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The relationship between liquidity and profitability in the automotive industry: A comparison between the electric car market and the traditional one

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ABSTRACT

This Work Project clarifies the relationship between liquidity and profitability, proxied by Return on Assets (ROA). Relying on data retrieved from the consolidated financial statements from the major traditional and electric players in the market, for the years 2015-2019, a negative relationship between the quick ratio and ROA was found in the traditional market and a positive one in the electric market. Cash Conversion Cycle is longer in the traditional market, however ROA shows a negative relationship with DIO and positive with DPO, for both markets. Thus, managers can increase ROA by reducing inventories or increasing the duration of payments.

Keywords Liquidity, Profitability, Automotive industry, Electric car

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1.Introduction

Fast-growing and fast-changing attributes describe the automotive industry for the last several years even though there are new and imminent challenges ahead. Digitalization, globalization and individualization are predominant forces pushing the industry to renovate itself and reimagine their entire business models. These forces even gained a greater purpose fuelled by the increases in safety measures and the voluntary environmental commitments by the automotive industry. The current market needs companies to innovate and find different ways of creating value in order to assure their long-term existence (Jain & Garg, 2007). Electric vehicles arose into life in the mid 19-th-century without being seen as a direct competitor with the traditional automotive industry. However, technical developments and a boosted focus on clean energy originated both their demand and profitability forecasts to skyrocket. Government incentives also have a direct impact on the customers decision since taking the form of tax exemptions and purchase discounts they shape the mind of the consumer into acquiring this so called "new" electrical vehicles (IEA,2020). Recently, government regulations emerged in some countries, that further contribute to the change of paradigm concerning electrical vehicles (IEA, 2020). For example, most of the European governments, in particular the Scandinavian countries, set long term monitoring goals and specific target timeframes related to the level of CO2 emissions and the reduction of the total fleet of internal combustion engine vehicles (IEA,2020).

Thus, this Work Project aims to clarify the relationship between profitability and liquidity in two different segments inside the automotive industry. It adds to the current the literature the way both markets are behaving.

This Work Project proceeds as follows. Section 2 introduces the key concepts for both profitability and liquidity and provides a brief overview of the automotive industry. Section 3 presents the literature review, the vast majority being generic since the studies around this topic

are still quite limited. Section 4 outlines the research questions and describes the model of research and the sample. Section 5 and 6 that present the data analysis for both profitability and liquidity and the results of the multivariate analyses, respectively. Section 7 includes the recommendations and finally Section 8 concludes this Work Project.

2. Key concepts and Contextual Background

Over the history of the automotive industry, all manufacturers proved to quickly adapt to adverse situations creating innovative products to meet the increasing consumer needs. Despite that, the low degree of differentiation inside the industry and high competitiveness have caused companies to keep managers steady and enough liquidity available to tackle eminent cash flow problems of the firm. Aligned with these difficult times it also comes a necessity to manage pricing strategies efficiently to ensure that profitability levels are growing and in line with the organization goals. Due to these conditions of the current automotive market, the key concepts in our research are profitability and liquidity. Thus, it is important to clarify them, in particular how to decompose and quantify the required ratios and metric.

Liquidity indicates the quantity of cash that it is quickly available to ensure that debt payments and investment opportunities are done. It also indicates how fast an asset can be converted into cash. Since the current economic environment, it is characterized by a high degree of uncertainty, it is fundamental to ensure significant liquidity to maintain the operations running efficiently. On the other hand, firms with excess of cash may contribute to the creation of some "agency costs". These costs might influence managers to invest in projects with negative net present value affecting the firm profitability, and as Jensen (1986) explains these costs are more severe when companies accomplish significant cash flows. The liquidity of a company can be measured performing the Cash Conversion Cycle analysis, as well as its liquidity ratios.

The liquidity ratios that were chosen to analyze this specific industry was the Current

ratio, Quick ratio and the Working Capital Turnover ratio allowing an insight into the firm's ability to meet their current obligations. However, these ratios have always been criticized by the absence of information regarding future cash flows (Finnerty, 1993). As Kamath (1989) noticed both the current and quick ratio rely on the use of past information thus transforming their ratios static in the current frame of analysis. Richards & Laughlin (1980) suggested that the Cash Conversion Cycle can be interpreted as a measure of liquidity, transforming liquidity analysis into something more particular when compared to the case of static liquidity ratios.

Profitability is the firm's capacity to create a return on a decision of investment considering a budget in comparison with a substitute investment. It can be defined as the amount of revenues that exceed expenses during a given time frame (absolute measure) or also recurring to relative measures such as financial ratios. Since each industry segment has its own specific characteristics, it is useful to use profitability ratios such as Return on Invested Capital (ROIC), Gross Sales Margin and Return on Assets (ROA). In order to specify which variables are responsible for the ROA variations, it can be decomposed into three ratios, denominated as asset turnover, gross sales margin and operational risk. By performing the breakdown of ROA, it's possible to highlight more accurately the similarities and the dissimilarities between the two different automotive markets (Electric *versus* Traditional). Since no further studies were conducted about the relationship of profitability and liquidity in the automotive market the relationship between both remains dubious.

Related to the industry itself, technological innovations have always been a part of the automotive industry business. Nowadays, the technological advancements allowed us to enter a disruptive era where business models are constantly being challenged and adapted to the contemporary times. As a result of these developments, car manufacturers are facing a decrease in sales worldwide, which amounted to 4% from 2018 to 2019 (OICA,2019). This is associated with a concern in substitute powertrain technology such as hybrid-electric vehicles (HEV) and

battery electric vehicles (BEV). From 2018 to 2019, the traditional car market is slowing in growth expecting the global growth rate to decrease from 3.6% to 2% by 2030 (McKinsey, 2016). This is a wake-up call to all the disrupters who are trying to conquer the new market. Traditional automakers need to innovate and target emerging economies in order to tackle the rise of car sharing and e-hailing.

Despite the clear trend towards automotive markets stagnation across the globe, electric cars sales increased. In 2019 sales of electric cars hit new records reaching 2.6% of global car sales (IEA,2020). This increase was propelled by the infrastructure for charging electric vehicles that saw a staggering increase in charging stations totalizing 7.3 million worldwide (IEA,2020).

3. Literature review

The automotive sector is one of the most important economic facilitators in every country (Orsato and Wells, 2007). The literature concerning the automotive industry is limited. It ranges from a limited scope of financial analysis papers to qualitative studies analysing the differences in ROA and CCC across the different segments of the industry. There are several studies examining the profitability of the automotive industry, covering various periods, different geographies and using diverse variables, proxies, and research methodologies.

Hagen, Hughes-Hallett and Strauch (2013) discovered in their study that ROA isn't the ideal predictor for evaluating the long-term financial stability of a company, but it is accurate in assessing the short-term performance. They also highlighted the vulnerabilities of this ratio due to changes in the financials of a company, mainly changes in revenues from income and assets. Lassala, Apetrei and Sapina (2017) studied the influence of financial performance of companies on sustainability relying their research on financial ratio analysis. Their analysis implied that return on assets it's a significative indicator of sustainability for several companies inside specific industries. Youn and Gu (2010) tried to evaluate the impact of return on assets

on the performance of housing firms in Korea. Their researched made clear that debt and operational costs had the most substantial impact in return on assets.

Research & Development expenses are one of the main factors that turned the automotive industry into such a disruptive market, allowing companies to further develop their new designs and business models. Sougiannis (1994) and Pindado (2010) emphasize that R&D expenses contributes to increase corporate value. Chan (2001) showed how changes in stock prices and market values are positively correlated with new R&D initiatives.

Regarding the effect of working capital management on liquidity as well as profitability, Raheman and Nasir (2007) research showed that a negative relationship is verified between variables of working capital management and profitability of the company. Additional studies also revealed a negative relationship between liquidity and profitability and a positive relationship between profitability and size of the firm. The majority of firms have a significant amount of cash devoted in working capital management, making efficient management and supervision vital to the profitability of the firms (Deloof, 2013). Shin and Soenen (1998) highlighted a strong negative relation between the cash conversion cycle and the profitability for a sample of 68 American listed companies on the New York Stock Exchange. Deloof (2013) also found a relevant negative correlation between Gross operating income and the CCC components Days Sales outstanding, and also Days inventories outstanding. Gill, Biger and Mathur (2010) also reported a very substantial relation between bad performance in collecting accounts receivable and decreased profitability. Mathuva (2009) also tried to clarify the impact of working capital management on profitability with a sample of 30 companies listed in the Nairobi Stock Exchange. This author concluded that it exists a strong relation between stock turnover period and profitability as well as a powerful connection between Days Accounts Payable and profitability.

In the automotive industry, Hallgren and Olhager (2009) stated that the increased

competition, globalization and increasingly demanding customers are all factors that will impact the company's profitability around this sector in the nearly future. Nishi (2011) studied the financial performance on the automotive industry mainly on the passenger and commercial vehicle segments. They concluded that profitability and managerial efficiency are highly associated and the correlation between profitability and liquidity is negative. Neeraj and Kuldip (2016) tried to assess the size and profitability relationship in the automotive market in India. A linear regression model was tested as well as a cross-sectional analysis. Their analyses exhibited a positive relationship between size and profitability on the linear model but cross-sectional showed no relationship between firm size and profitability. Sarbapriya (2012) tried to evaluate the performance of the automotive industry in India relying on indicators such as sales, production and export trend. The conclusions derived from it show the struggling conditions inside the automotive industry highly characteristic for augmented debt burden, low efficiency of assets and liquidity crunch.

Related to the electric vehicle market no research was found concerning the differences in profitability and liquidity between the traditional automotive companies and the new pure electric players in the market, making this research unique. Prior results found in the literature imply that automotive companies can keep building corporate profitability by reducing the number of days accounts receivable and inventories to a pondered minimum. Also, the negative relationship between accounts payable and profitability is as predicted related to the fact of struggling firms waiting longer to pay their bills. However, the relationship between profitability and liquidity remains unclear since the major automotive players of the market find themselves in different maturity stages with all the newcomers associated to the electric market. Trough conducting this research we aim to giving new insights into the relationship between profitability (relying on the ROA ratio) and liquidity (supported by liquidity ratios and CCC).

4. Methodology

4.1 Research Questions and Model of Research

As mentioned in section 3, the relationship between liquidity and profitability is not leading, in the long run, to better performance, and sustainable growth. The contrasting analysis of the traditional automotive companies and the electric automotive companies provides a better response as ROA keeps increasing in the electric market while traditional business shows an overall decrease both on ROA. The methods use in developing the research questions were a correlation matrix (available in the appendix) followed by linear regressions in order to verify the relationships between the mentioned variables. The linear regressions were done in order to test the relationship between ROA and Liquidity and size. An additional regression tested the relationship between R&D expenses and Revenues of the automotive sector. The program used to perform the statistical analysis was SPSS.

RQ 1. *Does Liquidity have a significant relationship with ROA?*

Utilizing the liquidity ratios, it's possible to compare the different size companies and report originally in different currencies. The liquidity ratios chosen for the analysis were the Quick Ratio and Inv/Current Liabilities.

Model 1a.: $ROA = \alpha_{00} + \beta_{11}\, Quick\ Ratio + \beta_{12}\, Inv/Current\ Liabilities$ [1]

Model 1b.:$ROA = \alpha_{00} + \beta_{11}\, Quick\ Ratio + \beta_{12}\, Inv/Current\ Liabilities$ [2]

RQ 2. *Does CCC components have a significant relationship with ROA?*

The relationship between the CCC, and its components, and ROA remain dubious in the automotive industry as it can be seen in the literature review. Moreover, no studies have been made specifically comparing the electric market which emphasizes the importance of the sign

of the relationship. The proxies used related to CCC are Days Sales Outstanding (DSO), Days Payable Outstanding (DPO) and Days Inventory Outstanding (DIO).

$$\text{Model 2: } ROA = \alpha_{20} + \beta_{21} DSO + \beta_{22} DPO + \beta_{23} DIO + \beta_{24} EUR \quad [3]$$

RQ 3. *Does Company size have a significant relationship with ROA?*

In such a disruptive era, where several companies are entering the market which leads to an increased interest in finding out if actual size is positively or negatively related to profitability

$$\text{Model 3: } ROA = \alpha_{40} + \beta_{41} Log\ (Total\ Assets) + \beta_{42} ELE \quad [4]$$

RQ 4. Do *R&D expenses have a significant impact with automotive revenues?*

Heavy investments have been made in the last few years inside the electric car industry and to the better of our knowledge, no studies have yet been made whether such expenses will be translated into actual revenues.

$$\text{Model 4: } REV = \alpha_{30} + \beta_{31} R\&D\ EXP \quad [5]$$

4.2. Sample and Data

A preliminary sample, including 18 large companies from Europe, the United States, and Asia, was taken. Data was retrieved from the firm's websites and SEC filings available on Bloomberg's terminal. The timeframe for analysis considered is from 2015 until 2020, and data was retrieved from the consolidated financial reports of the companies, as of the end of the year. It is worth mention that the year-end for some companies (in particular the Asian companies) differs from the US and Europe, the former begins on the 1st of April and ends on

the 31st of March of the following year.[1]

The 13 automotive companies remaining in the final sample operate in three different continents, what allows to evaluate the overall impact of the EV's around the globe. The sample covers three geographies, the US, Asia, and Europe. Companies based in the US were chosen since it is the most noteworthy automotive in the world behind China. The Asian zone has a noticeable presence in the electric market; however, reports are not always available in English and six Chinese companies were excluded due to lack of English reports. The three major European automotive players keep trying to adjust to change regarding the electric rush. The final sample includes 13 companies. They are the eight biggest automotive industries in the market plus two pure electric vehicle companies.

The final sample comprises 13 companies, two from the US, four from Europe and seven from Asia. In 2019, the most recent year of the analysis, the different between the two markets is evident. Regarding the average annual growth revenue, for the period 2015-2019, increased on average 136% on the electric market and only 11% on the traditional one, when compared to the initial sample in 2015. Aligned with the increase in revenues also the average cost of revenues increased 137% on the electric market and 12% on the traditional one when comparing the final sample with the initial sample in 2015. This trend shows that both markets face different maturity stages and that the emergent electric market showcased an impressive increase in the past few years. In terms of the ratio R&D expenses / Total Sales having in mind that both markets are currently living different parts of the life cycle it's seen as expected that the electric market showcases a higher percentage of the mentioned ratio throughout the time frame of the analysis. In 2019 the ratio was approximately 6,20% showing a growth compared to all years expect for the initial sample that remains higher since some companies of the sample

[1] The 31st December of 2019 in Europe and US is compared to the 31st March of 2020 in Asia, the 31st December of 2015 in Europe and US are compared to the 31st March of 2016 in Asia, onwards

still didn't revealed significant sales motivated by the early phase of expansion. However, it is clear the increase in R&D / Total Revenues in the traditional Market in the past few years. Motivated by the need of tackling competition and ensure that new electric car companies do not steal significant market share, traditional companies are increasing their R&D investments trying to come up with competitive models that will be propelled by their existing strong brand image. During the time frame of the analysis the ratio R&D/ Total Revenues increased from 3,75% in 2015 to 4,32% in 2019.

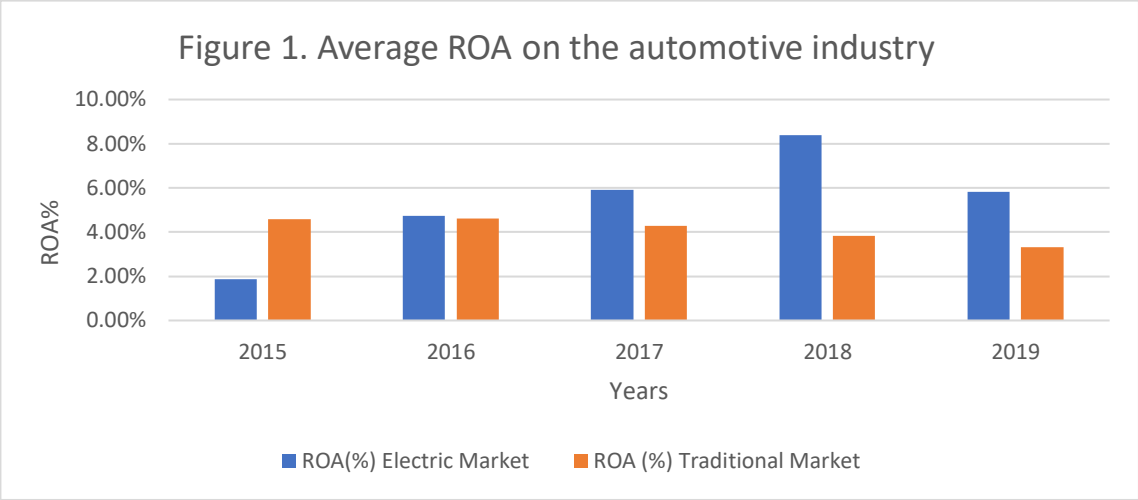
5. Data analysis

5.1 Profitability

To give closer insights into the Electric car companies and the Traditional car companies, a univariate analysis is done, with the calculation of the average, standard deviation, minimum and maximum, for ROA, CCC , Cash Ratio, Current Ratio and Inv/Current liabilities ratio . Considering the final sample, the companies in the Electric market have significant lower average sales, around 9.78% of the Traditional market, motivated by the fact that they are smaller. However, the electric market has been showcasing a tremendous increase since their sales rose by 136% from 2015 to 2020 while the traditional car market only grew 11% also in the same time period, probably explained by the recently established companies integrating the electric segment that are growing more. This major difference in growth can be attributed to the highly innovative electric market and also the heavy investment in R&D that contributes to this tremendous catching up in terms of market share. The overall growth ROA of the automotive industry (4.50 percentage points in 2019/2020) has been decreasing due to the increasing competition of the electric market and also the eminent shock that's going to be provoked by the current Covid-19 pandemic

. However, the average ROA for the electric market from 2015 to 2019 averages 5.3% when compared to the average ROA of 4.1% in the traditional car market.

The increase in the electric car firm's average ROA (3.96 percentage points), between



2015 and 2019, is explained by an increase in Operational Risk (23.06% from 2015 to 2019) and Asset Turnover (13.44% from 2015 to 2019). However, the Gross Sales Margin in the electric market decreased 1.05 % from 2015 to 2019, not offsetting the overall ROA growth of the market. In contrast in the traditional market the drop in the average ROA (-1.56% percentage points) between 2015 and 2019. This drop can be due to a decrease in OR (-7.77% from 2015 to 2019), a decrease in GSM (-1.35% from 2015 to 2019) such as a shrinkage in Asset turnover (-5.46% from 2015 to 2019). Regarding companies size, measured by Total Assets, in the five-year period of analysis the average total assets amounted to 21,346 million Euros and to 254,256 million Euros in the electric car companies and in the traditional market, respectively. Despite the huge difference of average size of total investment (assets) between them, when comparing the years 2015 to 2019, it is observed that a growth of 104% in the electric market and only 23% on the automotive market. Again, this is an indication of the different stages of life cycle the companies in each segment are facing, the traditional ones being more mature companies.

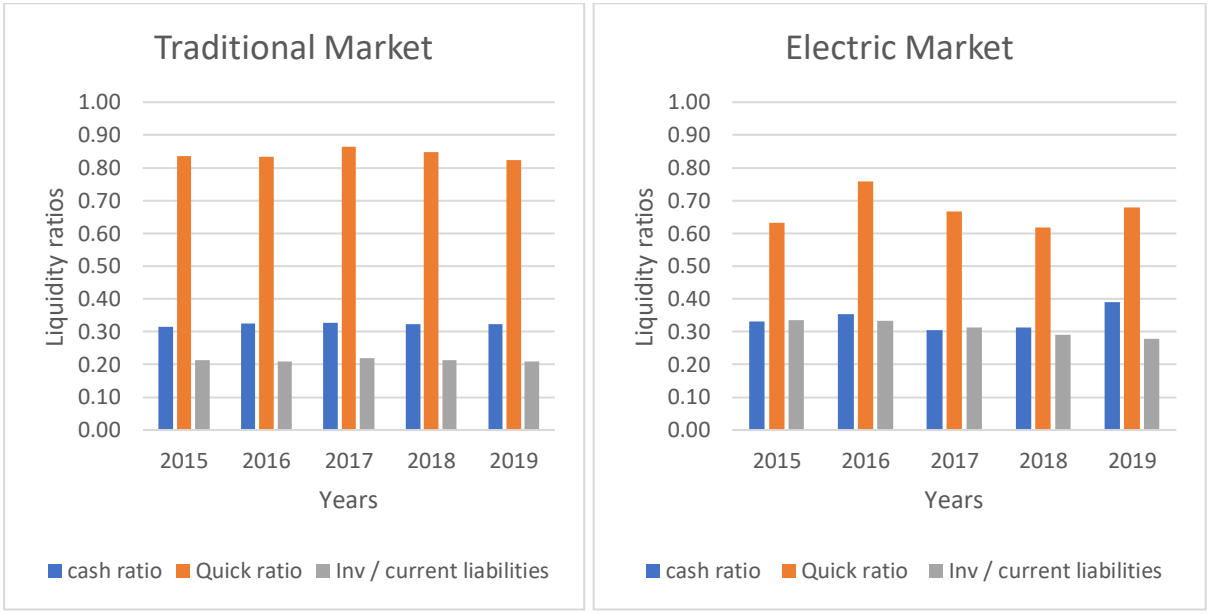
Traditional car companies have the necessity of reinventing themselves by adding value

to their business models mainly by investing in R&D but also keep acquiring and investing in technological companies to propel their business models.

5.2 Liquidity ratios and Cash Conversion Cycle

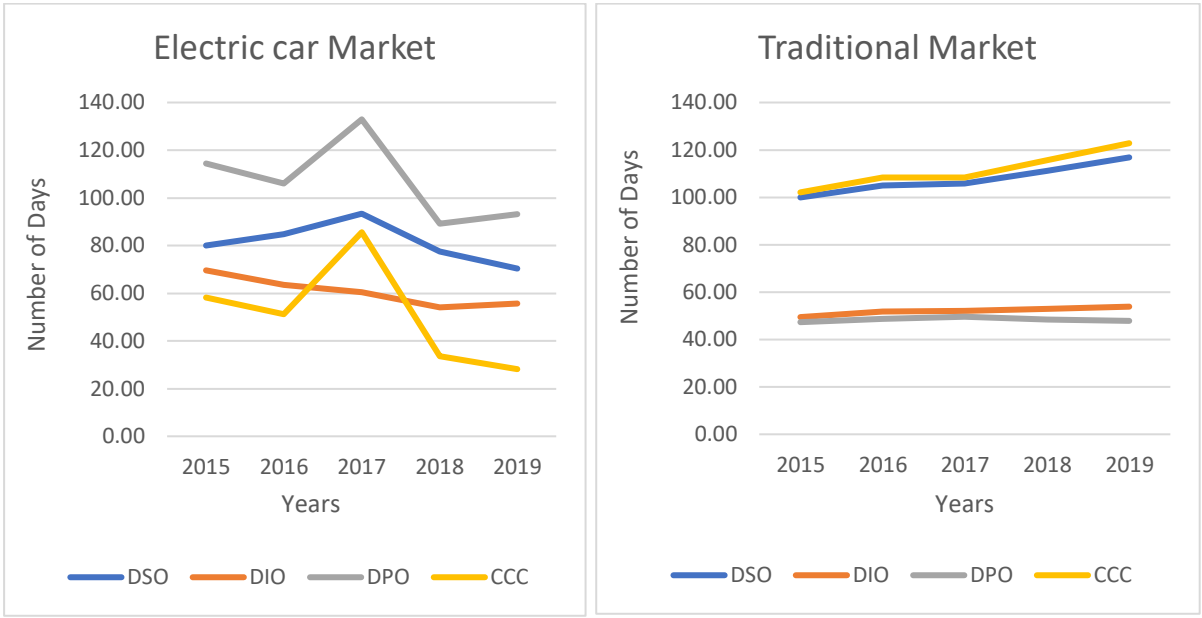
Regarding liquidity ratios, Quick ratio is the one that differs the most between the two automotive markets since the traditional car market has an average quick ratio 17% higher when compared to the electric market, between 2015 and 2019. The liquidity (QR) in the time frame of the analysis remained quite stable in the traditional market declining 1% and increasing 7% in the electric, between 2015 and 2019. This shows that the companies in the electric market have been increasing the possibility of meeting financial obligations with their available resources. Inventories/current liabilities ratio has decreased 17%, while this ratio remained constant in the traditional market when comparing 2015 to 2019. This convergence in the ratios might be explained by the fact that some electric car companies only started selling their cars in 2015.

Figure 2. Average Liquidity Ratios in the Automotive Industry (2015-2020)



Considering the CCC components, DPO, DSO and DIO, the one that differs the most between the EV market and the traditional is DPO. In 2019, the average DPO in the electric market and traditional automotive markets was, respectively, 48 and 100 days. The average DPO has been decreasing over the years in the electrical market which shows increased bargaining power mainly with the battery suppliers. This higher DPO could allow the likes of Tesla to use the excess of cash as a way to potentially invest in short-term activities facilitating the catching up in terms of market-share in the automotive market. Regarding DSO, the average DSO is lower in the electric car market than the conventional one with averages respectively of 81 days and 108 days. Thus, the newly established car manufacturers have been able to collect payment after a sale has been made faster, since most of the times customers' payments occur prior to the delivery of the vehicle. In terms of DIO, both markets relate quite similarly, with respective average DIO of 60 days on the electric car market and 52 days on the regular market. After mentioning all the CCC components it is clear that the average CCC for the two different markets it is significatively lower in the electric car one totalizing 64 days and 111 respectively. Cagle , Campbell and Jones (2013) defined Cash Conversion Cycle as a formula that takes into account time and that solves the disadvantages associated with using the static measures previously mentioned, such as the Quick Ratio.Thus, it's observed that in the electrical market the Cash Conversion Cycle it's lower for the electric market , meaning that electric companies have more liquidity than the traditional car market which can lead them to be better prepared to tackle adverse situations in the market.

Figure 3. Average CCC in the Automotive Industry (2015-2020)



6. Results

Does Liquidity have a significant relationship with ROA? **[Model 1]**

In order to currently assess the differences inside the sample a split file was used dividing the sample into two recurring to a split file (Pure electric vs Hybrid = 0 or 1). After that a correlation matrix was done for both samples. Regarding the (Pure electric vs Hybrid = 0) correlation matrix it was witnessed a positive significant correlation (correlation = 0.565, *p*-value =1%) between ROA and Quick ratio. In contrast, for the (Pure electric vs Hybrid =1) a negative significant correlation was found (correlation = -0.610, *p*-value = 0.0009%) between ROA and Quick ratio. In terms of Inv/Current liabilities the variable isn't significative for the electric market (*p*-value =86.2%) and also for the traditional one (*p*-value = 44.8%). Even if both variables aren't significatively related to ROA, they also show us opposing signs in their non-significant correlations (positive in the electric and negative in the traditional). The variables chosen to be included in the two linear regressions were ROA as a

dependent variable and Quick ratio and Inv/Current liabilities as independent variables.

In Model 1a, R-square = 49.6% meaning that the Quick Ratio and Inv/Current Liabilities significantly explain ROA. In terms of the ANOVA table presents a *p*-value = 0.3% showing us the that the model done is statistically significant. The table of coefficients allows us to observe that Quick ratio is positively related to ROA at a significate level (coefficient = 36.40; *p*-value =0.01%, coefficient = 36,40), which means that if the quick ratio increases profitability goes down. In terms of Inv/current liabilities we can witness that it is negatively related to ROA, at a significative level (coefficient = -26.014; *p*-value =3.3%). This implies that if the levels of Inv/Current Liabilities increase, ROA decreases.

In contrast, in model 1b. both variables have opposite sign relations with ROA. From the table of coefficients, we can see that the Quick ratio is negatively related to ROA at a significative level (p-value =0,001%, coefficient = -3.464) while Inv/ current liabilities demonstrates a positive relation with ROA , even if at a non-significant level(coefficient =2.841; *p*-value =37,9%). These results show us that regarding the significant variable in both models (Quick ratio) we can witness a positive correlation with ROA in the electric market and negative in the traditional market. The results of the traditional market support several studies such as Eljelly (2004) and Pimentel, Braga and Nova (2005) that discovered a significative negative relationship between profitability and liquidity, proxied by the quick ratio .The findings for the electric market are new since there is no previous literature regarding the topic. These findings bring to the companies new behaviors that demand different decisions in terms of liquidity and working capital management .

Table 1. Results for Model 1a. and 1b.
Model 1a: ***ROA = -11.014 + 36.398 Quick Ratio -26.014 Inv/Current liabilities*** **[6]**

Coefficients[a,b]

Model 1a		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-11.014	4.737		-2.325	.033
	Quick ratio	36.398	8.913	.919	4.084	.001
	Inv/ Current liabilities	-26.014	10.637	-.550	-2.446	.026

a. Pure Electric vs Hybrid (0 vs 1) = 0
b. Dependent Variable: ROA (%)

Model 1b: ***ROA = 6.435 - 3.464 Quick Ratio + 2.841 Inv/Current liabilities*** **[7]**

Coefficients[a,b]

Model 1b		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	6.435	.917		7.020	.000
	Quick ratio	-3.464	.690	-.609	-5.023	.000
	Inv/ Current liabilities	2.841	3.197	.108	.889	.379

a. Pure Electric vs Hybrid (0 vs 1) = 1
b. Dependent Variable: ROA (%)

Do CCC, and its component, have a significant relationship with ROA? **[Model 2]**

The correlation matrix presented in Section 4, helped to design the models approach and choose the variables to include in the models to test. Despite the Cash conversion cycle having no significant correlation with ROA (*p*-value = 47%), DIO shows a significant negative correlation (correlation = -0.554; *p*-value = 1%) and DPO shows a significant positive correlation (correlation= 0.390; *p*-value = 1%). DSO shows no significant correlation with ROA (*p*-value =91.5%). In Model 2, ROA is the dependent variable and the three components of the

Cash conversion cycle are the independent variables, namely Days Sales Outstanding (DSO), Days Payable Outstanding (DPO) and Days Inventory outstanding (DIO) are independent variables. Thus, the equation for Model 2 is as follows:

Table 2. Results for Research Question 2

Model 2: ***ROA = 6.801 + 0.001DSO - 0.101 DIO + 0.036 DPO + EUR VS NON-EU*** **[8]**

Coefficients

Model 2	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	6.801	1.859		3.659	.001
DSO	.001	.007	.017	.168	.868
DIO	-.101	.020	-.538	-5.052	.000
DPO	.036	.014	.290	2.674	.010
EUR VS NON_EU	1.680	.826	.214	2.036	.047

a. Dependent Variable: ROA (%)

In Model 2, R- Square = 73% which means that ROA is largely explained by the cash conversion cycle components. Also, the ANOVA table shows a *p*-value = 0.0002% showing that the model is statically significant. From Model 2 it is possible to observe that DSO is positively related to ROA, even if at a non-significance level. In terms of DIO it is possible to see that it is negatively related to ROA, at a significant level (*p*-value = 1%) and its effect turns to be negative (-10.1%). Regarding DPO despite the theoretical perspective suggesting that it should have a negative relation with ROA, it showcases a positive relation with ROA, at a significant level (coefficient =0.036). The findings of Sharma and Kunar (2011) and Deloof (2013) that concluded a significant negative relationship between DIO and ROA. However, regarding DPO the results contradict the previous authors since a significant negative relation was expected since firms who profit less usually take longer to pay their accounts.

The dummy variable Europe vs NON-EU has a positive and significant relationship with ROA (coefficient= 1.680; *p*-value =4.7%), meaning that being a company settled in a European country interferes with the levels of ROA of the industry. These results support our Section 2, where we stated that European firms benefit more than NON-EU in terms of tax benefits and subsides to foster the increase in demand. However, the constant of the model has a significant positive relationship with ROA (coefficient = 6.801; *p*-value =0.1%; coefficient = 6.801) which shows that there are other independent variables not included in the model that are able to explain ROA.

Does Company size have a significant relationship with ROA? **[Model 3]**

Size, proxied by log (Total Assets) was used when testing the relationship with ROA, a linear regression and both and also a dummy variable to capture the effect of companies operating in the electric *versus* traditional car markets. In terms of correlation Log Total Assets presents a negative non-significant correlation (*p*-value=61.2%, correlation = -0.064). Also, there was no correlation with the binary variable Electric vs Hybrid. Based on the linear regression we can notice that only Log (Total Assets) has a negative non-significative relationship with ROA (coefficient =-1.187; *p*-value =61.1%) while the dummy variable shows a positive non-significant relationship (coefficient = 0.043; *p*-value =98.7%). Thus, there is no evidence of significant relationship between ROA and firm size. These results contradict some of the existing literature such as Banchuenvijit (2012) that found a negative significant relationship between firm size and profitability. However, it supports the study carried by Whittington (1980) where no relationship between firm size and ROA was found.

Table 3. Results for Model 3
Model 3:***ROA = 10.433 – 1.187Log (Total Assets) + 0.043Electric vs Hybrid/Traditional*** **[9]**

Coefficients[a]

Model 3		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardize Coefficients Beta	t	Sig.
1	(Constant)	10.443	9.993		1.045	.300
	Pure Electric vs Hybrid (0 vs 1)	.043	2.673	.005	.016	.987
	Log Total Assets	-1.187	2.321	-.168	-.512	.611

a. Dependent Variable: ROA (%)

***Do R&D expenses have a significant impact with automotive revenues*? [Model 4]**

For this research question no split was done between the electric companies and the traditional ones since the purpose was to evaluate the overall impact of R&D expenses regardless of the market. With the increasingly competitive market, R&D expenses are fundamental to assure competitive advantages that might lead to increased sales. Before commenting the model, we can witness a significant positive correlation between the two variables (correlation=0.939 ; *p*-value = 1.1044E-23 %).In model 4 it is present a significant positive relationship between R&D expenses and Revenues automotive (coefficient = 0.04; *p*-value = 18.493). This means that, on average, for every increase of R&D expenses in 1 unit the increase in revenues automotive would be of 18.493.

Table 4. Results for Model 4
Model 4*: **REV = 4736.425 + 18.493 R&D EXP*** **[10]**

Coefficients[a]

Model 4		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	4736.425	6195.781		.764	.448
	R&D expenses	18.493	.943	.939	19.610	.000

a. Dependent Variable: Revenues automotive

7. Discussion

With increased competition and an eminent decrease in the price of electric batteries, the traditional automotive companies should diversify their range of products, more specifically continuing on betting in electric and hybrid vehicles in order to still enter the market at a stage where there are few electric companies fully established and with the required supply chain to efficiently operate. Both markets should keep investing heavily in R&D expenses since the automotive industry is predicted to increase the competitiveness a lot in the upcoming years. That added competitiveness comes associated to the vast number of Initial Public Offerings currently taking place for electric car companies and also the eminent threat of the autonomous vehicles, ridesharing and automated factories. Electric car companies should keep betting on decreasing the price of manufacturing processes in order to decrease the cost of goods sold / total sales and also increase their gross sales margin. In a market where the major upfront cost is the price of the battery would be vital to lower this manufacturing costs in order to lower prices and rely less on government regulations as the ones being currently adopted mainly throughout Europe. Given the enormous upfront costs necessary to develop this new era of the automotive sector it is becoming more common to partner with the competitors so that the technology it's not developed alone. For traditional automotive players it is vital not to fall back in the innovation and follow a long-run mindset, either partnering with former peers or see their cash flows continuing to decrease and electric car makers increasing their revenues even during the current pandemic.

To tackle decreasing ROA percentages players in the automotive industry should give more flexibility to their customers since younger generations hesitate to incur in higher investments. Nowadays, short-term leases have been substituting traditional car sales and represent an opportunity as well to diversify and meet the current customer flexibility. To face the huge instability surrounding the market companies should ensure that they possess a low

CCC to mitigate risk. Electric car companies decided to face the economic breakdown by reinventing their digital strategy by developing new online sales channels. By using this channels and the different purchasing methods companies, electric companies aim to capture a significant part of the predicted increase in customer demand.

Barriers of entry are expected to increase due to the high capital and energy intensive industry that is currently conquering the market. In order to support the entry of the market, companies will need to use disruptive business models and several alliances in order to obtain the needed capital to fund the technological features.

8. Conclusion

This Work Project intended to clarify the relationship between profitability and liquidity in the automotive industry, which has recently seen a reduction in terms of ROA for the traditional market due to the entry on the market of several pure electric companies, that compete for market share. The former was proxied by Return on Assets and the later by Liquidity ratios, Cash conversion cycle and its three components, namely Days sales outstanding, Days inventories outstanding and Days payable outstanding. The research added to the literature insights about the understanding of how and to what extent those variables affect the automotive industry, and so managers can improve profitability through working capital management decisions on liquidity variables. The analysis focused in the electric and traditional car market, and the analysis covered the periods 2015 to 2019. In the traditional car market, a significant negative relationship was found between profitability and liquidity, as proxied by the quick ratio. In contrast, a significative positive relationship between liquidity and profitability was observed in the electric car market. This is probably due to the different maturity stages of the two distinct car markets. Despite the Cash Conversion Cycle doesn't have a direct relationship with ROA for both markets, DIO shows a negative significant relationship with ROA and DPO

shows a positive significant relationship with ROA. In the electric car market higher ROA can be achieved with higher levels of liquidity while traditional car companies can increase their ROA with lower levels of liquidity, these results took into account the quick ratio. Regarding the relationship of ROA with company size it was witnessed no significant relationship between firm size and ROA probably because the companies included in the sample only included the biggest ones inside the automotive sector. Also, R&D expenses are positively related to revenues on the automotive sector which supports the business model of the new electrical companies that as seen have higher ratios of R&D expenses / Total Sales.

These results address managers who should leverage the companies by effectively incur in R&D expenses and differentiate the portfolio always betting on the upcoming technologies that will flood the market in the next years. By further improving the gross margins in the electric industry it will be possible to even challenge more the traditional automakers.

This research has some limitations. The sample includes companies from various countries, and so it contemplates different fiscal years (1st January till 31st December and 1st April till 31st March) which means that some variables weren't considered for that specific period, such as government regulations. Besides that, since some of the initial companies included in the sample didn't have financial reports in English they were excluded from the present sample. Also, the fact that major automotive players of the market find themselves in different maturity stages with all the electric newcomers might affect the results of our analysis. Finally, the different annual reports motivated by the cultural in reporting matters in countries such as China might impact the achieved results. Besides that, it would be interesting to perform a future research related to the Chinese market since the majority of the electric players still operate in that market.

This study only comprises part of the automotive markets, mainly in the electric market most companies still didn't start selling so their financials don't enable us to enter the present

analysis. With the overwhelming growth of the new electric market it could be of added importance to explore the R&D importance in actual revenues since newly established companies are investing heavily. Also, as topic for future research comes the distinct accounting measures since ones use IFRS and others use national accounting standards and that can motivate differences. For example, LIFO is forbidden for the IFRS and accepted in the US GAAP.

Concluding, in these times of economic breakdown it's fundamental that companies should target higher liquidity levels, and so reduce the vulnerabilities and achieve augmented ROA percentages. This can only be achieved by an efficient Working Capital Management.

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Appendix 1. Initial and Final Sample with exclusion reasons

Companies	EUROPE/ASIA/US	EXCLUSION REASONS
TESLA	UNITED STATES	
HYUNDAI	ASIA	
BAIC	ASIA	
DAIMLER	EUROPE	
BMW	EUROPE	
HONDA	ASIA	
VW	EUROPE	
TOYOTA	ASIA	
GM	UNITED STATES	
NISSAN	ASIA	
FCA	CHINA	
BYD	ASIA	
GEELY	ASIA	
Beijing Automotive Industry Holding Corporation	ASIA	Non available English reports
DONGFENG	ASIA	Non available English reports
FODAY	ASIA	Non available English reports
FUKANG	ASIA	Non available English reports
RENAULT	EUROPE	2016 non available accounts

In order to better understand the regression done in the results section above, all the model summaries and ANOVA tables are available in this part of the appendix.

Appendix 2. Model Summary and ANOVA table for Research Question 1

Electric vs Hybrid/Traditional = 0

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.704[b]	.496	.437	4.86785%

a. Pure Electric vs Hybrid (0 vs 1) = 0
b. Predictors: (Constant), Quick ratio, Inv/ Current liabilities

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	396.518	2	198.259	8.367	.003[c]
	Residual	402.831	17	23.696		
	Total	799.349	19			

a. Pure Electric vs Hybrid (0 vs 1) = 0
b. Dependent Variable: ROA (%)
c. Predictors: (Constant), Quick ratio, Inv/ Current liabilities

Electric vs Hybrid/Traditional = 1

1b.

Model Summary[a]

Model 1b.	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.619[b]	.384	.354	1.17087%

a. Pure Electric vs Hybrid (0 vs 1) = 1
b. Predictors: (Constant), Quick ratio, Inv/ Current liabilities

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	35.848	2	17.924	13.074	.000[c]
	Residual	57.580	42	1.371		
	Total	93.428	44			

a. Pure Electric vs Hybrid (0 vs 1) = 1

b. Dependent Variable: ROA (%)

c. Predictors: (Constant), Quick ratio, Inv/ Current liabilities

Appendix 3. Model Summary and ANOVA table for Research Question 2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.658[a]	.433	.392	3.03438%

a. Predictors: (Constant), EUR VS NON_EU, Days Sales Outstanding, Days Inventory Outstanding, Accounts Payable Turnover Day

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	393.699	4	98.425	10.690	.000[b]
	Residual	515.618	56	9.207		
	Total	909.317	60			

a. Dependent Variable: ROA (%)

b. Predictors: (Constant), EUR VS NON_EU, Days Sales Outstanding, Days Inventory Outstanding, Accounts Payable Turnover Days

Appendix 4. Model Summary and ANOVA table for Research Question 3

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.164[a]	.027	-.005	3.78670%

a. Predictors: (Constant), Log Total Assets, Pure Electric vs Hybrid (0 vs 1)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.435	2	12.218	.852	.431[b]
	Residual	889.023	62	14.339		
	Total	913.459	64			

a. Dependent Variable: ROA (%)

Appendix 5. Model Summary and ANOVA table for Research Q4

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.939[a]	.881	.879	28091.21170

a. Predictors: (Constant), R&D expenses

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	303466759586.735	1	303466759586.735	384.565	.000[b]
	Residual	41034041081.316	52	789116174.641		
	Total	344500800668.050	53			

a. Dependent Variable: Revenues automotive

b. Predictors: (Constant), R&D expenses

Appendix 6. Correlations – Research Question number 1

Correlations

		ROA (%)	Inv/ Current liabilities	Quick ratio
ROA (%)	Pearson Correlation	1	.116	-.025
	Sig. (2-tailed)		.359	.841
	N	65	65	65
Inv/ Current liabilities	Pearson Correlation	.116	1	.025
	Sig. (2-tailed)	.359		.846
	N	65	65	65
Quick ratio	Pearson Correlation	-.025	.025	1
	Sig. (2-tailed)	.841	.846	
	N	65	65	65

Appendix 7. Correlations- Research Question number 2

Correlations

		ROA (%)	DIO	DSO	DPO	CCC
ROA(%)	Pearson Correlation	1	-.554**	-.013	.390**	-.094
	Sig. (2-tailed)		.000	.915	.002	.470
	N	65	65	65	61	61
Days Inventory Outstanding	Pearson Correlation	-.554**	1	-.028	-.271*	.085
	Sig. (2-tailed)	.000		.825	.035	.516
	N	65	65	65	61	61
Days Sales Outstanding	Pearson Correlation	-.013	-.028	1	-.168	.928**
	Sig. (2-tailed)	.915	.825		.196	.000
	N	65	65	65	61	61
Accounts Payable Turnover Days	Pearson Correlation	.390**	-.271*	-.168	1	-.276*
	Sig. (2-tailed)	.002	.035	.196		.031
	N	61	61	61	61	61
Cash Conversion Cycle	Pearson Correlation	-.094	.085	.928**	-.276*	1
	Sig. (2-tailed)	.470	.516	.000	.031	
	N	61	61	61	61	61

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

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

Appendix 8. Correlations Research question 3

Correlations

		ROA(%)	Pure Electric vs Hybrid (0 vs 1)	Log Total Assets
ROA(%)	Pearson Correlation	1	-.150	-.164
	Sig. (2-tailed)		.232	.193
	N	65	65	65
Pure Electric vs Hybrid (0 vs 1)	Pearson Correlation	-.150	1	.925**
	Sig. (2-tailed)	.232		.000
	N	65	65	65
Log Total Assets	Pearson Correlation	-.164	.925**	1
	Sig. (2-tailed)	.193	.000	
	N	65	65	65

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

Appendix 9. Correlations Research question 4

Correlations

		R&D expenses	Revenues automotive
R&D expenses	Pearson Correlation	1	.939**
	Sig. (2-tailed)		.000
	N	60	54
Revenues automotive	Pearson Correlation	.939**	1
	Sig. (2-tailed)	.000	
	N	54	59

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