observable for DPO.

While the Japanese ROA is characterized by higher fluctuations, the German ROA had been steadily decreasing before the crisis. Following the outlined theory, Japanese OEMs had a shorter CCC and a higher ROA pre-crisis, indicating that a more aggressive WCM yields

[19] See Appendix 9.1 – 9.2 for the evolution of ROA and CCC parameters.

higher profits (Weinraub and Visscher 1998). However, the order of ROA levels changed in Q2 2020 after the outbreak of the COVID-19 pandemic, suggesting that Japanese OEMs might have experienced the downside of an aggressive WCM policy and the risk-return tradeoff.

When breaking down ROA, GER is constantly above JP in terms of ROS, whereas Japanese OEMs present a higher AT in all quarters. The change in order of ROA during the pandemic is primarily driven by the more severe dip of Japanese AT than the decrease in ROS. Comparing the averages of Q2 2020 until Q3 2021 with the six prior quarters shows that the ROS fell slightly (GER: -0.4%, JP: -1.9%), whereas AT dropped more significantly in both countries but especially in JP (GER: -4.0%, JP: -18.4%), leading to the higher ROA of German OEMs. Considering that ROS consists of only income statement figures, whereas AT incorporates WCM items, supports the notion that Japanese OEMs might have experienced the downside of an aggressive WCM policy during the pandemic. However, it is reasonable to assume that external factors played an important role in the AT evolution, such as longer production shutdowns at Japanese OEMs (Suzuki 2021, Mazda 2021) or the temporary VAT decrease in GER from 19% to 16% from July 2020 until December 2020 (Bundesregierung 2020). Comparing the components of AT over the same periods shows that the drop in AT was both caused by a more severe decrease in sales (JP: -7.7%, GER: -0.1%) and a higher increase in assets (JP: +9.8%, Ger: +7.2%).

German OEMs present a constantly higher OR. The corridor widens during the pandemic, with Japanese OR strongly decreasing, whereas the German OR exceeds prior fluctuations but remains limited in its downward movement. Possible reasons are the different durations in production shutdowns and the use of government-funded short-time allowances by German OEMs (BMW 2020; Mercedes 2020). While the German and Japanese governments provided significant fiscal support packages (Goodman 2020), no information about received governmental aid was found in the annual reports of Japanese OEMs. A possible reason might be the cultural stigmatization of receiving government support in Japan (Hahn 2021). For the German OEMs, information about received short-term allowances is publicly available (VW 2021; BMW 2021; Mercedes 2021).[20] Regarding GPM, JP is constantly on a higher level than GER, which experienced a more severe dip in 2020. The drop can be explained by the pandemic-related disruptions of supply chains and the longer geographic distance to essential supplies from Asia. While supply shortages continue to persist, the recovery of GPM of German OEMs in the subsequent quarters can be attributed to the use of available chips to manufacture high price vehicles (Bay 2022).

The comparison of the evolution of ROA and CCC and their respective breakdowns confirmed that country differences persist over time. The general trend suggests a negative relationship between ROA and CCC, which will be further assessed in the following parts. The fact that German OEMs passed by their Japanese competitors in terms of ROA during the COVID-19 pandemic might be related to the negative tradeoff of an aggressive WCM policy. However, other possible reasons are the outlined external factors as well as a potential time lag.

6.3 Bivariate Analysis

In a preliminary analysis, scatterplots were drawn for the linear relationship of CCC, including its components and ROA (Appendix 10). In both tests, Spearman´s rho and the Pearson correlation coefficient revealed similar results except for DIO in Japanese OEMs (Figure 3).

Figure 3: Correlation Analysis		**Total ROA**	**GER ROA**	**JP ROA**
CCC	Spearman's rho	-,378**	-,640**	-,358**
	Pearson Correlation	-,316**	-,690**	-,303**
DSO	Spearman's rho	-,276**	-,439**	-,174*
	Pearson Correlation	-,257**	-,486**	-,176*
DIO	Spearman's rho	-,204**	-,461**	0.038
	Pearson Correlation	-,209**	-,495**	-0.071
DPO	Spearman's rho	,333**	-,359**	,410**
	Pearson Correlation	,299**	-,334**	,277**

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

[20] For instance, Mercedes CEO Källenius quantified the impact of short-term allowances for 2020 at ca. EUR 700 million (Fockenbrock 2021).

For the full sample, CCC, DSO, and DIO are negatively correlated with ROA, whereas DPO is positively associated with DPO at the 0.01 significance level. Breaking down the sample into countries reveals diverging results. Regarding the German OEMs, all variables are negatively correlated with ROA at the 0.01 level, including DPO. However, while CCC and DSO are also negatively correlated with ROA in Japanese OEMs, a higher DPO is statistically associated with an increased ROA at the 0.01 level. Moreover, DIO is not statistically significant at the 0.05 level for Japanese OEMs. Therefore, **H2.1** and **H2.3** cannot be rejected, while **H2.2** and **H2.4** are rejected due to non-consensual outcomes. A negative correlation between CCC and ROA is in line with the presented theory and various other studies (Baños-Caballero et al. 2010, Raheman and Nasr 2007, Uyar 2009). The same holds for the negative correlation between ROA and DSO (García-Teruel and Martínez-Solano 2007; Raheman et al. 2010). The non-consensual results of previous research are reflected in the different DPO results. DPO is positively correlated with profitability in the Japanese OEMs (Lazaridis and Tryfonidis 2006) but adverse in German OEMs (Lyngstadaas and Berg 2016). A possible explanation for this difference is that less profitable firms in GER wait longer to pay their bills (Raheman and Nasr 2007), while more profitable firms in JP use their negotiation power to extend supplier credits. However, since correlations do not explain causation, companies in JP might be also more profitable thanks to extended supplier financing.

6.4 Multivariate Analysis

In line with previous research (Pais and Gama 2015; Lyngstadaas and Berg 2016; Enqvist et al. 2014), the regression results by country in Figure 4 confirm the correlation results that CCC is negatively impacting ROA in both countries[21]. Thus, **H3** cannot be rejected.

[21] The sample was split due to the identified significant country differences.

Regarding the coefficients, lowering CCC has a bigger impact on improving ROA in German OEMs when compared to the Japanese automotive manufacturers. Reducing CCC by one day would improve the ROA of German OEMs by 0.072 and that of Japanese OEMs by 0.025. As Japanese OEMs are operating on a significantly lower CCC than German OEMs, reducing the CCC by one day would have a smaller marginal benefit than for German OEMs.

Figure 4: Summary Regression Results

Figure 4: Summary Regression Results									
Model		**I**	**I**	**II**	**II**	**III**	**III**	**IV**	**IV**
Country		**GER**	**JP**	**GER**	**JP**	**GER**	**JP**	**GER**	**JP**
CCC	B	-0.072	-0.025						
	Sig.	(0.000)***	(0.078)*						
DSO	B			-0.0516	-0.011				
	Sig.			(0.000)***	(0.253)				
DIO	B					-0.041	0.153		
	Sig.					(0.021)**	(0.000)***		
DPO	B							-0.171	0.111
	Sig.							(0.000)***	(0.000)***
R^2		0.802	0.384	0.720	0.371	0.635	0.466	0.681	0.457
ANOVA p-value		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001

* Correlation is significant at the 0.10 level (2-tailed), ** correlation is significant at the 0.05 level (2-tailed),
*** correlation is significant at the 0.01 level (2-tailed)

Concerning DSO, both coefficients are negative, suggesting lower levels of outstanding payments to improve operating profitability. However, while the DSO of German OEMs is statistically significant at the 0.01 level, DSO was not found to be statistically significant in Japanese OEMs. Similarly, other scholars found a statistically significant negative impact (Högerle et al. 2020; Usman et al. 2017) and a negative but not significant influence of DSO on profitability (Basyith et al. 2021). Thus, **H5.1** cannot be rejected, whereas **H5.2** is rejected due to the lack of statistical significance.

The converging results of the correlation analysis of DIO are reflected in the regression outcome. While a lower DIO positively impacts ROA at the 0.05 level in German OEMs, it has an adverse impact on ROA at the 0.01 level in Japanese OEMs. Thus, **H4.1** cannot be rejected, whereas **H4.2** is rejected. The significant negative impact is in line with the studies of Shajar (2017) and Vijayakumar (2011) on the Indian automotive industry. However, in their research on Indian manufacturing companies, Altaf and Shah (2018) found a positive impact of DIO on profitability. A possible explanation is that Japanese OEMs buy inventories when needed.

Acquiring stocks just-in-time results in higher inventories during economic booms and lower inventory levels during economic downturns. When the order intake is high, quantity discounts for input materials are likely, and variable unit costs decrease, resulting in a higher ROA.

Considering DPO, the correlation results are confirmed with a lower DPO increasing the ROA of German OEMs (0.01 level) and a higher DPO improving the ROA of Japanese OEMs (0.01 level). Thus, **H6.1** is rejected, and **H6.2** cannot be rejected. The coefficients reveal that DPO is the strongest lever of CCC components to influence ROA. Increasing DPO by one day in German OEMs lowers ROA by 0.171, whereas a similar increase would improve the ROA of Japanese OEMs by 0.111. These findings reflect diverging results of previous studies. Analyzing the Indian automotive industry, Viajayakumar (2011) found a positive impact of DPO on profitability (0.01 level), while Shajar (2017) researched the same sector in the same country and found a negative effect of DPO on ROA (0.01 level). Shajar (2017) interprets this relationship with a loss of credibility if payments are postponed, ultimately lowering profitability. Arguing from a different angle, Deloof (2003) explains this relationship with less profitable firms requiring more time to settle their bills. Support for this explanation can be found in the sample. Mercedes presents the highest German average ROA in the period under research (4.54%), followed by BMW (4.27%) and VW (3.64%). However, the contrary holds for DPO, with VW presenting the highest level (45 days), followed by BMW (42 days) and Mercedes (39 days). The question remains if DPO impacts profitability or vice versa.

Regarding the control variables, LT_INVESTMENTS was found to have an overall significant and positive impact on ROA in 5 out of 8 models, signaling that investments in long-term assets pay off in the capital-intensive automotive industry. Vice versa, this result implies that managers of OEMs should try to minimize the share of current assets, stressing the importance of WCM. LT_DEBT was found to significantly impact ROA in six out of eight models. However, while the observed statistically significant impact of LT_DEBT on ROA in

German OEMs was positive, the contrary was found for Japanese OEMs[22]. A possible explanation is that German OEMs benefit from the leverage effects of LT_DEBT, whereas Japanese OEMs use LT_DEBT only if needed. This explanation is supported by the findings of Khoo and Durand (2017). Analyzing Japanese firms from 1990 to 2014, the authors found that Japanese firms rely on internal financing and are reluctant regarding the use of leverage.

COVID negatively impacts ROA at the 0.01 level in four out of eight models, in line with the descriptive analysis. The quarter dummies were not significant throughout all models, meaning that potential seasonality does not impact ROA.

7. Conclusion

This study set out to extend the current body of literature on the impact of WCM on profitability by analyzing six years of quarterly data of German and Japanese OEMs. CCC was used as a dynamic measure of WCM and ROA as a proxy for profitability. Descriptive statistics and independent t-tests revealed that Japanese and German OEMs are, on average, significantly different. The evolution over time showed a similar development of CCC per country, shifted on the y-axis with German OEMs being constantly on higher levels than Japanese OEMs. Furthermore, the sample firms of both countries are impacted by similar external effects, particularly reflected in the quarters affected by the COVID-19 pandemic. The recent crisis caused a significant decrease in ROA and an increase in CCC in both geographies. While Japanese OEMs were found to follow a more aggressive WCM policy, expressed by a significantly lower CCC and a higher ROA, German OEMs employ a more conservative approach with a higher CCC and lower ROA. The evolution over time revealed that German OEMs passed Japanese OEMs in terms of ROA during the pandemic. The breakdown of ROA demonstrated that this development could be attributed to a more stable AT and a higher ROS.

[22] The steep increase of short-term debt (+22.3%) and long-term debt (+28.8%) at Japanese OEMs during the pandemic suggests that this relationship might be explained by the simultaneously plummeting ROA. However, a robustness test with pre-pandemic data was performed, which returned similar results.

Japanese OEMs might have experienced the tradeoff of an aggressive WCM policy during the COVID-19 pandemic. However, it cannot be ruled out that this shift in order was driven by country factors instead of management practices, such as different durations of production shutdowns, a lagged COVID-19 impact, or governmental short-time allowances and tax incentives during the pandemic. The bivariate analysis proved a negative correlation between CCC and ROA, which was confirmed in the multivariate OLS regression for both countries.

Regarding the components of CCC, results indicate that a lower level of DSO enhances ROA. However, this relationship was only statistically significant for German OEMs. Considering DIO and DPO, significant but divergent results were found for both countries. While both lower levels of DIO and DPO improve the ROA of German OEMs, the contrary was found for Japanese automotive manufacturers. A possible explanation is that Japanese OEMs invented just-in-time manufacturing, which includes acquiring inventories when needed. The negative link between DPO and ROA at German OEMs can be explained by less profitable German OEMs requiring more time to pay their bills.

Overall, managers of OEMs should strive for low levels of CCC to improve ROA. Customer loans in terms of DSO should be reduced, and just-in-time practices should be applied to lower the capital being tied up in inventories. The results for LT_INVESTMENTS underline the importance of low current assets and WCM. Demanding suppliers to store certain amounts of critical inventories can help to hedge against external supply chain disruptions[23].

8 Limitations and Future Research

Despite all companies being international players with some owning various brands[24], analyzing nine OEMs represents a relatively small sample. Moreover, the results are limited to

[23] Toyota has been requesting suppliers to stockpile semiconductors for two to six months' worth of chips after the tsunami of 2011, which had caused long lasting supply bottlenecks (Shirouzu 2021).
[24] Volkswagen for example is the mother of the following brands: Volkswagen, Audi, Seat, Skoda, Bentley, Bugatti, Lamborghini, Porsche, Ducati, Volkswagen Nutzfahrzeuge, Scania, MAN (VW 2021).

two countries, with JP comprising six companies and GER three. This imbalance in the subsamples should not affect the overall conclusions but limits the meaningfulness of direct comparisons between the standard deviations and variances of the subsamples. In addition, the control variables ACCOUNTING and SIZE could not be incorporated in the OLS part to maintain the statistical validity of the regression models. Since the sample companies are large international players, SIZE should matter less than when researching a sample comprising SMEs and MNEs (multinational enterprises). Yet, incorporating this control variable might change the outcome. While all German OEMs use IFRS, JP GAAP was the prevailing accounting method of Japanese firms, suggesting that the split by country should also incorporate the impact of major accounting differences. However, accounting differences were not explicitly addressed. For instance, research and development expenditures are recorded as expenses when incurred under Japanese GAAP. In contrast, expenses for internally developed products may be under certain requirements amortized as an intangible asset under IFRS (Toyota Industries 2017). This difference might alter the operating income and thus, also affect ROA. Moreover, managers' use of different accounting options impedes exact comparability, even under the same accounting standard. In addition, even though historical tax rates were similar in GER (ca. 30%) and JP (ca. 31%)[25], taxation was not explicitly considered but plays an essential role in business decisions. Regarding CCC, DSO and DPO are directly affected by taxation, and the temporary VAT decrease in GER during the pandemic might further distort the results.

Therefore, future research should expand this topic to an increased number of OEMs of different sizes and geographies. Furthermore, differences in accounting and taxation should be directly addressed. Finally, future research should elaborate on the diverging results per country for DIO and DPO in the regression analysis.

[25] See Appendix 13 for the annual corporate tax evolution by country.

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Appendix

Appendix 1: Abbreviations and Acronyms

AT	Asset Turnover
Ca.	Circa
CCC	Cash Conversion Cycle
COGS	Costs of Goods Sold
DIO	Days Inventory Outstanding
DPO	Days Payable Outstanding
DSO	Days Sales Outstanding
EBIT	Earnings Before Interest and Taxes
EUR	Euro
EV	Electric Vehicle
GAAP	Generally Accepted Accounting
GER	Germany
GOI	Gross Operating Income
GPM	Gross Profit Margin
H	Hypothesis
IFRS	International Financial Reporting Standards
IQR	Interquartile Range
JP	Japan
Log	Logarithm
LT	Long Term
LTM	Last Twelve Months
MNE	Multinational Enterprise
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
OR	Operating Risk
PESTEL	Political, Economic, Social, Technological, Environmental, and Legal factors
Q	Quarter
R&D	Research & Development
ROA	Return on Assets
ROCE	Return on Capital Employed
ROS	Return on Sales
SE	Stock Exchange
SME	Small and Medium-sized Enterprises
USD	US Dollar
VAT	Value added tax
VIF	Variation Inflation Factor
WC	Working Capital
WCM	Working Capital Management

Appendix 2: Industry Analysis

Appendix 2.1: PESTEL Analysis

Factor	Impact
Political	• Different safety requirements for different geographies make entering a market more costly and protect domestic players • Directed taxation allows governments to drive desired developments, such as the revision of the Energy Taxation Directive (ETD) as part of the European Union´s fit for 55 package (EPRS 2022). The ETD historically taxed Diesel lower than petrol (European Commission 2021). • Prescribed emission targets, e.g. in the EU, OEMs had to lower C02 emissions to a maximum of 95 grams per kilometer by 2021 to avoid financial penalties (Tschiesner et al. 2020) • Protective trade tariffs hinder the movement of goods • Governmental involvement as shareholder, such as VW in GER or the “big four” in China: SAIC Motor, Dongfeng, FAW, and Chang´an (Wikipedia)
Economic	• Deteriorating income disparity expected for 72 out of 103 major economies between 2020 and 2040 (Hodgson 2021). OEMs need strategies for a polarized market with a shrinking middle class and a higher share of low-income consumers at the pyramid base. • External shocks, such as the recent US-China trade dispute, the current pandemic, and the war in Ukraine
Social	• Rural areas continue to rely on cars • Decreasing number of cars in urban areas due to social change • Owning a car continues to be a symbol of social standing • Powerful labor unions, such as IG Metall in GER or United Auto Workers in North America, express stakeholder interests
Technological	• Emission-free drive requires vast R&D investments to stay in the market • Increasing importance of software to differentiate in various areas, in particular, autonomous driving, active safety, connectivity, and infotainment (Gao et al. 2016)

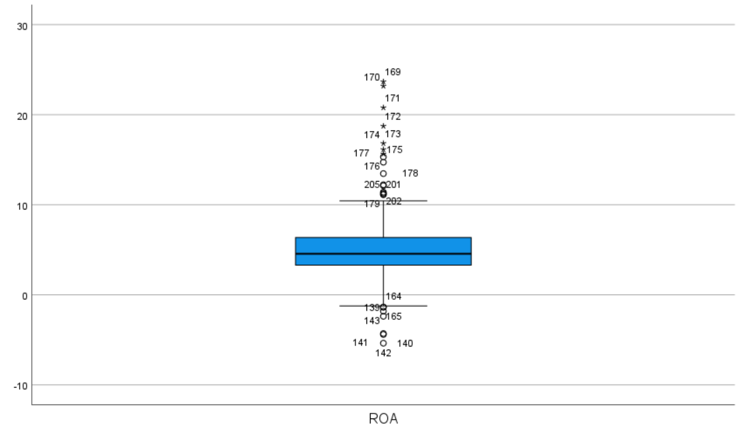
Environmental	• Political agendas to cut emissions:
	  o Fitfor55 program by the European Union to cut greenhouse gas emissions by 55% until 2030 (Deloitte)(Deloitte n.d.)
	  o JP´s goal of net-zero greenhouse gas emissions by 2050 (METI)
	  o China´s goal of EVs representing 40% of all car sales by 2030 (Stauffer 2021)

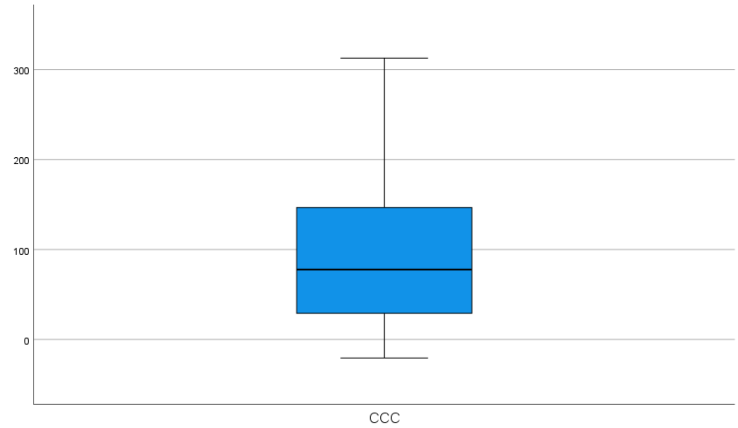
Legal	• Long history of copyright issues in the automobile industry. Chinese manufacturers have repeatedly presented imitates of Western brands (Tumminelli 2009). • Ongoing trials due to manipulated emission values (Dieselgate) (Stern 2021)

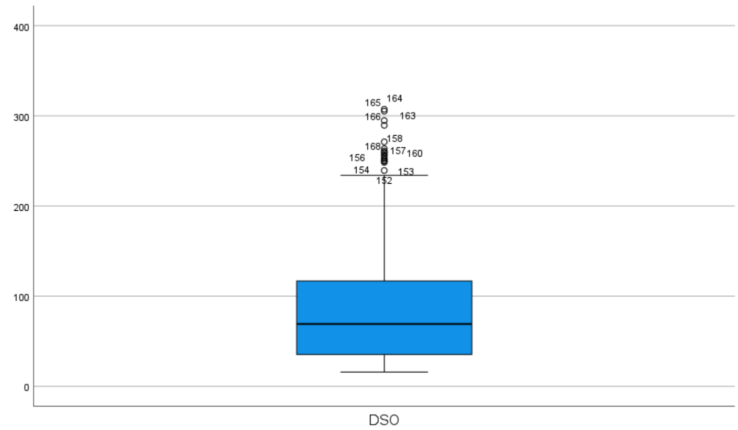
Appendix 2.2: *SWOT Analysis*

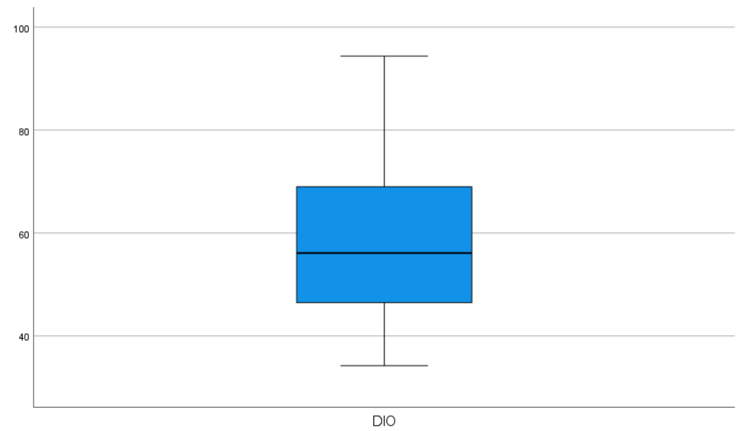
Force	Impact	Reasoning
Threat of New Entrants	**Low**	• Vast human and monetary capital requirements to develop automobiles, build up the production infrastructure, supply chain, distribution network, etc. • Strong market position of established competitors benefitting from well-known brands and economies of scale • New EV players, like Tesla, however, show that modern capital markets can provide the necessary funds for entering the market
Bargaining Power of Suppliers	**Low**	• Immense size of established OEMs leaves suppliers with limited negotiation power • Fewer parts required for EV machines vs. combustion machines intensifies the competition between existing suppliers
Bargaining Power of Buyers	**High**	• Low change barriers for customers give them a strong bargaining position • Various globally operating OEMs cover the entire product range, allowing customers to choose the option that meets best their preference of price and quality
Threat of Substitutes	**Moderate**	• Unlikely that any sort of transport will fully substitute cars. However, the number of vehicles might decrease in urban areas due to other transportation solutions, such as e-scooters, trains, or car-sharing. • Rural areas will continue to depend on automobiles for personal mobility • Missing the shift for new technologies, such as alternative ways of powering (EV, hydrogen), poses a risk of substitution
Industry Rivalry	**High**	• Unchanged composition of the world´s top 10 car producers from 2007 to 2017 (OICA 2007, 2017). Comparatively low market share of 10.5% of the biggest player Toyota in 2021 reflects a strong peer group and fierce competition (Carlier 2022). • Continuous consolidation pressure to achieve a competitive edge through economies of scale and negotiation power, e.g., Stellantis merger of Fiat Chrysler Automobiles and Group PSA in 2021 or the Chinese government´s aspiration to build national champions (Han 2010; Reuters 2021)

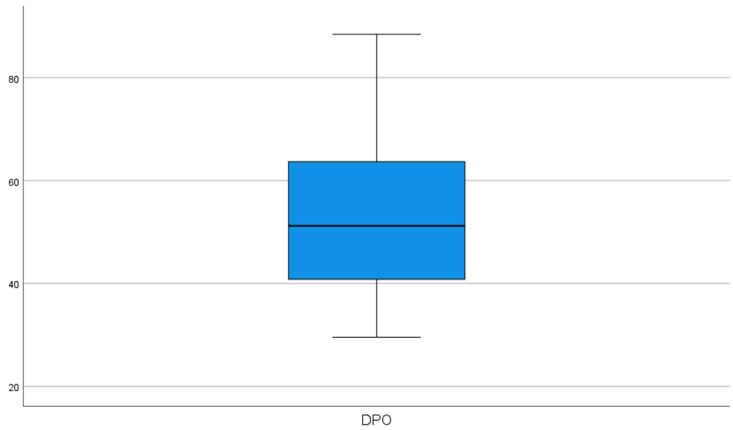
Appendix 3 Outlier Analysis











Appendix 3.1: Identified Outliers

Identified Individual Outliers following Hoaglin and Iglewicz (1987):

Parameter	**Company**	**Value**	**Maximum (2.2*IQR+Q3)**	**Date**
ROA	Subaru	23.7%	13,10%	31.12.2015
ROA	Subaru	23.2%	13.10%	30.03.2016
ROA	Subaru	20.8%	13.10%	30.06.2016
ROA	Subaru	18.7%	13.10%	30.09.2016
ROA	Subaru	16.8%	13.10%	31.12.2016
ROA	Subaru	16.1%	13.10%	30.06.2017
ROA	Subaru	15.6%	13.10%	31.03.2017
ROA	Subaru	15.3%	13.10%	30.09.2017
ROA	Subaru	14.7%	13.10%	31.12.2017
ROA	Subaru	13.5%	13.10%	31.03.2018
DSO	Nissan	307.3	297.00	30.09.2020
DSO	Nissan	305.2	297.00	31.12.2020

Appendix 4: Sample

Appendix 4.1: Initial Sample

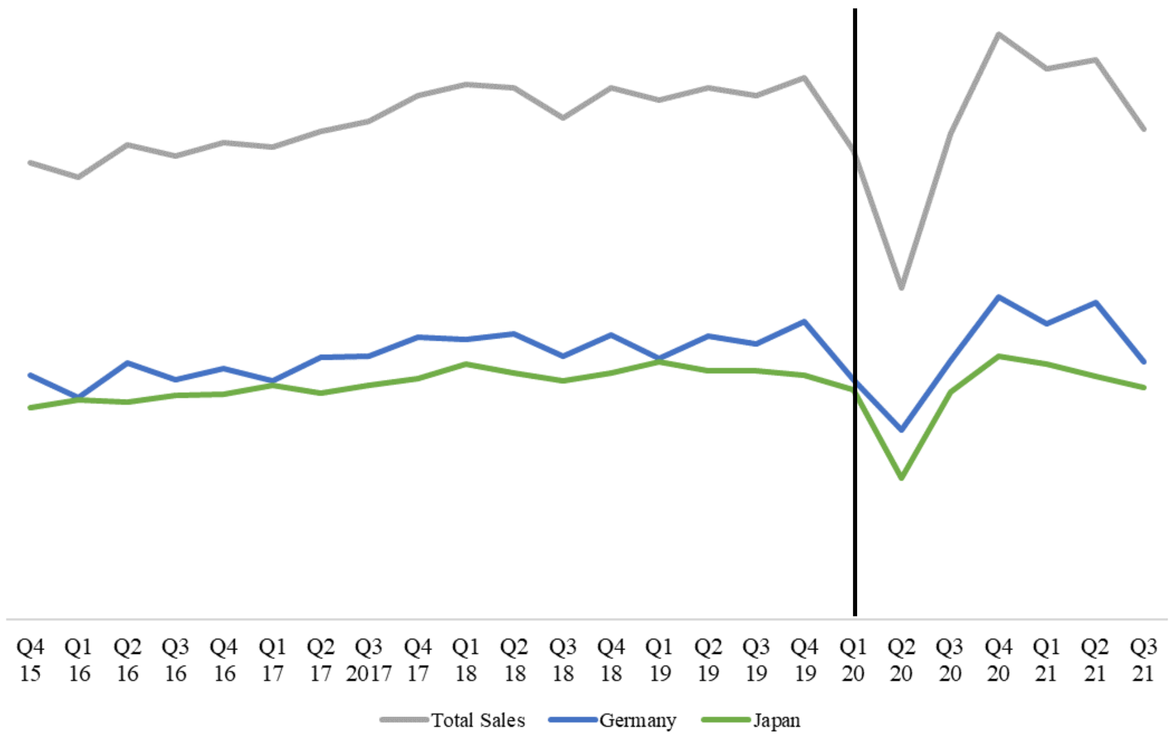
Company	Ticker	Country	End FY	Reason for exclusion
Bayerische Motoren Werke AG (BMW)	BMW GR	GER	31.12.	
Daihatsu Motor Co Ltd (Daihatsu)	7262 JP	JP	31.12.	Since Q4 2016 100% part of Toyota
Honda Motor Co Ltd (Honda)	7267 JP	JP	31.03.	
Isuzu Motors Ltd (Isuzu)	7202 JP	JP	31.03.	
Mazda Motor Corp (Mazda)	7261 JP	JP	31.03.	
Mercedes-Benz Group AG [26](Mercedes-Benz)	MBG GR	GER	31.12.	
Mitsubishi Motors Corp (Mitsubishi)	7211 JP	JP	31.03.	
Nissan Motor Co Ltd (Nissan)	7201 JP	JP	31.03.	Extreme Outliers
Subaru Corp (Subaru)	7270 JP	JP	31.03.	Extreme Outliers
Suzuki Motor Corp (Suzuki)	7269 JP	JP	31.03.	
Toyota Motor Corp (Toyota)	7203 JP	JP	31.03.	
Volkswagen AG (VW)	VOW GR	GER	31.12.	

Appendix 4.2: Final Sample

Company	Ticker	Country	End FY	Accounting
Bayerische Motoren Werke AG (BMW)	BMW GR	GER	31.12.	IAS/IFRS
Honda Motor Co Ltd (Honda)	7267 JP	JP	31.03.	IAS/IFRS
Isuzu Motors Ltd (Isuzu)	7202 JP	JP	31.03.	JP GAAP
Mazda Motor Corp (Mazda)	7261 JP	JP	31.03.	JP GAAP
Mercedes-Benz Group AG (Mercedes-Benz)	MBG GR	GER	31.12.	IAS/IFRS
Mitsubishi Motors Corp (Mitsubishi)	7211 JP	JP	31.03.	JP GAAP
Suzuki Motor Corp (Suzuki)	7269 JP)	JP	31.03.	JP GAAP
Toyota Motor Corp (Toyota)	7203 JP	JP	31.03.	US GAAP until Q1 2019; since then, IAS/IFRS
Volkswagen AG (VW)	VOW GR	GER	31.12.	IAS/IFRS

[26] Daimler AG was renamed to Mercedes-Benz Group AG as of February 2022

Appendix 5: Historical Sales Development per Country

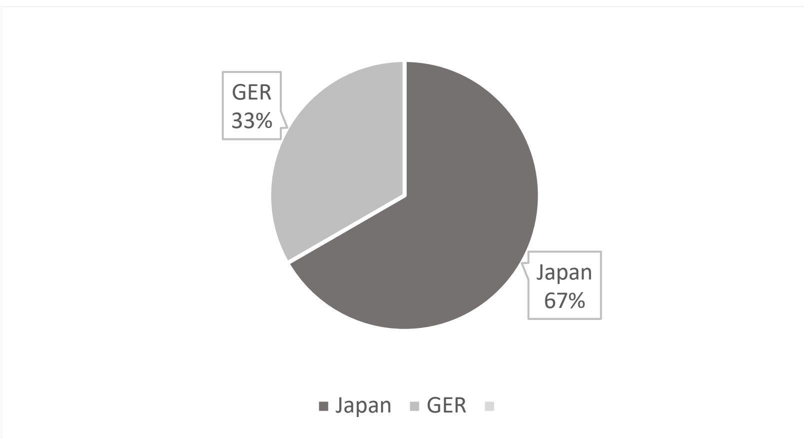


The historical sales development indicates that the COVID-19 pandemic started impacting the sample companies in Q1 2020.

Appendix 6: Descriptives

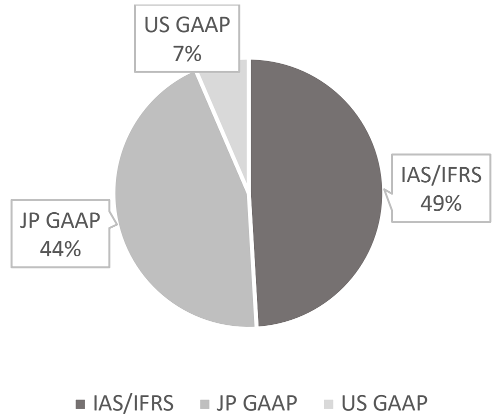
Appendix 6.1: Sample Distribution by Country

Six OEMs are headquartered in Japan and three in Germany.



Appendix 6.2: Sample Distribution by Accounting Standard

Accounting Standard	GER	JP	Total
IAS/IFRS	72	34	106
JP GAAP	0	96	96
US GAAP	0	14	14
Total	72	144	216



Appendix 6.3: Summary Statistics of Variables of Total Sample

Note, the following tables describe data from Q4 2015 to Q3 2021.

Variables	N	Minimum	Maximum	Mean	Median	Std. Deviation
ROA	216	-0.054	0.122	0.048	0.046	0.027
ROS	216	-0.065	0.109	0.062	0.067	0.030
OR	216	-0.602	0.567	0.305	0.331	0.171
GPM	216	0.108	0.299	0.203	0.200	0.038
AT	216	0.437	1.541	0.833	0.777	0.311
CCC (Days)	216	-20.606	193.243	85.362	77.859	57.999
DSO (Days)	216	15.827	155.574	78.188	69.154	39.122
DIO (Days)	216	34.221	94.385	59.658	58.324	15.635
DPO (Days)	216	29.550	88.436	52.484	46.660	16.696
CASH_HOLDINGS	216	0.112	0.328	0.193	0.180	0.048
LT_INVESTMENTS	216	0.317	0.673	0.542	0.577	0.097
LT_DEBT	216	0.000	0.333	0.184	0.203	0.087
SIZE (Log Total Assets)	216	4.065	5.787	4.981	5.247	0.603
SGROW	216	-0.615	1.013	0.020	0.014	0.185
GDPGROW	216	-0.100	0.090	0.001	0.004	0.024
INTEREST	216	-0.006	0.006	0.000	0.000	0.002

Appendix 6.4: Summary Statistics of Variables by Country – GER

	N	Minimum	Maximum	Mean	Median	Std. Deviation
ROA	72	0.004	0.064	0.042	0.042	0.012
ROS	72	0.009	0.107	0.076	0.078	0.020
OR	72	0.057	0.567	0.398	0.394	0.087
GPM	72	0.138	0.216	0.190	0.197	0.020
AT	72	0.437	0.716	0.540	0.532	0.067
CCC (Days)	72	128.756	193.243	154.678	144.511	16.194
DSO (Days)	72	98.389	155.574	120.034	110.192	15.727
DIO (Days)	72	60.034	94.385	76.803	73.187	9.240
DPO (Days)	72	36.453	48.162	42.158	43.168	3.092
CASH_HOLDINGS	72	0.126	0.271	0.177	0.167	0.031
LT_INVESTMENTS	72	0.504	0.645	0.599	0.600	0.025
LT_DEBT	72	0.166	0.333	0.269	0.285	0.050
SIZE (Log Total Assets)	72	5.272	5.787	5.523	5.422	0.152
SGROW	72	-0.288	0.534	0.014	0.014	0.146
GDPGROW	72	-0.100	0.090	0.003	0.004	0.029
INTEREST	72	-0.006	0.006	0.000	0.001	0.004

Appendix 6.5: Summary Statistics of Variables by Country – JP

	N	Minimum	Maximum	Mean	Median	Std. Deviation
ROA	144	-0.054	0.122	0.051	0.049	0.032
ROS	144	-0.065	0.109	0.055	0.060	0.032
OR	144	-0.602	0.550	0.259	0.248	0.184
GPM	144	0.108	0.299	0.209	0.205	0.042
AT	144	0.466	1.541	0.980	1.032	0.280
CCC (Days)	144	-20.606	116.890	50.705	57.305	36.037
DSO (Days)	144	15.827	125.325	57.266	61.671	29.255
DIO (Days)	144	34.221	77.192	51.086	54.371	10.156
DPO (Days)	144	29.550	88.436	57.647	52.777	18.271
CASH_HOLDINGS	144	0.112	0.328	0.201	0.187	0.053
LT_INVESTMENTS	144	0.317	0.673	0.514	0.494	0.107
LT_DEBT	144	0.000	0.260	0.141	0.140	0.069
SIZE (Log Total Assets)	144	4.065	5.750	4.710	4.466	0.561
SGROW	144	-0.615	1.013	0.022	0.014	0.202
GDPGROW	144	-0.079	0.053	0.000	0.002	0.021
INTEREST	144	-0.002	0.003	0.000	0.000	0.001

Appendix 7: Common-sized Analysis

Appendix 7.1: Common-sized Balance Sheet, Liquidity Ratios and Cash Equation

	N	Minimum	Maximum	Mean	Std. Deviation
Total Assets in mio. USD	216	11615.77	612734.30	201406.77	191204.04
Common-sized Balance Sheet					
Cash %	216	5.52%	41.71%	16.28%	8.02%
Accounts Receivable %	216	4.03%	22.34%	14.80%	4.25%
Inventories %	216	4.30%	17.03%	10.35%	3.47%
Other ST Assets %	216	1.23%	19.54%	4.33%	2.21%
Total Current Assets %	216	32.68%	68.30%	45.76%	9.72%
PP&E %	216	17.14%	39.03%	28.62%	6.22%
LT Investments %	216	0.61%	35.75%	15.45%	8.53%
Other LT Assets %	216	1.79%	31.34%	10.16%	6.04%
Total Noncurrent Assets %	216	31.70%	67.32%	54.24%	9.72%
Total Assets %	216	100.00%	100.00%	100.00%	0.00%
Accounts Payable %	216	3.89%	29.18%	10.14%	6.65%
Other Payables %	216	0.00%	13.79%	3.74%	3.63%
ST Debt %	216	0.60%	23.21%	13.19%	6.74%
Other ST Liabilities %	216	2.33%	21.91%	8.17%	3.99%
Total Current Liabilities %	216	24.14%	56.50%	35.24%	5.58%
LT Debt %	216	0.02%	33.31%	18.41%	8.74%
Other LT Liabilities %	216	2.41%	20.55%	8.53%	3.85%
Total Noncurrent Liabilities %	216	6.33%	44.91%	26.94%	10.72%
Total Debt %	216	1.77%	54.11%	31.60%	14.54%
Total Liabilities %	216	44.58%	80.03%	62.18%	10.26%
Total Equity %	216	19.97%	55.42%	37.82%	10.26%
Total Liabilities & Equity	216	100.00%	100.00%	100.00%	0.00%
Liquidity Ratios					
Current Ratio	216	87.72%	197.52%	130.92%	25.39%
Quick Ratio	216	55.42%	132.59%	88.89%	16.05%
Cash Ratio	216	14.19%	105.34%	46.02%	20.25%
Cash Equation					
WC	216	-5.32%	28.33%	10.52%	8.15%
WCN	216	-5.30%	26.51%	15.01%	6.72%
Net Cash	216	-24.37%	26.01%	-4.49%	13.16%

Appendix 7.2: Income Statement Items as Percent of Total Sales

	N	Minimum	Maximum	Mean	Std. Deviation
Total Sales in mio. USD	216	2134.93	81102.49	29437.75	24396.59
COGS %	216	67.15%	98.63%	79.91%	4.30%
Gross Profit %	216	1.37%	32.85%	20.09%	4.30%
Other Operating Income %	216	0.00%	11.53%	0.30%	0.98%
Operating Expenses %	216	6.84%	32.78%	14.44%	4.71%
Operating Margin	216	-23.24%	17.51%	5.95%	4.42%

Appendix 7.3: Common-sized Balance Sheet, Liquidity Ratios and Cash Equation – GER

	N	Minimum	Maximum	Mean	Std. Deviation
Total Assets in mio. USD	72	187084.27	612734.30	354541.82	128471.70
Common-sized Balance Sheet					
Cash %	72	5.52%	13.21%	9.53%	1.64%
Accounts Receivable %	72	13.29%	20.87%	17.49%	1.96%
Inventories %	72	6.28%	11.64%	9.10%	1.57%
Other ST Assets %	72	1.56%	19.54%	3.97%	2.43%
Total Current Assets %	72	35.47%	49.60%	40.10%	2.46%
PP&E %	72	21.04%	30.62%	26.59%	3.12%
LT Investments %	72	15.33%	27.85%	20.35%	3.68%
Other LT Assets %	72	7.36%	23.13%	12.96%	6.16%
Total Noncurrent Assets %	72	50.40%	64.53%	59.90%	2.46%
Total Assets	72	100.00%	100.00%	100.00%	0.00%
Accounts Payable %	72	3.92%	5.95%	4.95%	0.53%
Other Payables %	72	0.00%	1.46%	0.40%	0.43%
ST Debt %	72	15.86%	23.21%	19.64%	1.52%
Other ST Liabilities %	72	8.13%	15.73%	10.84%	1.85%
Total Current Liabilities %	72	32.14%	43.32%	35.84%	2.12%
LT Debt %	72	16.65%	33.31%	26.95%	4.98%
Other LT Liabilities %	72	5.83%	20.55%	12.12%	4.07%
Total Noncurrent Liabilities %	72	34.00%	44.91%	39.07%	2.66%
Total Debt %	72	37.19%	54.11%	46.59%	5.29%
Total Liabilities %	72	67.75%	80.03%	74.91%	2.36%
Total Equity %	72	19.97%	32.25%	25.09%	2.36%
Total Liabilities & Equity	72	100.00%	100.00%	100.00%	0.00%
Liquidity Analysis					
Current Ratio	72	87.72%	129.58%	112.27%	9.47%
Quick Ratio	72	55.42%	91.61%	75.78%	8.91%
Cash Ratio	72	14.19%	39.71%	26.71%	4.97%
Cash Equation					
WC	72	-5.32%	11.32%	4.26%	3.35%
WCN	72	16.52%	26.51%	21.64%	2.54%
Net Cash	72	-24.37%	-5.20%	-17.38%	2.73%

Appendix 7.4: Income Statement Items as Percent of Total Sales – GER

	N	Minimum	Maximum	Mean	Std. Deviation
Total Sales in mio. USD	72.00	21992.10	81102.49	46940.84	16708.10
COGS %	72	75.27%	93.54%	81.08%	3.10%
Gross Profit %	72	6.46%	24.73%	18.92%	3.10%
Other Operating Income %	72	0.00%	11.53%	0.91%	1.54%
Operating Expenses %	72	6.84%	32.78%	12.29%	3.45%
Operating Margin	72	-4.92%	17.51%	7.54%	3.61%

Appendix 7.5: Common-sized Balance Sheet, Liquidity Ratios and Cash Equation – JP

	N	Minimum	Maximum	Mean	Std. Deviation
Total Assets in mio. USD	144	11615.77	562943.13	124839.25	170472.23
Common-sized Balance Sheet					
Cash %	144	8.79%	41.71%	19.66%	7.80%
Accounts Receivable %	144	4.03%	22.34%	13.45%	4.45%
Inventories %	144	4.30%	17.03%	10.97%	3.96%
Other ST Assets	144	1.23%	9.10%	4.51%	2.07%
Total Current Assets	144	32.68%	68.30%	48.59%	10.71%
PP&E	144	17.14%	39.03%	29.64%	7.09%
LT Investments	144	0.61%	35.75%	13.00%	9.20%
Other LT Assets	144	1.79%	31.34%	8.76%	5.49%
Total Noncurrent Assets	144	31.70%	67.32%	51.41%	10.71%
Total Assets	144	100.00%	100.00%	100.00%	0.00%
Accounts Payable	144	3.89%	29.18%	12.73%	6.78%
Other Payables	144	0.49%	13.79%	5.41%	3.36%
ST Debt	144	0.60%	20.74%	9.96%	5.97%
Other ST Liabilities	144	2.33%	21.91%	6.84%	4.11%
Total Current Liabilities	144	24.14%	56.50%	34.94%	6.66%
LT Debt	144	0.02%	25.98%	14.15%	6.89%
Other LT Liabilities	144	2.41%	10.92%	6.74%	2.08%
Total Noncurrent Liabilities	144	6.33%	32.91%	20.88%	7.63%
Total Debt	144	1.77%	42.94%	24.10%	11.59%
Total Liabilities	144	44.58%	71.70%	55.82%	5.76%
Total Equity	144	28.30%	55.42%	44.18%	5.76%
Total Liabilities & Equity	144	100.00%	100.00%	100.00%	0.00%
Liquidity Analysis					
Current Ratio	144	100.11%	197.52%	140.25%	25.73%
Quick Ratio	144	68.62%	132.59%	95.45%	14.77%
Cash Ratio	144	29.63%	105.34%	55.68%	17.97%
Cash Equation					
WC	144	0.04%	28.33%	13.65%	8.05%
WCN	144	-5.30%	24.42%	11.69%	5.61%
Net Cash	144	-17.14%	26.01%	1.96%	11.46%

Appendix 7.6: Income Statement Items as Percent of Total Sales – JP

	N	Minimum	Maximum	Mean	Std. Deviation
Total Sales in mio. USD	144.00	2134.93	78018.39	20686.20	22910.52
COGS %	144	67.15%	98.63%	79.33%	4.69%
Gross Profit %	144	1.37%	32.85%	20.67%	4.69%
Other Operating Income %	144	0.00%	0.00%	0.00%	0.00%
Operating Expenses %	144	8.21%	32.55%	15.52%	4.89%
Operating Margin	144	-23.24%	12.57%	5.15%	4.58%

Appendix 7.7: Common-sized Country Comparison Non-COVID and COVID

	Germany			Japan		
	Non-COVID	**COVID**	**Δ**	**Non-COVID**	**COVID**	**Δ**
Current Assets						
Cash	9.1%	10.7%	18.2%	19.5%	20.0%	2.3%
Accounts Receivable	17.8%	16.7%	-6.6%	13.5%	13.3%	-1.4%
Inventories	9.3%	8.6%	-7.9%	11.1%	10.7%	-3.2%
Other ST Assets	3.8%	4.4%	15.8%	4.8%	3.8%	-20.2%
Total Current Assets	**40.0%**	**40.3%**	0.8%	**48.9%**	**47.8%**	-2.2%
Noncurrent Assets						
PP&E	26.5%	26.7%	0.6%	29.8%	29.4%	-1.3%
LT Investments	20.6%	19.8%	-3.9%	13.4%	12.0%	-10.6%
Other LT Assets	12.9%	13.2%	2.4%	7.9%	10.8%	36.0%
Total Noncurrent Assets	60.0%	59.7%	-0.5%	51.1%	52.2%	2.1%
Total Assets	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%
Total Assets in mio USD	337,856.1	395,064.2	16.9%	118,894.0	139,277.6	17.1%
Current Liabilities						
Accounts Payable	5.1%	4.5%	-12.6%	13.8%	10.2%	-25.7%
Other Payables	0.5%	0.3%	-40.2%	5.5%	5.1%	-7.6%
ST Debt	19.7%	19.4%	-1.6%	9.3%	11.4%	22.3%
Other ST Liabilities	10.9%	10.6%	-3.0%	6.8%	7.0%	3.9%
Total Current Liabilities	36.3%	34.8%	-4.1%	35.4%	33.8%	-4.6%
Noncurrent Liabilities						
LT Debt	26.6%	27.8%	4.6%	13.0%	16.8%	28.8%
Other LT Liabilities	12.3%	11.7%	-5.1%	6.9%	6.4%	-6.4%
Total Noncurrent Liabilities	38.9%	39.5%	1.5%	19.9%	23.2%	16.7%
Total Debt	46.3%	47.2%	2.0%	22.4%	28.2%	26.1%
Total Liabilities	75.2%	74.3%	-1.2%	55.3%	57.0%	3.1%
Total Equity	24.8%	25.7%	3.5%	44.7%	43.0%	-3.9%
Total Liabilities & Equity	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%
Liquidity Ratios						
Current Ratio	110.8%	115.9%	4.6%	138.5%	144.4%	4.2%
Quick Ratio	85.0%	91.2%	7.3%	106.8%	111.3%	4.3%
Cash Ratio	25.0%	30.8%	23.1%	53.9%	60.0%	11.3%
CCC						
DSO (Days)	116.3	129.0	10.9%	53.9	65.4	21.4%
DIO (Days)	75.5	80.0	6.0%	48.5	57.3	18.0%
DPO (Days)	42.6	41.2	-3.2%	58.6	55.4	-5.5%
CCC (Days)	149.3	167.8	12.5%	43.8	67.4	53.6%
ROA						
ROS	8.1%	6.4%	-21.3%	6.2%	3.7%	-39.4%
OR	41.3%	36.2%	-12.2%	29.4%	17.2%	-41.6%
GPM	19.6%	17.4%	-11.6%	21.5%	19.4%	-9.5%
AT	56.1%	49.0%	-12.6%	104.0%	83.5%	-19.7%
ROA	4.5%	3.2%	-29.8%	6.1%	2.7%	-55.3%
WC	3.7%	5.5%	49.1%	13.5%	14.0%	4.1%
WCN	21.9%	21.0%	-4.3%	10.8%	13.8%	27.8%
Net Cash	-18.3%	-15.6%	-14.9%	2.7%	0.2%	-91.7%

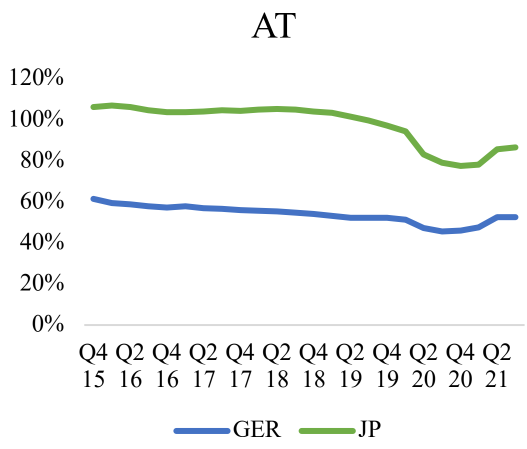
	Germany			Japan		
	Non-COVID	COVID	Δ	Non-COVID	COVID	Δ
Income Statement Ratios						
Total Sales in mio USD	46,706.6	47,509.7	1.7%	20,924.0	20,108.7	-3.9%
Gross Margin	19.6%	17.4%	-11.1%	21.3%	19.2%	-9.5%
Other Operating Income Margin	0.9%	1.0%	13.9%	0.0%	0.0%	
Operating Expenses Margin	12.5%	11.7%	-6.3%	15.3%	16.0%	4.3%
Operating Income Margin	7.9%	6.6%	-15.9%	5.9%	3.3%	-45.1%

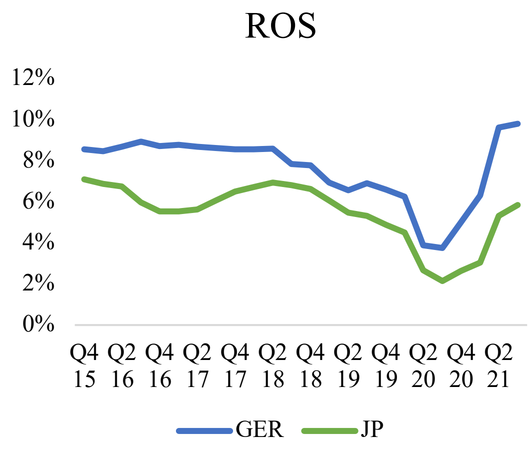
Appendix 8: Results of Independent t-tests

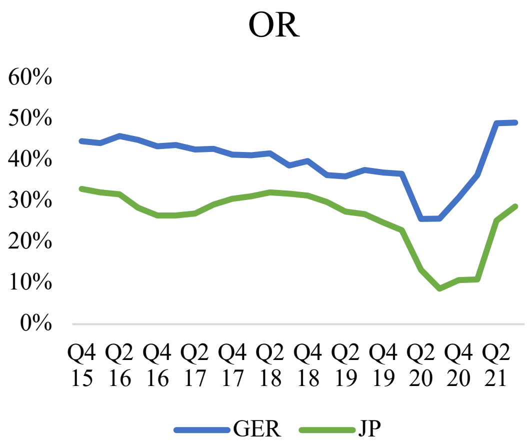
Country		N	Mean	Std. Deviation	p-Value	Significant Difference
ROA	Japan	144	0.051	0.032	0.002	yes
	Germany	72	0.042	0.012		
ROS	Japan	144	0.055	0.032	0.000	yes
	Germany	72	0.076	0.020		
OR	Japan	144	0.259	0.184	0.000	yes
	Germany	72	0.398	0.087		
GPM	Japan	144	0.209	0.042	0.000	yes
	Germany	72	0.190	0.020		
AT	Japan	144	0.980	0.280	0.000	yes
	Germany	72	0.540	0.067		
CCC (Days)	Japan	144	50.705	36.037	0.000	yes
	Germany	72	154.678	16.194		
DSO (Days)	Japan	144	57.266	29.255	0.000	yes
	Germany	72	120.034	15.727		
DIO (Days)	Japan	144	51.086	10.156	0.000	yes
	Germany	72	76.803	9.240		
DPO (Days)	Japan	144	57.647	18.271	0.000	yes
	Germany	72	42.158	3.092		

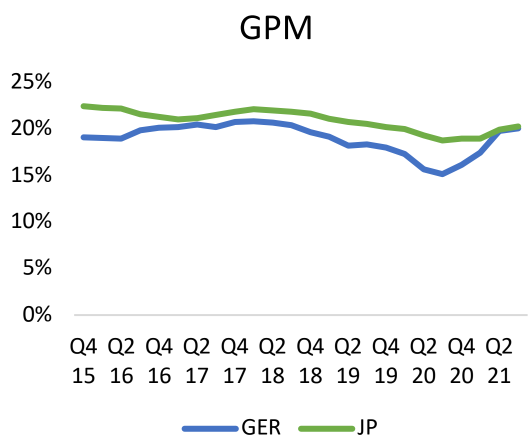
Appendix 9: Evolution of Key Parameters Over Time

Appendix 9.1: Evolution of ROA Components

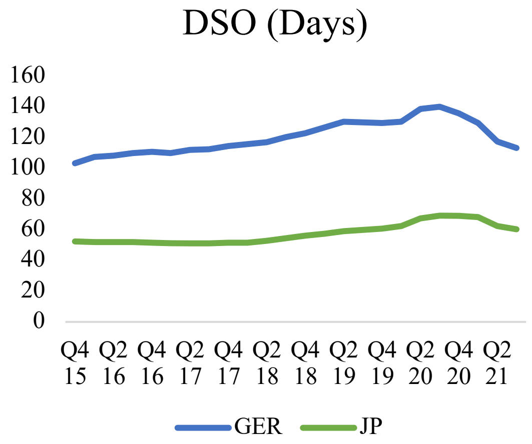


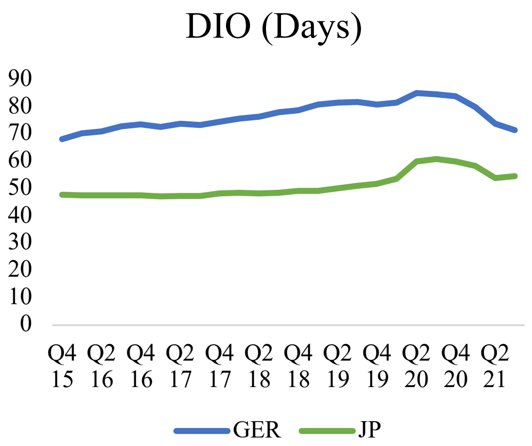


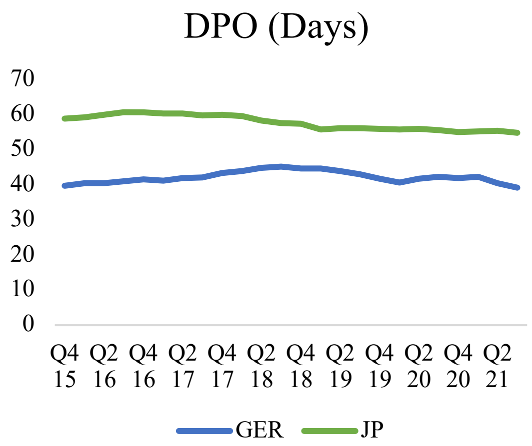




Appendix 9.2: Evolution of CCC Components

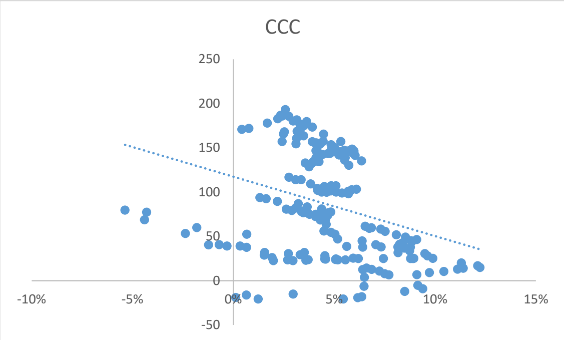


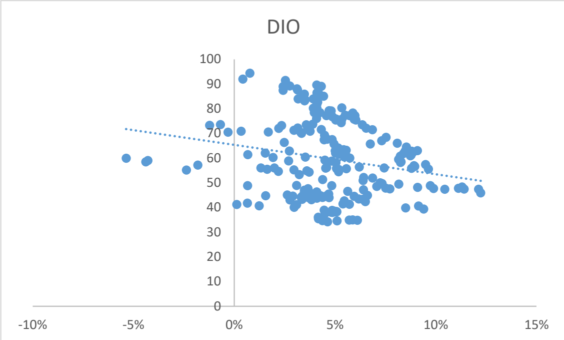


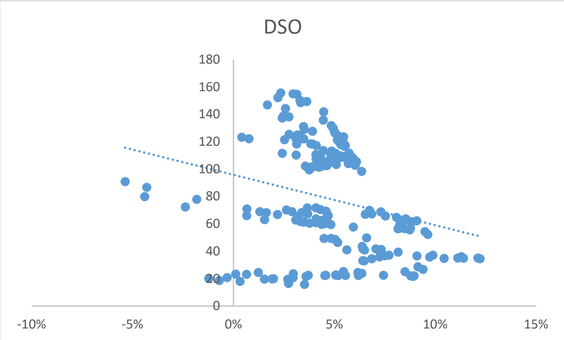


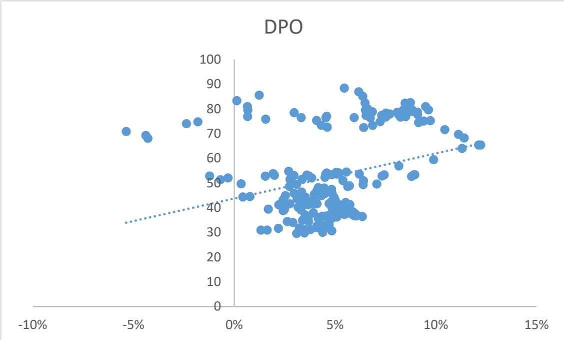
Appendix 10: Scatterplots

Appendix 10.1: Scatterplots of CCC, DSO, DIO, and DPO vs. ROA – Global Sample

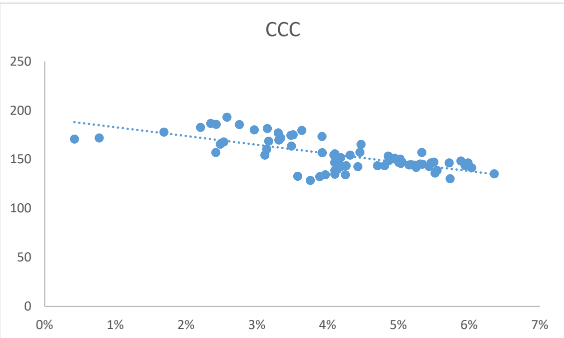


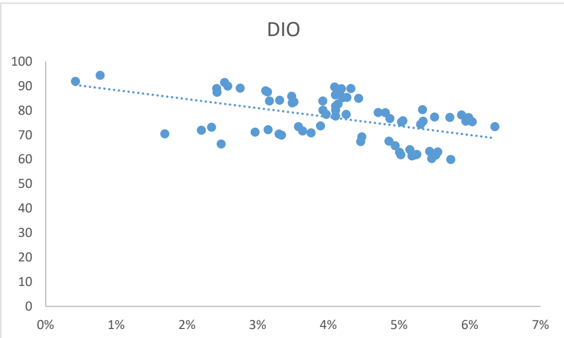


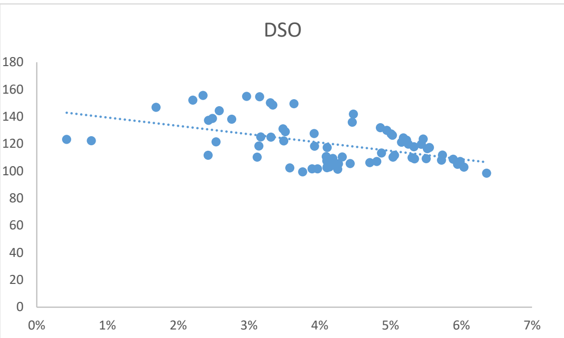


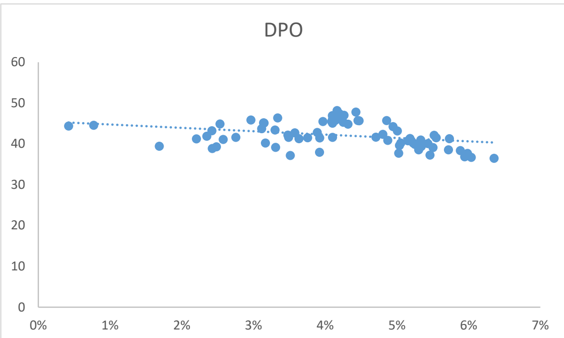


Appendix 10.2: Scatterplots of CCC, DSO, DIO, and DPO vs. ROA – GER

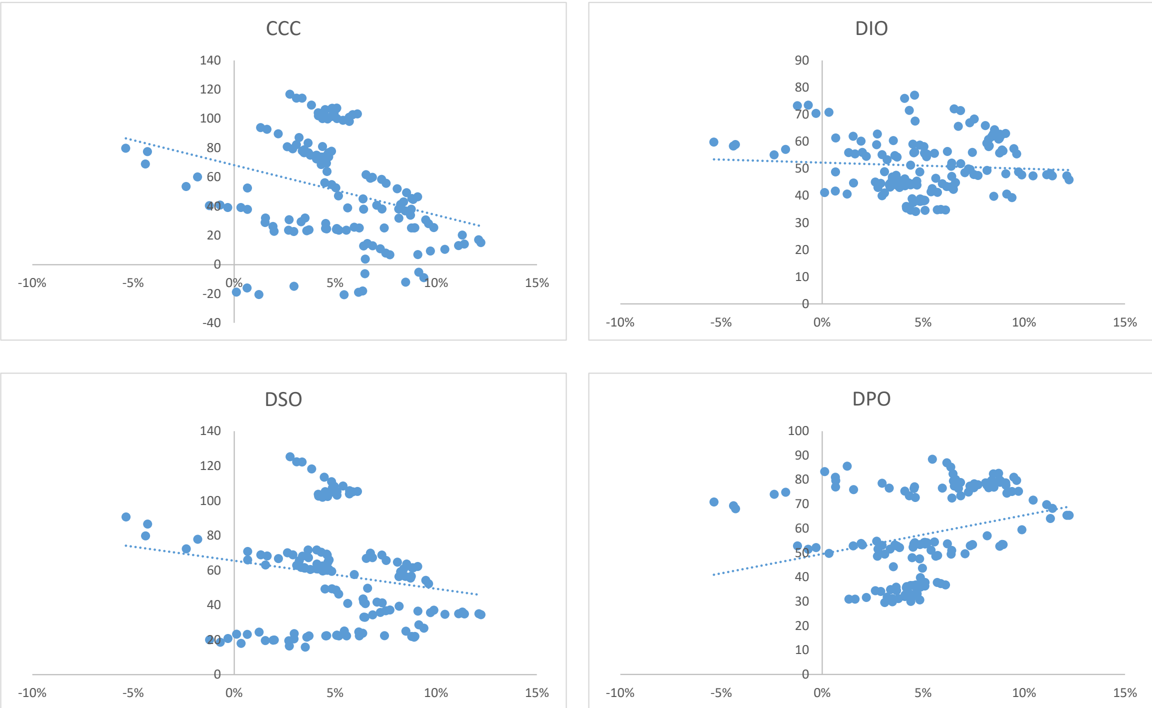




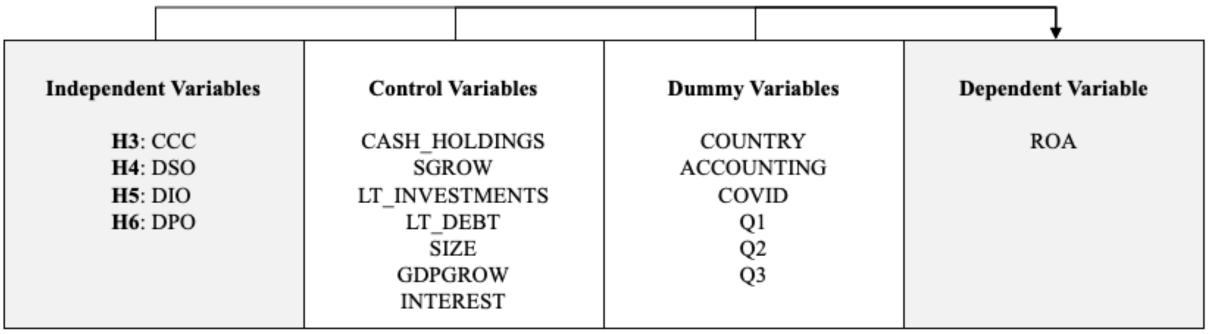




Appendix 10.3: Scatterplots of CCC, DSO, DIO, and DPO .vs ROA – JP



Appendix 11: Regression Model



Appendix 12: Model Assumptions

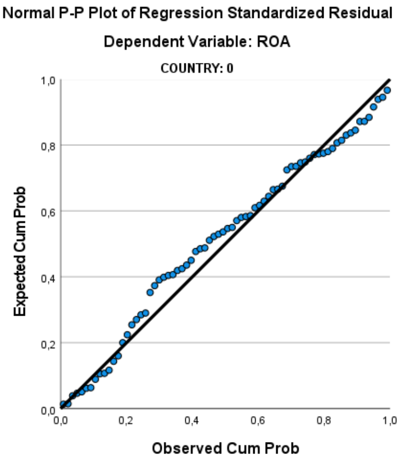
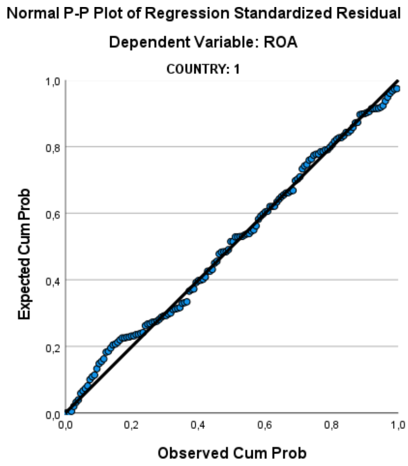
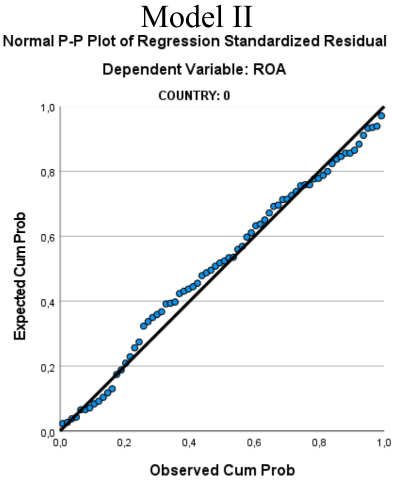
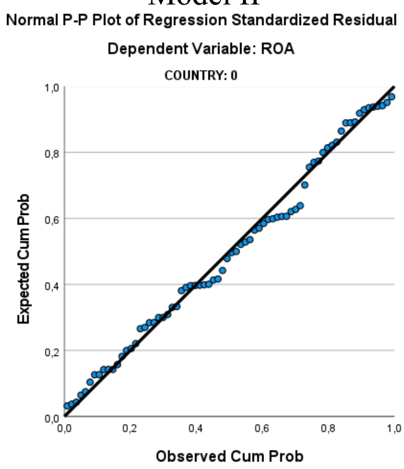
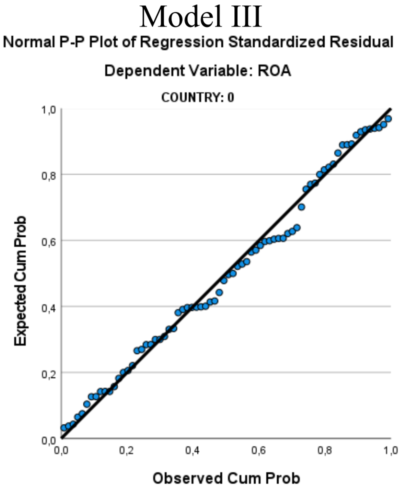
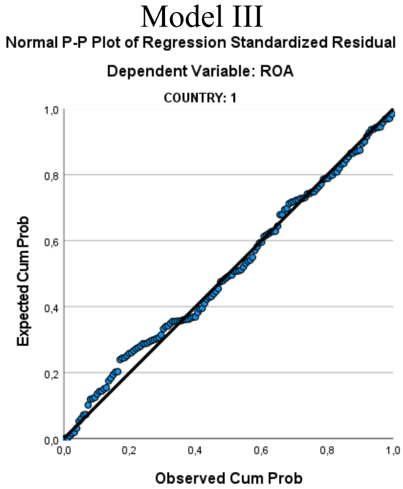
Linearity is assessed using scatterplots. In accordance with Montgomery et al. (2012 pp. 136–138), normality of residuals is assumed if the normal probability plot of residuals follows a straight line without intercept close to the origin. With the sample size of all models exceeding 30 observations, errors are approximately normally distributed (Wooldridge 2016). In accordance with Hayes and Cai (2007 p. 713), the heteroskedasticity-consistent standard error estimator HC3 is used in the OLS regression to account for possible heteroskedasticity. Multicollinearity is tested with the Variation Inflation Factor (VIF). Following Montgomery et al. (2012, p.296), no multicollinearity is assumed if the maximum VIF in a model is below 5. Autocorrelation is assessed with the Durbin-Watson test, which can assume values between 0 and 4. The acceptable values to determine autocorrelation depend on the sample size and the number of independent variables (Montgomery et al. 2012, p. 477). No autocorrelation is assumed if the results lie within the lower and upper bounds of Savin and White (1977, p. 1993).

Appendix 13: Regression Results

Model	I	I	II	II	III	III	IV	IV
Country	**GER**	**JP**	**GER**	**JP**	**GER**	**JP**	**GER**	**JP**
Independent Variables								
CCC	-0.072	-0.025						
	*(0.000)****	*(0.078)**						
DSO			-0.0516	-0.011				
			*(0.000)****	*(0.253)*				
DIO					-0.041	0.153		
					*(0.021)***	*(0.000)****		
DPO							-0.171	0.111
							(0.000)***	(0.000)***
Control Variables								
CASH_HOLDINGS	-0.050	0.081	-0.056	0.089	-0.133	0.269	-0.039	0.114
	(0.291)	*(0.166)*	*(0.349)*	*(0.149)*	*(0.089)**	*(0.000)****	*(0.572)*	*(0.044)***
SGROW	-0.014	-0.018	-0.027	-0.021	-0.026	-0.039	-0.032	-0.026
	(0.407)	(0.317)	(0.162)	(0.246)	(0.242)	(0.031)**	(0.144)	(0.213)
LT_INVESTMENTS	-0.024	0.162	0.1008	0.125	-0.087	0.216	0.045	0.235
	(0.436)	(0.006)***	(0.071)*	(0.012)**	(0.133)	(0.000)***	(0.338)	(0.000)***
LT_DEBT	0.142	-0.202	0.147	-0.230	-0.013	-0.294	-0.011	-0.147
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.676)	(0.000)***	(0.668)	(0.026)**
GDPGROW	0.073	0.132	0.135	0.148	0.146	0.252	0.152	0.192
	(0.151)	(0.404)	(0.070)*	(0.357)	(0.066**)	(0.101)	(0.062)*	(0.226)
INTEREST	0.135	2.983	0.928	3.263	1.089	3.986	1.333	3.361
	(0.655)	(0.188)	(0.009)***	(0.151)	(0.005)	(0.077)*	(0.000)***	(0.118)
Dummy Variables								
COVID	0.138	-2.681	-0.039	-3.051	0.113	-5.207	-0.627	-3.349
	(0.675)	(0.000)***	(0.93)	(0.000)***	(0.802)	(0.000)***	(0.19)	(0.000)***
Q1	-0.249	0.488	-0.306	0.559	-0.371	0.980	-0.282	0.655
	(0.436)	(0.457)	(0.395)	(0.399)	(0.357)	(0.115)	(0.46)	(0.288)
Q2	0.106	0.449	0.346	0.502	0.300	0.621	0.479	0.443
	(0.656)	(0.549)	(0.199)	(0.508)	(0.351)	(0.370)	(0.128)	(0.529)
Q3	-0.187	0.428	-0.120	0.522	-0.268	0.789	-0.10	0.491
	(0.538)	(0.508)	(0.735)	(0.428)	(0.489)	(0.187)	(0.783)	(0.406)
Intercept	13.741	-0.229	1.348	1.309	15.239	-14.0447	9.783	-12.936
R^2	0.802	0.384	0.720	0.371	0.635	0.466	0.681	0.457
ANOVA p-value	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
n	72	144	72	144	72	144	72	144
k	11	11	11	11	11	11	11	11
Durbin Watson Lower Bound	1.131	1.314	1.131	1.314	1.131	1.314	1.131	1.314
Durbin Watson Upper Bound	1.831	1.790	1.831	1.790	1.831	1.790	1.831	1.790
Durbin Watson Result	1.575	1.570	1.671	1.538	1.561	1.436	1.738	1.584
Max. VIF	4.18	4.309	3.493	3.254	2.976	3.977	4.131	4.356

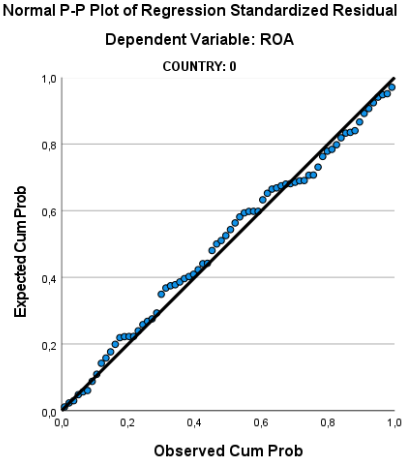
* Correlation is significant at the 0.10 level (2-tailed), ** correlation is significant at the 0.05 level (2-tailed),
*** correlation is significant at the 0.01 level (2-tailed)

Appendix 13.2: P-P Plots per Model

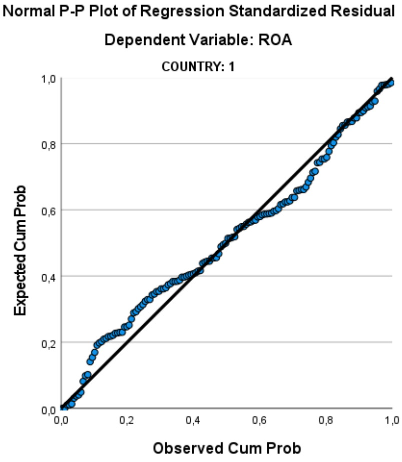
<table>
<tr><th></th><th>GER</th><th>JP</th></tr>
<tr><td>CCC</td><td>Model I
</td><td>Model I
</td></tr>
<tr><td>DSO</td><td>Model II
</td><td>Model II
</td></tr>
<tr><td>DIO</td><td>Model III
</td><td>Model III
</td></tr>
</table>

DPO

Model IV



Model IV

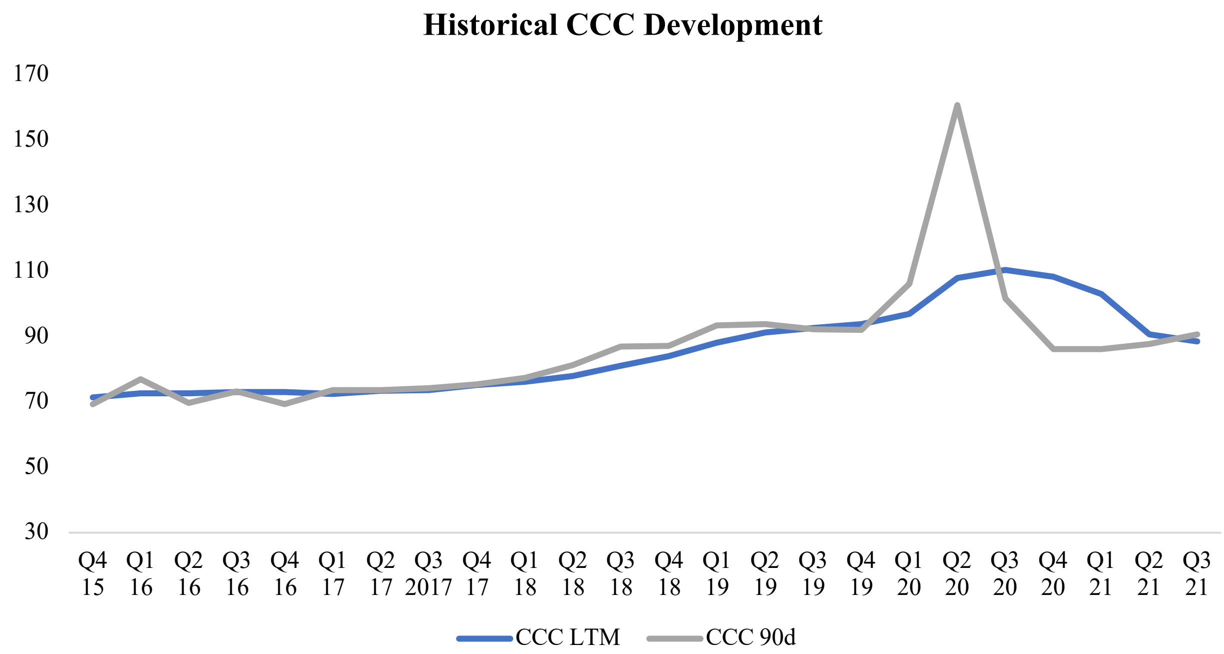


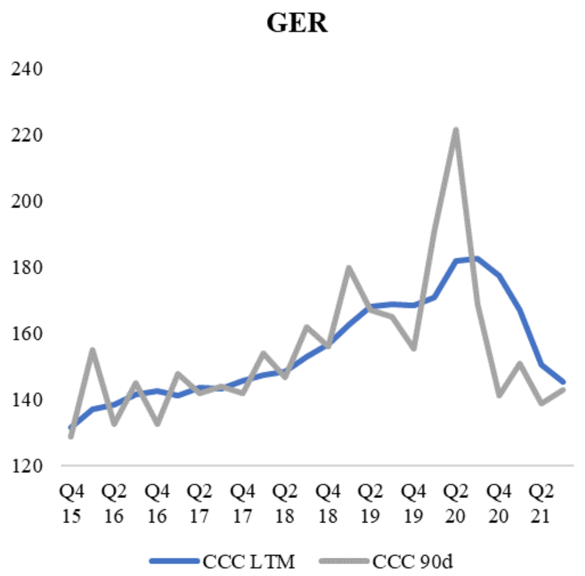
Appendix 14: Corporate Tax Evolution per Country

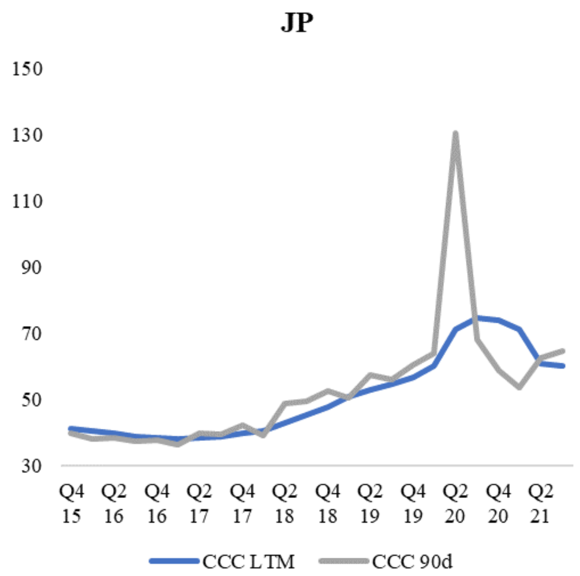
	2015	2016	2017	2018	2019	2020	2021
GER	29.72%	29.72%	29.79%	30.00%	30.00%	30.00%	30.00%
JP	33.86%	30.86%	30.86%	30.86%	30.62%	30.62%	30.62%

Source: KPMG (2021)

Appendix 15: Seasonality Analysis of CCC Development per Country







To investigate seasonality, CCC LTM and CCC 90d were compared. CCC LTM consists of the sum of LTM income statement figures and the average of LTM balance sheet numbers. CCC 90d incorporates only one quarter in which the income statement items are multiplied by four and set into relation with the balance sheet item of the respective quarter.

The visual impression suggests recurring patterns, with the COVID-19 pandemic disrupting the series. Further, it can be perceived that the reporting period seems to impact the CCC-90d level. While the low points in GER happen primarily during the important reporting quarters of Q2 and Q4, the Japanese low marks occur mainly in Q1, the end of the Japanese financial year. This pattern suggests that management tries to lower the CCC for the reporting date, which might be due to the positive perception of a shorter CCC.

The averages of both CCC LTM and CCC 90d were calculated for the four quarters before and during the pandemic to validate the perceived pattern. The CCC 90d figures confirm that the lowest points have historically happened at the end of the financial year, which is Q4 in GER and Q1 in JP. This result proves that analyzing quarterly data helps to mitigate accounting adaptations at the financial year-end.

Subtracting CCC 90d from CCC LTM demonstrates the existence of volatility over the course of the year. To quantify the impact of the pandemic, the volatility of the COVID-19 periods was subtracted from the historical seasonality. While the pandemic seemed to magnify the usual fluctuations of JP, the results for GER are not only stronger in total values but also more dispersed. Note that this is only a preliminary analysis. More data is required for a deeper analysis.

GER Non-COVID	Q1	Q2	Q3	Q4
CCC LTM	147.0	149.6	151.6	148.9
CCC 90d	158.9	147.0	153.9	**142.9**
Seasonality	12.0	-2.6	2.3	-6.0

JP Non-COVID	Q1	Q2	Q3	Q4
CCC LTM	46.0	49.0	50.4	49.6
CCC 90d	**45.5**	62.9	50.0	48.5
Seasonality	-0.5	13.9	-0.4	-1.1

GER COVID	Q1	Q2	Q3	Q4
CCC LTM	169.0	166.1	163.8	177.3
CCC 90d	170.8	180.0	155.9	141.2
Historical Seasonality	12.0	-2.6	2.3	-6.0
COVID Impact	-10.2	16.5	-10.2	-30.0

JP COVID	Q1	Q2	Q3	Q4
CCC LTM	65.6	66.0	67.3	73.9
CCC 90d	58.8	96.4	66.2	58.6
Historical Seasonality	-0.5	13.9	-0.4	-1.1
COVID Impact	-6.3	16.5	-0.7	-14.2

In the next step, quarterly dummies (Q1, Q2, Q3) are used to clarify if the apparent seasonality impacts profitability measured by ROA. The regression results demonstrate that neither in GER nor in JP, seasonality is significantly impacting ROA.

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4,164	,300		13,864	<,001		
	Q1	-,040	,425	-,014	-,095	,924	,667	1,500
	Q2	,019	,425	,007	,044	,965	,667	1,500
	Q3	-,034	,425	-,012	-,079	,937	,667	1,500

a. JAPAN = 0

b. Dependent Variable: ROA

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	5,289	,537		9,855	<,001		
	Q1	-,123	,759	-,017	-,161	,872	,667	1,500
	Q2	-,208	,759	-,028	-,274	,784	,667	1,500
	Q3	-,373	,759	-,051	-,492	,623	,667	1,500

a. JAPAN = 1

b. Dependent Variable: ROA