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Working Capital Management and Firm Performance

An empirical study of the relationship between net working capital and firm performance in Europe

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ii. Summary

Considering the magnitude of working capital as a proportion of a firm's total assets, working capital management should interest corporate managers. We will, in our master's thesis, examine if working capital management is value-enhancing. Our methods are based on Aktas et al. (2014) 's study on US firms from 1982 to 2011. In comparison to Aktas et al. (2014), we study the accounting data and stock performance from a sample of 7 725 listed European firms in 15 countries from 2005 to 2021. Previous studies on the subject have found evidence of a negative relationship between net working capital (NWC) and firm performance. The studies suggest that firms should reduce their NWC level to increase firm performance. However, because of differences in NWC level between firms within industries, it is not given whether all corporate managers should decrease investments in NWC. We, therefore, examine the existence of an optimal level of NWC to see if corporate managers can adjust NWC investment to increase profitability and stock returns.

We answer this question by performing regression analyses on different performance measures. Based on our empirical results, we find evidence of the existence of an optimal level of NWC. Our findings show that corporate managers can adjust their NWC level to the optimal level of NWC in their industry to increase profitability. By performing additional tests with different profitability and time horizon measurements, we increase our findings' robustness. In addition, Aktas et al. (2014) also found evidence of an optimal NWC level, which strengthens the conclusion. However, compared to Aktas et al. (2014), our findings report a different effect for firms with positive and negative excess NWC, whereas our results show a stronger effect for firms with positive excess NWC. The results imply that corporate managers with a positive excess NWC level should be especially interested in adjusting the NWC level closer to the optimal level. In contrast to Aktas et al. (2014), we do not find evidence that NWC management can increase stock performance.

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1. Introduction

Working capital management (WCM) is essential for having control of short-term financing and liquidity in firms. In 2020, European firms had a total net working capital (NWC) amounting to €5,5 trillion (PwC, 2021). NWC is defined as inventories and account receivables minus account payables. We observe a decreasing trend in the NWC level to firms, both from our sample and previous research. The negative trend may be explained by previous research that has found evidence of a negative relationship between NWC and firm performance. However, investments in NWC are essential for almost every business, and it is not given that every corporate manager should focus on decreasing the NWC level.

In 2014, Aktas et al. contributed significantly to our understanding of the role of NWC in firms. They conducted a study on US firms from 1982 to 2011, documenting that an optimal level of NWC could be identified. Firms could adjust their investment in NWC to improve their performance, depending on whether they were over or under this optimal level. However, this study was conducted a decade ago and with a sample of US firms. We, therefore, want to examine in our master's thesis whether we can generalize and strengthen the findings of Aktas et al. (2014) by using a sample of European firms with more recent data. We, therefore, study the following question:

Can corporate managers adjust working capital investment towards an optimal level to enhance operating profit and stock performance? Evidence from European listed firms.

We construct a sample based on the countries defined in Morgan Stanley Capital International as Europe, which counts 7725 individual firms from 2005 to 2021. Similar to Aktas et al. (2014), our results report the existence of an optimal NWC level and suggest that corporate managers should increase or decrease the level of NWC to get closer to the optimal level. We also find evidence that the effect of an adjustment towards the optimal level of NWC is especially efficient for firms with positive excess NWC. We perform additional tests to strengthen the robustness of our findings. However, in contrast to Aktas et al. (2014) findings, we do not find evidence that adjustment towards an optimal level can improve stock performance.

2. Previous research

In 2014, Aktas et al. published a study to examine the relationship between working capital management (WCM) and value enhancement, which this master thesis is primarily inspired by. From a sample of listed US firms from 1982 to 2011, they examined the statistical relationship between Net Working Capital level (NWC level) and the value-enhancing measures in Return on Assets (ROA) and excess stock returns. They reported evidence of an optimal level of working capital.

By dividing their sample into industries, defined in Fama French 49 industries classification, they identified the median NWC level within each industry. They calculated the excess NWC level for each firm from the industry median and categorized the firms into two groups, firms with positive and negative excess NWC. The results indicated that firms should converge to the optimal level of NWC, either by increasing or decreasing their NWC level.

Previous studies have discovered a negative relationship between net working capital and firm performance. They indicate that firms should minimize their investment in working capital to increase profitability and firm value. The findings are in line with the well-known standard free cash flow valuation model:

We suppress firm subscripts to simplify notation.

$$FCF_t = NOPAT_t - \Delta NOWC_t - \Delta Fixed\ Assets_t.$$

$$NOPAT_{i,t} = Net\ operating\ profit\ less\ adjusted\ tax\ for\ firm\ i\ during\ period\ t$$

$$\Delta NOWC_t = The\ change\ in\ net\ operating\ working\ capital$$

$$\Delta Fixed\ Assets_t = The\ change\ in\ investments\ in\ long-term\ assets$$

$$WACC = weighted\ average\ cost\ of\ capital$$

Free cash flow valuation:

$$V_t = \sum_{\tau=1}^{\infty} \frac{E_t[FCF_{t+\tau}]}{(1+WACC)^{\tau}}$$

The valuation expression clarifies that investment in working capital affects a firm's valuation. In isolation, an increase in working capital results in lower firm value because the cash flow is reduced. However, we cannot conclude that all corporate managers should reduce investments in working capital to increase firm value. Investments in working capital and long-term assets are made to increase future sales and profit and, as a result, the firm's value. It is, therefore, not given whether a corporate manager should increase or decrease the level of NWC. This is why we, in similarity to Aktas et al. (2014), explore the existence of an optimal level of NWC.

Other supporting literature on the subject is, for example, Shin and Soenen (1998), who studied the relationship between the cash conversion cycle (CCC) and firm profitability for a large sample of American firms from 1975-1994. The results showed a negative relationship and suggested that management should decrease the cash conversion cycle to increase profitability. The cash conversion cycle is calculated from days account receivables plus the number of days inventory minus days account payables (Garcia-Teruel & Solano, 2007). Therefore, research conducted with the CCC variable is comparable to our study with the variable NWC (inventories plus account receivables minus account payables).

Garcia-Teruel and Martinez-Solano (2007) collected data from 8872 SMEs covering 1996-2002 to study the effects of working capital management on profitability. The results implied that businesses could increase their profitability by reducing their firm's number of accounts receivable and inventories. They also found evidence that reducing the cash conversion cycle (CCC) improves the firm's profitability.

Kieschnick, Laplante and Moussawi (2013) empirically studied the correlation between working capital management and shareholders' wealth. The sample consisted of 3786 US public corporations from 1990 to 2006. With the valuation method followed by Faulkender and Wang (2006), they computed excess returns using the characteristics benchmarks and included variables in the regression that may influence the equity returns. Their research showed that an incremental dollar invested in net operating capital is, for the average firm, lower valued by investors than an incremental dollar held in cash. They indicated that corporate managers should reduce investments in NWC.

There have been some previous studies that have looked at the different components of NWC separately. For example, studied Deloof (2006) how days account receivable, days inventories and days accounts payable correlated with gross operating income. Deloof used a sample of

1009 large Belgian non-financial firms from 1992-1996. The results reported that managers could increase the firm profitability by reducing the number of days accounts receivable and inventories (Deloof, 2003).

One argument for splitting up NWC is that the different components of NWC influence the profit and share value differently. For example, can a large inventory reduce supply costs and reduce the risk of stock-outs. Corsten and Gruen (2004) studied the stock-outs effect on customers, with a sample of 71 000 consumers in 29 countries. The results showed that between 21% and 43% of the customers who go to one store will go to another in case of stock-outs (differences between product categories). On the other hand, overinvestments in inventory reduce opportunities to invest in growth initiatives, which can give long-term profitability. A high amount of trade credit may appear from a strategy to increase sales because increased credit time to customers can allow for higher prices and help customer loyalty (Brennan et al. (1988). However, high values of receivables in the balance sheet may also be a sign of bad routines of receivable collection or bad customers. It is also unclear whether a firm should have a high or low amount of accounts payables. A high amount of account payables may indicate poor liquidity and higher financial cost. On the other hand, it can also describe a business with an efficient financing strategy.

Even though inventories, receivables and account payables have different characteristics, we do not separate them when we look at the relationship between NWC and firm performance. The reason is that the components of NWC are fundamentally linked, according to Schiff and Lieber's research (1974.) Using a dynamic optimization model, they found evidence that credit policy and inventory management affect each other over time. When firms lengthen the trade credit time to customers, sales increase, and it is necessary to invest more in inventory. Additional research on the subject is done by Sartoris and Hill (1983). Their study introduced the need for a generalized approach to managing working capital and affecting any firm's whole operating level. It describes a historical situation where cash managers manage cash, credit managers manage receivables, and payables managers manage payables. They conclude that all variables within the working capital should be managed together as working capital management because it can give better control over a firm's liquidity and make it possible to make better short-term financial decisions. In other words, it states the importance of looking at all components of NWC simultaneously. Therefore, in our study, we will also look at NWC jointly. This aligns with previous research by, for example, Aktas et al. (2014) and Kieschnick et al. (2013).

Most of the previous research finds a negative correlation between net working capital and firm performance, suggesting that corporate managers should decrease investments in NWC. However, as discussed above, there can be negative consequences with low NWC, for example, stock-outs due to too low inventory or less customer loyalty and sales due to short account receivable credit time to customers. In addition, late payments of account payables may increase financing costs. We will therefore replicate methods from Aktas et al. (2014) to examine the existence of an optimal NWC level and see if corporate managers can adjust the NWC investments to increase firm performance.

3. Sample construction and empirical methods

3.1 Sample construction

In our master's thesis, we construct a sample based on listed firms in the defined geographic investment zone "Europe" by MSCI (NBIM). The sample includes all firms with available data in the WRDS-Compustat Global database from 2005 to 2021. We have excluded all financial firms identified by SIC code 6000-6999, just as Aktas et al. (2014) did in their study. With these preconditions set, the sample counts 7 725 individual firms with 75 870 firm-to-year observations. As shown in Table 1, our sample consists of between 4333 to 4788 observations per year.

3.1.1 Sample decision

As described in the methods section, this longitudinal study examines data over extended periods. The selected sample is designed to investigate the evolution of the relationship between WCM and value-enhancing performance in a distinct European geographical context, diverging from Aktas et al. (2014), which focused on the US. In our study, we define Europe as our population, the same way that Aktas et al. (2014) defines the US as their population. Within the population, the target population is listed firms since those are the ones for which it is possible to retrieve comparable accounting data. We also, as mentioned, exclude all financial firms, as those firms have another definition of working capital and, therefore, could bias our analyses (Aktas, Croci, & Petmezas, 2014).

The choice of the subject adds academic interest because it can help corporate managers be aware of what impact working capital management has on profitability and share value. By replicating Aktas et al. (2014) methods with a different sample, we can examine Aktas et al. (2014) conclusion of the existence of an optimal NWC level. We construct our sample "Europe" with the same countries as defined in Morgan Stanley Capital International's (MSCI) "investment region" in their definition of the investment universe. This choice of sample is mainly to ensure comparability within the sample on stock performance measures, as MSCI describes. The countries in the sample are then equivalent to the Fama-French European region-based portfolio benchmarks. We, therefore, use the following countries (with number of firms): Austria (86), Belgium (153), Denmark (206), Finland (214), France (922), Germany (899), Greece (249), Ireland (91), Netherlands (229), Norway (387), Portugal (58), Spain (201), Sweden (1068), Switzerland (266), and Great Britain (2196).

3.1.2 Data collection and processing

All data we retrieve for this master's thesis is from secondary sources, which gives the same base for all entities in the sample. As mentioned in the sample decision, we use the WRDS-Compustat Global database as our primary data source, which is the same as in Aktas et al. (2014) and other similar studies. From WRDS, we collect all needed accounting values as described in Appendix 1, including identifying firm, time, and industry code (SIC). In addition, we retrieved data on Total Return and Market Cap from Refinitiv Eikon for stock performance analysis. All data in the study are publicly accessible, making collecting data and replicating the study possible for everyone.

Our data processing approach utilizes the Fama French 49 Industries classification system, using the Standard Industry Classification (SIC). This tool enables us to calculate each industry's annual surplus NWC, allowing for detailed trend analysis across various industries (French, Detail for 49 Industry Portfolios, 2023). We employ the Windsorizing technique at the 1st and 99th percentile level for all variables to ensure a robust and reliable analysis, effectively adjusting the extremal values in ratios and measures without eliminating them (Dixon, 1960). Currency-wise, we maintain the native currency of all data points, except for Market Cap, which is presented in a standardized currency.

3.1.3 IFRS

International Financial Reporting Standards (IFRS) is the common accounting standard in the EU. It was introduced in 2002, and since 2005 it has been the mandatory accounting standard for public firms in the EU to create more transparency and comparability in accounting data across borders. 2005 is also the first year of our sample, mainly because of the implementation of IFRS this year. Almost every firm in the sample uses IFRS as an accounting standard for accounting numbers. The exception is Switzerland, where IFRS is not mandatory for listed firms, but 56% of public firms use the accounting standard (IFRS, 2023).

During our sample period, IFRS has been through changes with new accounting standards. For example, in 2019, the IFRS 16 was implemented, which changed how leasing is handled in financial accounting. With the implementation of IFRS 16, operating leasing is not accounted for anymore as an operating cost. On the other hand, operating leasing is now accounted for as leasing debt and right-to-use assets in the balance sheet. Furthermore, are the annual payments registered as depreciation and interest (IFRS, 2023). IFRS 16 is only one of several changes in the standard, and more will come to make IFRS a more robust and reliable accounting standard. With these changes implied, there are new challenges in using fundamental measures in our analysis. How this is handled will be explained in the methods section.

The different accounting rules between our European sample and Aktas et al. (2014) US sample may explain differences in results. In the US, the accounting standard is the US Generally Accepted Accounting Principles (US GAAP). There are many differences in the specific accounting requirements between IFRS and US GAAP. However, the accounting standards are primarily built on similar concepts an often lead to similar accounting outcomes (Orrell & Perez, 2022).

3.1.4 Limitations in sample construction

In data collection, several firms have missing values on essential variables. Missing values can provide wrong conclusions in the analyses when observations are excluded, and the sample can be less representative.

3.2 Descriptive statistics

3.2.1 NWC level development

Table 1
NWC level and sample size development

Year	Mean	St. Dev	Median	N
2005	17.9 %	37.6 %	16.8 %	4691
2006	15.1 %	47.8 %	17.0 %	4788
2007	14.2 %	51.5 %	17.1 %	4755
2008	15.1 %	51.6 %	16.6 %	4614
2009	12.8 %	60.2 %	15.8 %	4511
2010	13.2 %	59.3 %	15.8 %	4414
2011	13.8 %	54.6 %	15.9 %	4346
2012	13.0 %	53.7 %	15.2 %	4340
2013	11.4 %	65.8 %	14.6 %	4359
2014	10.3 %	72.0 %	14.9 %	4333
2015	7.9 %	89.9 %	14.9 %	4333
2016	8.5 %	84.2 %	15.0 %	4377
2017	6.4 %	90.5 %	14.8 %	4396
2018	2.7 %	119.6 %	15.0 %	4411
2019	7.2 %	92.9 %	14.5 %	4441
2020	9.0 %	91.7 %	14.4 %	4441
2021	13.0 %	62.7 %	15.3 %	4320
Total	11.3 %	72.6 %	15.5 %	75870

Table 1 reports the cross-sectional average and median for the NWC level for the whole study period. The general trend in the median is down from 2005 at 16.8% to the lowest point of 14.4% in 2020 until a slight increase in 2021. The mean and standard deviation vary more during the period. The mean is at its top in 2005 at 17.9% and at its lowest in 2018 at 2.7%. However, the standard deviation varies during the whole period, and it is highest in 2018 at 119.6%, indicating that the mean value is less representative for the whole sample. To further examine the time trend on the NWC level, we do a regression analysis on the average and median values with year as a constant variable. This regression gives a coefficient of -0,0014 with an R^2 at 69% for the median and a coefficient of -0,0064 with an R^2 at 65% for the average, both coefficients are highly significant. The values show a slight decrease in the median but a more significant decrease in the average. The R^2 for both median and average is lower than in Aktas et al. (2014), which may be explained by the fact that our sample consists of 15 different countries, whereas Aktas is based on the US alone. Compared to the measures in Aktas et al. (2014), the median coefficient is smaller in our sample (0,0028 > 0,0014).

Table 2
Development in NWC components

Year	Inventory	Receivables	Payables
2005	7.6 %	17.9 %	10.1 %
2006	7.4 %	18.2 %	10.3 %
2007	7.4 %	18.3 %	10.3 %
2008	7.2 %	17.3 %	10.0 %
2009	7.1 %	16.6 %	9.7 %
2010	7.3 %	16.6 %	10.1 %
2011	7.3 %	16.3 %	9.9 %
2012	7.3 %	16.1 %	9.8 %
2013	6.8 %	16.0 %	10.0 %
2014	7.0 %	15.9 %	10.4 %
2015	7.0 %	15.8 %	10.3 %
2016	7.1 %	16.4 %	10.6 %
2017	6.9 %	16.3 %	10.7 %
2018	7.3 %	16.3 %	10.9 %
2019	7.3 %	15.6 %	10.5 %
2020	8.0 %	15.4 %	10.9 %
2021	8.4 %	16.2 %	11.4 %

By examining the development of components in NWC in Table 2, we see that Inventory and Payables stay relatively stable, with slight changes, during the period. However, receivables decreased from 17.9% to 15.4% from 2005 to 2020. One explanation for the decreasing trend in receivables may come from decreased interest rates in the period, which may give customers less incentive to delay payments as long as possible (ECB, 2023).

Aktas et al. (2014) documented a decreasing trend in the NWC level during the whole sample period. They explained the negative trend due to the implementation of the Just-in-Time (JiT) inventory system. In Aktas et al. (2014), the inventory level stays relatively stable in the overlap period of our studies (2005-2011). Gao (2018) shows that implementing JiT systems in inventory management has increased the cash ratios in firms that successfully implemented the system and that the inventory level has been generally lowered. But, in our sample period, the inventory level has stabilized, which the JiT system may explain (Gao, 2018).

3.2.2 Descriptive statistics in industries

**All bold slope values are statistically significant at a 5% level.*

Table 3	(1) 2005			(2) 2021			(3)Slope	(4)Slope
Industry	Median	Std. Dev.	N	Median	Std. Dev.	N	median	Std. Dev.
Agriculture	13.80 %	72.01 %	23	15.66 %	125.37 %	29	**-0.0025**	**0.0205**
Food Products	16.17 %	36.33 %	128	13.97 %	57.50 %	96	**-0.0012**	**0.0164**
Candy & Soda	14.14 %	15.39 %	11	14.47 %	7.00 %	9	**-0.0005**	**-0.0092**
Beer & Liquor	16.88 %	53.58 %	62	27.63 %	65.11 %	56	**0.0034**	**0.0123**
Tobacco Products	29.59 %	18.70 %	6	19.72 %	11.46 %	5	-0.0006	0.0002
Recreation	29.02 %	18.25 %	32	18.97 %	18.82 %	25	**-0.0066**	-0.0017
Entertainment	4.20 %	38.85 %	160	1.57 %	57.39 %	113	**-0.0013**	**0.0209**
Printing and Publishing	12.03 %	16.82 %	78	8.19 %	20.09 %	52	**-0.0026**	**0.0057**
Consumer Goods	27.35 %	29.34 %	103	23.66 %	33.05 %	79	**-0.0028**	**0.0277**
Apparel	24.32 %	19.49 %	72	20.71 %	15.08 %	54	**-0.0013**	**0.0066**
Healthcare	9.72 %	9.01 %	39	9.58 %	74.33 %	39	**0.0004**	**0.0681**
Medical Equipment	27.06 %	42.47 %	95	30.28 %	73.85 %	155	**0.0008**	**0.0579**
Pharmaceutical Products	14.30 %	70.86 %	193	14.02 %	116.17 %	280	**0.0002**	**0.0862**
Chemicals	21.16 %	33.10 %	104	18.55 %	145.89 %	96	**-0.0011**	**0.0889**
Rubber and Plastic Products	20.78 %	32.22 %	60	18.70 %	11.16 %	39	**0.0005**	**0.0019**
Textiles	33.31 %	32.20 %	54	24.86 %	59.57 %	35	**-0.0041**	**0.0250**
Construction Materials	21.78 %	22.34 %	157	20.36 %	32.36 %	120	**-0.0016**	**0.0054**
Construction	19.62 %	45.19 %	141	18.64 %	62.06 %	143	**-0.0023**	**0.0227**
Steel Works Etc.	24.00 %	19.13 %	77	21.32 %	32.32 %	53	**-0.0032**	**-0.0094**
Fabricated Products	23.89 %	13.00 %	19	26.55 %	22.25 %	15	**0.0019**	**-0.0259**
Machinery	29.59 %	29.12 %	229	31.54 %	45.55 %	222	**-0.0001**	**0.0213**
Electrical Equipment	26.62 %	37.53 %	66	26.59 %	71.36 %	95	**-0.0003**	**0.0191**
Automobiles and Trucks	20.15 %	28.61 %	61	19.27 %	26.35 %	71	**-0.0023**	**-0.0163**
Aircraft	36.61 %	38.96 %	20	40.56 %	20.79 %	22	**-0.0009**	**-0.0202**
Shipbuilding, Railroad Equipment	27.93 %	69.79 %	15	18.19 %	17.73 %	21	**-0.0095**	**-0.0132**
Defence	28.99 %	16.46 %	5	43.18 %	47.93 %	7	**0.0087**	0.0212
Precious Metals	23.59 %	115.88 %	12	5.22 %	150.86 %	20	**-0.0080**	**-0.0184**
Non-Metallic and Industrial Metal	14.29 %	44.10 %	45	10.68 %	101.84 %	49	**-0.0017**	**0.0399**
Coal	9.81 %	9.19 %	9	0.35 %	138.55 %	4	**0.0056**	**0.0532**
Petroleum and Natural gas	9.73 %	57.66 %	115	11.09 %	56.92 %	111	**-0.0003**	**0.0310**
Utilities	9.37 %	20.90 %	94	8.09 %	56.04 %	104	**-0.0005**	**0.0240**
Communication	4.36 %	20.98 %	137	3.36 %	29.82 %	104	**-0.0012**	**0.0171**
Personal Service	9.74 %	22.88 %	48	11.51 %	20.98 %	56	**0.0014**	**-0.0001**
Business Service	14.60 %	25.33 %	375	12.90 %	54.62 %	291	**-0.0012**	**0.0172**
Computer Hardware	20.29 %	17.16 %	55	25.58 %	13.24 %	46	**0.0011**	**0.0126**
Computer Software	17.00 %	32.96 %	652	11.24 %	36.62 %	621	**-0.0042**	**0.0192**
Electronic Equipment	24.93 %	42.51 %	193	25.88 %	42.01 %	179	**0.0006**	**0.0124**
Measuring and Control Equipment	27.91 %	29.65 %	57	26.85 %	35.00 %	72	**-0.0013**	**0.0453**
Business Supplies	21.09 %	11.08 %	70	17.36 %	68.78 %	45	**-0.0028**	**0.0304**
Shipping Containers	21.39 %	25.96 %	16	16.41 %	9.30 %	14	**-0.0010**	**-0.0004**
Transportation	3.74 %	33.04 %	196	4.36 %	35.13 %	155	**0.0003**	**0.0118**
Wholesale	15.48 %	30.96 %	187	16.14 %	19.96 %	145	**-0.0010**	**-0.0212**
Retail	9.27 %	33.07 %	212	7.78 %	30.69 %	195	**-0.0017**	**0.0030**
Restaurants, Hotels, Motels	-0.66 %	16.02 %	93	-4.06 %	58.27 %	63	**-0.0008**	**0.0397**
Almost Nothing	16.54 %	46.05 %	110	14.88 %	86.62 %	108	**-0.0007**	**0.0392**
Total	***16.8 %***	***37.3 %***	***4686***	***15.3 %***	***62.7 %***	***4313***		

Table 3 shows the NWC level median for the first and last year of our sample by industry. The first columns 1 & 2 show the measures for 2005 and 2021. We see that there are differences between the industries and that several industries' NWC level median has changed from 2005 to 2021. For example, Aircraft had the highest NWC level in 2005, with 36,61%, but in 2021 the ratio was 40,56%. The highest ratio in 2021 was the Defence industry at 43,18%, a significant increase from 28,99% in 2005. The standard deviation measures the dispersion of the data relative to the mean for each industry, and N shows how many firms were in the industry that specific year. We can see that the industries of Computer Software, Business Service and Pharmaceutical Products are the largest industries in number of firms, with 621, 291 and 280 individual firms in 2021. Moreover, Coal and Tobacco Products are the smallest, with 4 and 5 individual firms each. For those small industries, the median may be less representative of how an ideal NWC level could be when the excess NWC level is calculated within each industry.

In addition to the median and standard deviation descriptive statistics, we report the slope for the median and standard deviation in columns 3 & 4 to show the development for the whole study period. For most industries, there is a decreasing trend with negative slopes. For example, Computer Software and Shipbuilding, Railroad Equipment, with slopes at -0,0042 and -0,0095. However, compared to Aktas et al. (2014), our sample reports several industries with positive slopes, whereas Aktas et al. (2014) only reported a small number of positive slopes. For example, Defence and Coal with slopes of 0,0087 and 0,0056, which were industries with negative slopes in Aktas et al. (2014). Studying the standard deviation for each industry shows differences within the same industries, and the slope for the standard deviation shows that the differences are increasing for most industries in our sample. The industries with the most outstanding slope values are Chemicals and Pharmaceuticals products, with slope values of 0,0889 and 0,0862.

3.2.3 Summary statistics

In the table below, we report a summary of the different characteristics of the variables in our sample. Q1 and Q3 refer to the first and third quartiles. From the table, we observe a median NWC level of 15.51% which is lower than the 18.59% Aktas et al. (2014) reported. As discussed previously, it has been a declining trend in the NWC level, and our sample is from a later period. An interesting observation from the summery statistics is the standard deviation to the excess NWC of 71.91%. The excess NWC is calculated from the industry median NWC level. The high standard deviation value shows that it may be misleading to give general advice to corporate managers on the relationship between NWC and firm performance because firms with differences in NWC level probably have a different effect of a change in NWC. By replicating Aktas et al. (2014) methods, we consider that corporate managers may have different NWC strategies based on the firm's level of NWC. We will explain our methods further in the next section.

Table 4
Summary statistics
The table reports different characteristics of the variables in our sample.

Stats	Mean	Median	Q1	Q3	St. Dev.	N
NWC level	11,34 %	15,51 %	4,89 %	27,33 %	72,60 %	75870
Excess NWC	-4,25 %	0,00 %	-8,12 %	9,30 %	71,91 %	75870
Excess return	13,28 %	-6,12 %	-31,91 %	21,65 %	1702,04 %	68977
ROA	0,45 %	7,47 %	-1,13 %	12,72 %	27,69 %	80023
Profit margin	-99,11 %	8,58 %	1,36 %	16,35 %	642,63 %	75857
Risk	12,88 %	2,68 %	1,85 %	4,29 %	101,24 %	66869
R&D	2,94 %	0,00 %	0,00 %	1,55 %	8,07 %	80525
Cash flow	-78,12 %	6,35 %	-0,68 %	13,85 %	507,94 %	73364
Fixed Assets growth	22,44 %	2,42 %	-0,48 %	13,21 %	101,39 %	80525
Sales growth	22,63 %	5,81 %	-4,77 %	20,26 %	101,50 %	75411
Intangible assets	19,45 %	10,91 %	1,35 %	31,72 %	21,70 %	79676
Leverage	56,04 %	54,91 %	35,89 %	70,84 %	33,21 %	80322
Book-to-market	0,76	0,52	0,26	0,96	1,05	67707
Cash	15,80 %	9,18 %	3,82 %	19,99 %	18,51 %	79026
Financial distress	5,51 %	0,00 %	0,00 %	0,00 %	22,81 %	80525

3.3 Empirical Methods

3.3.1 Research design

We have chosen to use a deductive approach to answer our research question. By using a deductive approach, we can examine already established theories from, for example, Aktas et al. (2014) and Kieschnick et al. (2013). The study's purpose is mainly explanatory, as we are trying to study relationships as defined in our research question. In addition, we use simple descriptive analyses in the sample description, but with the primary purpose of giving a picture of how the development in our main variables has been for the last years, with possible explanations on why.

3.3.2 Independent variable of interest

In the profitability and firm value analysis, we use excess working capital as the independent variable of interest. As mentioned earlier, we define net working capital as follows,

$$NWC_{i,t} = inventory_{i,t} + receivables_{i,t} - account\ payables_{i,t}$$

As we see in Table 3, the level of working capital is different for each industry. Therefore, we control for industry-specific characteristics when we estimate the excess NWC. To calculate the excess NWC, we first find each industry's median NWC level. We categorize each industry by Fama-French 49-industry classification and remove financial institutions from the sample. We subtract the industry-median NWC level from each firm's ratio to find the excess NWC to the respective firm. In other words, we use the following equation, equal to Aktas et al. (2014):

$$Excess\ NWC\ firm\ i\ = NWC\ to\ sales\ ratio\ firm\ i - \ industry\ median\ adjustet\ NWC\ to\ sales\ ratio$$

Inspired by Aktas et al. (2014), this method assumes that the industry-median NWC level is the most efficient NWC level for a firm. A firm with positive excess NWC has a higher NWC level than the median firm in the same industry, and it may indicate that the firm is overinvesting in working capital. On the other hand, a negative excess NWC indicates an aggressive inventory and account receivables collection strategy.

3.3.3 Dependent variable

Profitability analysis

In the first part of the research, we look at the relationship between firms' excess NWC and profitability. Prior literature uses return on assets (ROA) to estimate profitability. For example, did Garcia-Teruel and Martinez-Solano (2007) divide earnings before interest and tax by assets as a profitability measurement, and Aktas et al. (2014) used operating income before depreciation divided by total assets.

In our research, we use EBITDA (earnings before interest, taxes, depreciation, and amortization) as a measurement for return. The main reason is the similarity to operating income before depreciation, which Aktas et al. (2014) use in their research. Because we had insufficient data for the operating income of each company, we could not use the exact same measurement as Aktas et al. (2014). However, we believe the differences between the two measurements are small, and some will argue that the operating income before depreciation is equivalent to EBITDA for most firms.

Another reason to use EBITDA as a return measurement is that capital expenditures (and then depreciation) can be discretionary and give a wrong picture of a firm's current profitability. For example, capital expenditures to a firm can occur from investments in future growth and not in sustaining present business. Therefore, firms with high investments in future growth will also have higher depreciations, which may give a misleading picture of the present profitability when we use, for example, net income or EBIT. In addition, there are some flexibility and discretionary options when a firm estimates its depreciation and amortization. By excluding depreciation and amortization in profitability measurement, we reduce this variation among firms and may get a more correct view of the present profitability. Plenborg and Kinserdal (2020) point out that the criticism of using accrual-based performance measures is that accruals can be manipulated due to arbitrary cost allocation, alternative accounting policies, and accounting estimates. In addition, it ignores the time value of money (Plenborg & Kinserdal, 2020). However, it is important to highlight that since we have a large sample and timeframe, the consequences of year-to-year flexibility in accounting have a smaller impact on the results.

Investments and financial costs may represent a great part of a firm's overall costs, depending on the industry and risk profile. Judging whether a company is profitable can be misleading by only looking at the EBITDA. Consequently, we did an additional test with net income as a return estimate (Appendix 2). Both methods reported similar results and were in line with our conclusion.

On the one hand, ROA is a good way to compare the profitability of firms because it measures how efficiently a company is using their assets. Moreover, in contrast to return on equity, ROA factors in the company's debt. On the other hand, there are some disadvantages to using ROA to estimate profitability because of the accounting rules. One example is the IFRS 3 Business Combinations standard, which outlines the accounting when a company acquires control of another business. In most of these situations, assets acquired and liabilities assumed are required to be measured at fair value. Therefore, the acquirer must estimate the value of the different assets to the acquired company even though the assets are not in the accounts of the acquired company. Examples of such assets are brand name, research, and goodwill. Consequently, firms that have acquired other firms with a low book-to-market level (ex., consulting businesses) will have more assets in their accounts than those that have not acquired any firms, even though the brand names' and other assets' value may be the same. As a result, the ROA for firms with an acquisition strategy is lower and can give an unfair picture of profitability.

Another disadvantage of ROA is the change in accounting rules that affect the ratio without any other underlying change. One example is the implementation of IFRS 16 Leases in January 2019. The new standard requires all lease agreements to be recognized as assets and liabilities unless the lease term is one year or less or if the asset has a low value. This greatly impacts income statements and balance sheets for firms with many operational lease agreements, such as airline and retail firms (Deloitte, u.d.). Deloitte (2019) researched a sample of 75 JSE (Johannesburg Stock Exchange) listed firms to look at how firms will be affected by IFRS 16. The results implied an increase in net debt by approximately 16 % (18 out of 75 firms increased their net debt by more than 50%). In addition, the increase in EBITDA was 10% (Khan & MCPhee, 2019). It is time demanding to adjust for the effects of IFRS 16 for every company; therefore, we analyze the data before 2019 and IFRS 16 (Appendix 3), in addition to the whole period (2005 to 2021). We did not find any significant differences.

Because of the limitations of ROA as a measurement of profitability, we conduct an additional regression where we use EBITDA-margin as a measurement of profitability (EBITDA divided by sales) to check the robustness of our findings. Plenborg and Kinserdal (2020) discuss accounting flexibility, and they write about less accounting flexibility in revenue than in the balance sheet. However, we report some extreme values of the profit margin to firms, and therefore the standard deviation to the profit margin is 642,63% (see table 5), and the mean to firms with negative excess NWC is -164,04% (see table 6). The extreme values will make some noise in the regressions, but we maintain the winsorization of the variable at the 1st and 99th percentiles and reports the results in the appendix (Appendix 4).

Stock performance

In the second part of the research, we analyze the relationship between NWC and firm value, using the excess stock return as the dependent variable. Equivalent to previous research on the subject, we define excess return as the realized return of a firm's stock during the fiscal year t and subtract it with a risk-adjusted benchmark portfolio.

$$Excess\ return_{i,t} = r_{i,t} - R_t^T$$

Following Daniel & Titma (1997) and Aktas et al. (2014), the risk-adjusted benchmark portfolio is a value-weighted portfolio that are made by sorting stocks on size (ME) and book-to-market characteristics. The reason for the benchmark is the research of Fama and French (1992), where they concluded that two variables, market equity and the book-to-market equity ratio, capture most of the average stock returns. This means that if all stock prices are priced rationally and correctly, the differences in average stock returns must come from differences in risk. Therefore, the variables for size (ME) and book-to-market (BE/ME) must represent some common risk factors in return if the market is rationally priced (Fama & French, 1995). As a result, we distribute our sample into different groups of benchmark portfolios based on ME and BE/ME when we calculate the excess returns. But in contrast to Daniel & Titma (1997) and Aktas et al. (2014), we use the six Fama-French European portfolios instead of the global twenty-five Fama-French value-weighted portfolios. The countries included in the European benchmark portfolio are the same countries we use in the sample (Description of Fama/French European Factors and Portfolios, u.d.).

3.3.4 Control variables

We include control variables based on previous research to control for other variables that may influence investments in NWC, profitability and firm value. The research done by Schiff and Lieber (1974), Sartoris and Hill (1983), and Kim and Chung (1990) all conclude that it is more valuable to invest in NWC if the firm expects future sales to grow. This expectation is intuitive because most firms need to have a product in stock to sell it. Consequently, we expect firms with higher expected sales growth to have higher investments in NWC. It is difficult to know the expected sales growth, but following Hill et al. (2010), we use the 1-year sales growth rate $\frac{Sale_t - Sale_{t-1}}{Sale_{t-1}}$ as an estimate. In addition to sales growth, Hill et al. (2010) argued for using sales volatility as a control variable. This is intuitive because firms with high fluctuations in sales may need more stock on hand, which increases the level of NWC. However, we lose a lot of data because sales volatility is calculated from a firm's sales over a five-year period in the research of Aktas et al. (2014). We, therefore, exclude this control variable in the regression. In addition, the sales volatility control variable is less relevant when we look at NWC separately for each industry since firms in each industry have similar sales volatility. Furthermore, Aktas et al. (2014) reported that the sales volatility control variable is not statistically significant in the stock performance regression.

Hill et al. (2010) also argued for using cash flow and financial distress as control variables, which have previously been reported to influence stock performance. Aktas et al. (2014) used a cash flow ratio, defined as operating income before extraordinary items plus depreciation scaled by lagged fixed assets. Because our data set has missing data on operating income for each firm, we decided to use EBITDA as a proxy for operating income before extraordinary items plus depreciation. We do not include this control variable in the profitability analyses because of the similarity to the independent variable of interest.

The control variable for financial distress is constructed as a dummy variable. Following Hill et al. (2010), a company is financially distressed if it has problems with covering its interest expenses and if the firm has too much leverage. They defined a financially distressed firm as a firm with an interest coverage ratio below one for two consecutive years or less than 0.8 for any year. In addition, a firm is defined as overleveraged if it is among the top two deciles of overleveraged firms in their industry in any given year. Both criteria must be met before a firm is financially distressed.

Another control variable we use is cash reserves as a percentage of total assets; this control variable is based on Bates, Kahle, & Stulz (2009) research, where they found evidence of a substitution effect between cash reserves and working capital. They argued that the components of working capital could be converted into cash relatively quickly and, therefore, can the cash level influence the NWC level.

We also use other control variables to help isolate the relationship between the independent and dependent variables and reduce the risk of omitted variable bias. We include the same control variables as Aktas et al. (2014), which are based on previous research from Kieschnick, Laplante, & Moussawi (2013), Coles, Daniel, & Naveen (2008), Duchin, Matsusaka, & Ozbas (2010) and Cooper, Gulen, & Schill (2008). As discussed above in the excess stock return paragraph, Fama and French (1992) found evidence that a firm's market value of equity influences the excess return and is, therefore, an essential control variable to include. We also include a control variable for risk by calculating the standard deviation of daily stock returns. The standard deviation is annualized in the regression analysis.

Another control variable is the fixed asset growth rate, which Lipson et al. (2011) argue is linked to stock performance. Because the components of NWC are included in total assets, we look at the growth in fixed assets. We also set intangible assets (as a percentage of total assets) and R&D expenses (as a percentage of total assets) as control variables based on Chan, Lakonishok, & Sougiannis (2001) research. They reported evidence that firms with high research and development costs to equity market value earn large returns. Ozdagli (2012) found evidence that financial leverage influences stock returns beyond the standard Modigliani-Miller paradigm and argues that market leverage explains a major part of the value premium compared to operating leverage and investment irreversibility. We, therefore, have a last control variable, leverage (total debt divided by total assets).

3.3.5 Regression equations

To find the linear relationship between the profitability of the firm and the excess NWC, we use the following formula:

$$ROA_{i,t} = \alpha_t + \eta_i + \beta_1 Excess\ NWC_{(i,t-1)} + \beta_2 Controls_{i,t-1} + \varepsilon_{(i,t)}$$

Where ROA is the EBITDA divided by the total assets, and α_t and $\varepsilon_{(i,t)}$ are the year and firm fixed effects. In the section below, we will explain our findings that made us use fixed effects. A positive β_1 coefficient indicates that an increase in excess NWC is related to an increase in profitability. Controls describe all the different control variables that we described above. Both the excess NWC and control variables are lagged by one year to see the effect on profitability by the previous year's excess NWC, sales growth, cash reserves etc., equivalent to what Aktas et al. (2014) and previous research have done. We control indirectly for specific industries' effects by calculating the excess NWC from the industry median NWC level, as explained above. To reduce extreme values' effect on the results, we winsorize all variables at the 1st and 99th percentiles.

To discuss our research question of an optimal NWC level, we allow for a non-linear relation around the optimal level, where we include two variables that cause the regression to be different if the excess NWC is positive or negative. We, therefore, include a dummy variable, D, that is 1 if the excess NWC is zero or higher and 0 if the excess NWC is negative. As a result, Υ_1 is the coefficient for positive excess NWC, demonstrating the effect a unit increase in excess NWC has on profitability for firms with positive excess NWC. On the other hand, Υ_2

is the coefficient for firms with negative excess NWC. We use the same control variables as in the regression above.

$$ROA_{i,t} = \alpha_t + \eta_i + \Upsilon_1[Excess\ NWC_{(i,t-1)} * D] + \Upsilon_2[Excess\ NWC_{(i,t-1)} * (1 - D)] \ + \Upsilon_3\ Controls_{i,t-1} + \varepsilon(i,t)$$

In the second part of the research, we set excess stock return as the dependent variable in the regression. The right-hand side of the model is equivalent to the regressions above, except for one additional control variable, EBITDA divided by total assets.

$$Excess\ stock\ return = \alpha_t + \eta_i + \Upsilon_1[Excess\ NWC_{(i,t-1)} * D] + \Upsilon_2[Excess\ NWC_{(i,t-1)} * (1 - D)] \ + \Upsilon_3\ Controls_{i,t-1} + \varepsilon(i,t)$$

3.3.6 Pre-testing

Auto-correlation in the errors can have significant implications for regression models and is one of the key assumptions in regression analysis. Autocorrelation appears when the errors are correlated. The assumption of no auto-correlation holds if (Wooldridge, 2020):

$$Corr(u_t, u_s) = 0, for\ all\ t \neq s$$

The consequences of autocorrelation in the errors are that the estimated standard deviation of the coefficients can be biased and inconsistent. In addition, R^2 may be exaggerated, indicating that the regression has a greater fit than what is correct. We, therefore, execute a Wooldridge test to look for auto-correlation in the dataset. The null hypothesis is that there is no auto-correlation. As the Wooldridge test below reports, we reject the null hypothesis and conclude that the data set contains autocorrelation.

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,    4765) =      66.178
           Prob > F =       0.0000
```

Heteroscedasticity appears when the variance of the error term is not constant across different independent variable values. In other words, when Var(u|x) depends on x, we say that the error term exhibit heteroscedasticity (Wooldridge, 2020). We must be aware of heteroscedasticity in the regression because it violates one of the key assumptions of linear regression: constant variance in the error terms. The consequences of heteroscedasticity are that the variance does not reflect the true sampling variations of our estimates, and we get biased estimates of standard errors.

We use a modified Wald test to detect if our data set has heteroscedasticity. The modified Wald test is a statistical test for discovering if the fixed effect regression models have groupwise heteroscedasticity. The null hypothesis is homoskedasticity and constant variance. As the test below reports, we reject the null hypothesis and conclude with heteroskedasticity.

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (5705)  =  3.3e+34
Prob>chi2 =      0.0000
```

Hausman test

To test whether we should use random effects or fixed effects, we perform a Hausman test. We use the Hausman test to test the null hypothesis that the difference in coefficients between two sets of variables is not systematic. If we fail to reject the null hypothesis, the test suggests that we should use the random effects estimates (Wooldridge, 2020). As reported below, the p-value associated with the test is 0.0000, which implies strong evidence against the null hypothesis. In other words, the Hausman test indicates that the fixed effects model is more efficient. We tested all the different regressions, and the results gave the same conclusion. Furthermore, Aktas et al. (2014) used fixed effects in all their regressions.

```
                 b = Consistent under H0 and Ha; obtained from xtreg.
  B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

   chi2(29) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            = 4484.39
Prob > chi2 =  0.0000
(V_b-V_B is not positive definite)
```

Multicollinearity test

We examine the presence of multicollinearity by performing a VIF test on the dependent and independent variables. If multicollinearity can be identified, it may lead to increased standard errors in our regressions. We test the variables for two of the regressions performed in the next chapter.

Table 5
VIF test

Variable	VIF	Variable	VIF
ROA EBITDA	1.41	Excess return	1.01
Positive excess NWC	1.07	Positive excess NWC	1.07
Negative excess NWC	1.13	Negative excess NWC	1.14
Cash	1.36	Cash	1.37
Intangible Assets	1.1	Intangible Assets	1.1
Sales growth	1.09	Sales growth	1.09
Size	1.18	Size	1.21
Leverage	1.44	Leverage	1.46
Fixed Assets	1.09	Fixed Assets	1.09
R&D	1.21	R&D	1.27
Financial distress dummy	1.42	Financial distress dummy	1.43
Risk	1	Risk	1
		ROA	1.58
Mean VIF	*1.21*	*Mean VIF*	*1.22*

We observe that all VIF values are below 4, which is a threshold value for regular VIF tests. In fact, all values are close to 1, indicating no great risk for multicollinearity in the variables for the regressions (Pennsylvania State University, 2018). We also report all the pairwise correlations in Appendix 5. As the table reports, we do not observe any correlations which indicate that multicollinearity is a concern.

The pre-testing section reports findings of heteroscedasticity and auto-correlation, we therefore cluster standard errors at the firm level. Consequently, we allow for the fact that the observations within the same firm or cluster may be correlated, while still preserving the independence assumption between different firms or clusters (Thompson, 2011). This is equivalent to the methods used by Aktas et al. (2014). By performing a Hausman test, we find evidence that the fixed effects model is more efficient than the random effects. The VIF test and the pairwise correlation table report no evidence of multicollinearity. In the next section, we discuss the empirical evidence of the fixed effects regressions, where standard errors are robust and clustered at firm level.

4. Empirical evidence

Summary statistics: positive vs negative excess NWC

The table below shows great differences between firms with positive and negative excess capital. The median NWC level is naturally significantly higher for firms with positive excess NWC. The median excess stock return is relatively equal, with negative numbers for both groups. These excess stock return results align with the numbers reported by Aktas et al. (2014). Interestingly the median ROA with EBITDA is relatively similar for both groups, which is the same as Aktas et al. (2014) reported. However, they reported a higher median ROA of 10.32% for firms with positive excess NWC and 11.00% for firms with negative excess NWC.

Table 6

Summary statistics, divided by excess NWC

Stats	Positive excess NWC		Negative excess NWC	
	Mean	Median	Mean	Median
NWC level	35,19 %	26,78 %	-12,96 %	5,58 %
Excess NWC	19,60 %	9,17 %	-28,55 %	-8,22 %
Excess return	20,92 %	-6,08 %	4,34 %	-6,17 %
ROA	0,84 %	7,35 %	0,00 %	7,62 %
Profit margin	-35,63%	9,79%	-164,04%	7,14%
Risk	11,85 %	2,64 %	14,11 %	2,74 %
R&D	2,73 %	0,00 %	3,18 %	0,00 %
Cash flow	-30,29 %	6,73 %	-127,70 %	5,96 %
Fixed Assets growth	23,12 %	2,57 %	21,67 %	2,26 %
Sales growth	17,07 %	5,67 %	28,48 %	5,93 %
Intangible assets	18,26 %	9,50 %	20,82 %	12,81 %
Leverage	52,95 %	52,26 %	59,58 %	57,87 %
Book-to-market	0,84	0,56	0,66	0,47
Cash	15,14 %	8,72 %	16,55 %	9,76 %
Financial distress dummy	4,55 %	0,00 %	6,60 %	0,00 %

4.1 NWC and profitability

Table 7 below reports the regression results with profitability as the dependent variable. As discussed earlier, we use return on assets as a measurement of profitability. The independent variables are lagged by one year in connection with the dependent variable. Column 1 reports the linear model where the lagged excess NWC is the independent variable of interest. Column

2 reports the results from the non-linear model, where we report one coefficient for firms with positive excess NWC and one coefficient for firms with negative excess NWC. As the pre-testing section concluded, we ensure standard errors are clustered at firm level and robust.

As column 1 reports, we observe a positive coefficient for the excess NWC variable, which means that an increase in excess NWC correlates with higher ROA. This result contrasts with Aktas et al. (2014), who found evidence of a negative relationship between excess NWC and profitability. However, the coefficient for excess NWC in column 1 is relatively small, with a value of 0.0097. In addition, as we have discussed previously, the results from the regression can be less relevant for corporate managers because of the high variation in NWC level between firms, even for firms within the same industries. When the standard deviation in NWC level is 71.91% (see table 4), general advice for corporate managers on the relationship between excess NWC and profitability may be misleading. In line with Aktas et al. (2014) we therefore give more attention to the regression with both positive and negative excess NWC as independent variables of interest.

For firms with positive excess NWC, a decrease in NWC can release capital for other investments and intuitively give the firms higher profitability if the investments are profitable. On the other hand, firms with already a low level of NWC compared to their peers are not expected to have the same effect of a decrease. As already discussed, low inventory increases the risk of stock-outs, small values of receivables on the balance sheet due to a short collection period may be negative for sales and customer contact, and a high value of accounts payable may increase financing costs. Therefore, we expect the coefficients to be different for the positive and negative excess NWC variables. This expectation is also what column 2 report. In column 2, we can see that the coefficient estimate for firms with positive excess NWC is -0.0558 and 0.02263 for firms with negative excess NWC, both coefficients are strongly statistically significant. This is consistent with previous discussions and comparable to the results Aktas et al. (2014) reported, with coefficients at -0.1104 and 0.1007.

Compared to Aktas et al. (2014), our results indicate a more asymmetric relation between positive and negative excess NWC. We see from column 2 that the coefficient for positive excess NWC is approximately twice as different from zero as the negative excess NWC coefficient. This difference indicates that a decrease in NWC for firms with positive excess NWC has two times the effect on profitability than an increase for firms with negative excess NWC. Our findings imply that corporate managers with a positive excess NWC level should be especially interested in adjusting the NWC level closer to the optimal level. The findings can be linked to previous research, for example, Shin and Soenen (1998) and Garcia-Teruel and Martinez-Solano (2007), who found evidence of a negative relationship between NWC and profitability. However, our research emphasizes the existence of an optimal NWC level, and we do not find evidence of a negative relation between NWC and profitability. On the other hand, our results indicate that corporate managers should adjust the firms NWC level closer to the optimal level, either by increasing or decreasing investments in working capital to maximize profitability.

Regarding the control variables, column 2 reports some statistically significant control variables at a 1% level. For example, can we see that cash (as a percentage of total assets) has a statistically significant negative coefficient with -0.0549, which means a higher portion of cash on the balance sheet is correlated with lower profitability. In comparison, Aktas et al. (2014) reported a statistically significant coefficient at -0.0984 for cash. The control variable for size (market value equity) is also statistically significant but with a positive coefficient of 0.0182. Aktas et al. (2014) reported a coefficient of 0.0178, indicating that larger firms are more profitable. Two other highly statistically significant variables are R&D expenses (as a percentage of total assets) and the dummy for financial distress. Equivalent to Aktas et al. (2014), both coefficients are negative, indicating a negative relationship with profitability.

Table 7
Regression: ROA

Variable	(1) ROA EBITDA		(2) ROA EBITDA	
	Coef.	p-value	Coef.	p-value
Excess NWC	0,0097	0,014		
Positive excess NWC			-0,0558	0,000
Negative excess NWC			0,02263	0,000
Cash	-0,0501	0,003	-0,0549	0,001
Intangible Assets	0,0208	0,200	0,0135	0,404
Sales growth	0,0048	0,003	0,0030	0,064
Size	0,0182	0,000	0,0182	0,000
Leverage	0,0199	0,096	0,0189	0,112
Fixed Assets	0,0009	0,448	0,0017	0,156
R&D	-0,2674	0,000	-0,2714	0,000
Financial distress dummy	-0,0262	0,000	-0,0259	0,000
Risk	0,0000	0,909	0,0000	0,971
R-squared	0,029		0,036	
Firm- and year-fixed effects	Yes		Yes	

Naturally, there are some differences between our results and Aktas et al. (2014). They looked at a sample of US firms, while we look at European firms. In addition, our data period is between 2005 and 2021, whereas they looked at firms between 1982 and 2011. As discussed in the descriptive statistics section, the level of NWC had a declining trend during Aktas et al. (2014) sample period, led by lower inventory levels due to Just in Time. In comparison, the NWC level was much more consistent during our sample period, as we observed in Table 1. Despite the differences in data sets, both samples indicate an optimal level of NWC and managers who adjust the NWC level closer to this optimal level can increase the firm's profitability. This adjustment is either done by decreasing NWC for firms with positive excess NWC or increasing NWC for firms with negative excess NWC.

4.2 NWC and stock performance

In the second part of the empirical evidence analysis, we examine the relationship between excess net working capital and stock performance. We apply the equivalent econometric approach as in the performance regression and use the same set of control variables (except that we include ROA). As discussed previously, we include control variables based on previous research to control for other variables that may influence NWC and firm value. The control variables are comparable to Aktas et al. (2014) study. We still use the deviation from the industry median NWC level to measure the excess NWC. As mentioned, the dependent variable is now the excess stock return, calculated from the Fama-French value-weighted portfolios made by sorting stocks on size (ME) and book-to-market characteristics. Equivalent to the performance analysis and Aktas et al. (2014), we use fixed effects, winsorizing at 1st and 99th percentiles and standard errors are clustered at firm level and robust.

Table 8 below reports the results of four regressions with the same dependent variable, excess stock returns. The regressions in columns 1 and 2 look at the relation between excess returns and excess NWC, where column 1 is without control variables. The regressions report different signs for the excess NWC coefficients. However, none of the coefficients are statistically significant at the 10% level. It is, therefore, difficult to give a meaningful interpretation. In comparison, Aktas et al. (2014) reported of a negative relationship between excess NWC and stock performance. However, they only report a statistically significant coefficient for excess NWC in the regression without control variables, which makes the negative relation not robust.

Column 4 reports the regression results with positive and negative excess NWC and control variables. Like the profitability analysis, positive and negative excess NWC are the independent variables of interest. In line with the profitability analysis and Aktas et al. (2014), we report a negative excess NWC coefficient for firms with positive excess NWC and a positive excess NWC coefficient for firms with negative excess NWC. However, the coefficients are not statistically significant. Therefore, we cannot conclude that the positive/negative excess NWC variables impact the next year's excess stock return. The results contrast with Aktas et al. (2014), who reported statistically significant variables with a coefficient at -0.0731 (p-value of 0.02) for firms with positive excess NWC and a coefficient of 0.0687 (p-value of 0.07) for firms with negative excess NWC.

We report more statistically significant results regarding the control variables, equal to Aktas et al. (2014). Cash reserves, R&D expenses and ROA are all highly statistically significant with positive coefficients, indicating a positive correlation with next year's excess stock returns. It is also in line with other research papers in the field. For example, Simutin (2010) reported a positive relationship between corporate excess cash holdings and future stock returns. Chan, Lakonishok, & Sougiannis (2001) found evidence that firms with high R&D to equity market value earn larger excess returns. The control variables for leverage, financial distress and size are highly statistically significant with negative coefficients. These findings are also consistent with previous research, for example, Faulkender (2006) who examined the variation in excess returns and found evidence that the value of cash declines with higher leverage. Aktas et al. (2014) have also reported coefficients with the same sign.

Table 8
Regression: Excess return

Variable	(1) Excess Return		(2) Excess Return		(3) Excess Return		(4) Excess Return	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
Excess NWC	-0,0070	0,333	0,0011	0,905				
Positive excess NWC					-0,0171	0,352	-0,0055	0,825
Negative excess NWC					-0,0052	0,531	0,0025	0,823
Cash			0,1457	0,000			0,1451	0,000
Intangible Assets			-0,0121	0,763			-0,0128	0,748
Sales growth			0,0102	0,028			0,0100	0,029
Size			-0,2581	0,000			-0,2581	0,000
Leverage			-0,0753	0,002			-0,0756	0,002
Fixed Assets			0,0004	0,904			0,0005	0,886
R&D			0,3978	0,000			0,3967	0,000
Financial distress dummy			-0,1181	0,000			-0,1182	0,000
Risk			-0,0001	0,231			-0,0001	0,232
ROA			0,2999	0,000			0,2990	0,000
R-squared	0,035		0,117		0,035		0,117	
Firm- and year-fixed effects	Yes		Yes		Yes		Yes	

Compared to the profitability analysis, the stock performance analysis reported greater differences between our research and Aktas et al. (2014). Even though the control variables have similar signs and comparable values, the independent variables of interest were not statistically significant compared to Aktas et al. (2014). There can be different explanations for why this is the case.

One reason can be based on what Mclean & Pontiff (2006) found in their research. They studied the out-of-sample and post-publication return predictability of 97 variables that have been shown to predict cross-sectional stock returns. They found evidence for significantly lower returns for publication-informed trading and suggested that investors can learn about mispricing from academic publications. Taking this finding into account, we perform the same regression analysis as in Table 8, but we exclusively look at the period 2005 to 2013. In that way, we examine if our results are different in the period before the publication of Aktas et al. (2014) research, as Mclean and Pontiff (2016) suggested, may be an explanation. However, as the table below shows, we do not find any statistically significant coefficient for excess NWC in this period either.

Table 9
Regression: Excess return (2005-2013)

Variable	(1) Excess Return		(2) Excess Return		(3) Excess Return		(4) Excess Return	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
Excess NWC	-0,0102	0,445	-0,0099	0,905				
Positive excess NWC					0,0214	0,456	0,0,361	0,358
Negative excess NWC					-0,0202	0,221	-0,0243	0,270
Cash			0,1767	0,001			0,1807	0,001
Intangible Assets			0,0152	0,789			0,0188	0,741
Sales growth			0,0054	0,377			0,0068	0,277
Size			-0,3531	0,000			-0,3533	0,000
Leverage			-0,1476	0,000			-0,1465	0,000
Fixed Assets			0,0049	0,245			0,0043	0,312
R&D			0,4133	0,003			0,4184	0,003
Financial distress dummy			-0,1316	0,000			-0,1312	0,000
Risk			-0,0001	0,450			-0,0001	0,439
ROA			0,3005	0,000			0,3060	0,000
R-squared	0,041		0,152		0,041		0,152	
Firm- and year-fixed effects	Yes		Yes		Yes		Yes	

Another reason may be the use of another data sample and variables. Hamermesh (2007) proposed grouping replications of research into three categories, pure replication, statistical replication and scientific replication. In our replication study of Aktas et al. (2014), we do a statistical replication, meaning that we use alternative comparable data, variable constructions, statistical methods, or estimation methods. The most significant difference in the replication is the sample of European listed firms compared to the US, in addition to the sample period. There are several differences between the European and US equity markets. One difference is the composition of equities, where European equities are more sensitive to economic changes than US ones. The reason is that cyclical industries like energy, materials, industrials, and banks take up a larger part of the European market than in the US, where industries such as tech, pharmaceuticals and consumer staples are larger (Armstrong, 2022). It is intuitive to believe that this will have some influence on our results. However, when we do an additional test that only includes tech, pharmaceuticals and consumer staples industries in the regression, we do not find statistically significant results for positive or negative excess NWC (see Appendix 6).

We are not the first to replicate an empirical finance study with anomalies and not find the same results. Hou et al. (2020) replicated anomalies in empirical finance studies to see if the findings hold from the original studies. Their findings show that the economic magnitudes of the replicated anomalies are significantly smaller than what was originally reported. They concluded that capital markets are more efficient than previously recognized (Hou, Xue, &

Zhang, 2020). Whereas Aktas et al. (2014) studied firms in 1982, our research goes back to 2005. Bertone et al. (2015) investigated whether the market has become more efficient, and their results indicated an increase in operational market efficiency from 1998 to 2010. The increase in efficiency may be an explanation for why our newer sample does not report excess returns for positive or negative excess NWC. However, the study on efficient markets is performed on the US equity market, which is known to be highly efficient (see, e.g. Malkiel (2003)).

One more explanation for the absence of statistically independent variables of interest may be the use of annual accounting data. Because most firms have reported quarterly accounting data during the sample period (not all firms have reported quarterly, set, e.g. Pozen, Nallareddy, & Rajgopal (2017), the investors have updated data during the year. As a result, the effect of one year's accounting data on next year's stock performance may be influenced by quarterly reporting. This effect has been previously researched, for example, studied May(1971) if the quarterly accounting data significantly influenced investor decisions and market prices. He concluded that quarterly accounting data affect the basis for actual investment decisions. Although May (1971)'s research is old, we do not expect the influence of quarterly accounting data on stock prices to be less significant in more recent times. We can therefore expect that quarterly accounting data may also influence our findings.

5. Conclusion

In this master thesis, we use methods inspired by Aktas et al. (2014) to study the relationship between working capital management and firm performance. By defining the excess NWC to firms, we study the research question of an optimal level of NWC. Compared to Aktas et al. (2014), who used a sample of listed US firms between 1982 and 2011, our sample includes firms from 15 European countries in a later period between 2005 and 2021. Despite the differences in data, both studies found evidence of an optimal level of NWC for maximizing profitability. The fact that both studies reach the same conclusion strengthens the suggestion that corporate managers should adjust their NWC level to the optimal level of NWC in their industry. However, compared to Aktas et al. (2014), our findings report an asymmetric effect for firms with positive and negative excess NWC. The results indicate that a decrease in NWC for firms with positive excess NWC has two times the effect on profitability than an increase for firms with negative excess NWC. We therefore conclude of the existence of an optimal level of NWC, and firms who converge to that optimal level increase profitability in the following year. Our findings are especially interesting for firms with positive NWC, because the effect of conversion to the optimal level is strongest. The results are of interest to corporate managers because of the magnitude of working capital assets and liabilities on the balance sheet for most firms.

However, we do not find evidence of an optimal level of NWC to increase excess stock returns. The results contrast with Aktas et al. (2014), who reported a statistically significant relationship between excess stock return and positive and negative excess NWC. The are several possible explanations why our results are different, for example, the differences in samples, the market has become more efficient, or the effect quarterly accounting data may have on our results. We also know from Hou et al. (2020) study, that the absence of statistically significant results for replication of anomalies is not uncommon.

6. References

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7. Appendix

Appendix 1: Variable definitions

Note:

- Most of the variables are the same as in Aktas et al. (2014).
- All retrieved variables have been downloaded from Compustat and Eikon Refinitiv 365 in 2023.

NWC: Net operating working capital (Inventories + receivables – accounts payable)

NWC level: NWC divided by total sales.

Excess NWC: NWC level minus the industry median of the NWC level in the corresponding year. Industries are defined in the Fama-French 49-industry classification.

Sales growth: One-year growth rate of sales at time t: ($sales_t$ – $sales_{t-1}$) / $sales_{t-1}$.

Financial distress dummy: Following Hill et al. (2010), a firm is financially distressed if two criteria are met: (1) the firm faces difficulty to cover its interest expenses and (2) the firm is overleveraged. The firm faces difficulty to cover its interest expenses if its interest coverage ratio (i.e., operating income before depreciation divided by interest expense) is below one for two consecutive years or less than 0.80 in any given year. The firm is considered to be overleveraged if it is in the top two deciles of industry leverage in a given year.

Excess return: The difference between each firm's one-year stock return and the yearly return benchmark in Fama-French six-portfolios value-weighted portfolios based on size and book-to-market.

ROA: EBITDA divided by Total Assets.

R&D: Research and Development costs divided by Total Assets.

Fixed asset growth: One-year growth rate of Fixed assets at time t: ($Fixed_t$ – $Fixed_{t-1}$) / $Fixed_{t-1}$.

Size: Market value of the firm's equity at the end of the yar. The values are retrieved from the Eikon database, using the Market Cap variable for each firm for every year it is listed within the sample period.

Risk: The risk is calculated as the standard deviation for each firm's daily returns, adjusted for dividends and stock splits. We annualize the standard deviation on the regression.

Leverage: Total debt, scaled by Total Assets.

Book-to-market: The book value of equity divided by the market value of equity.

Cash: Cash and cash equivalent, scaled by Total Assets.

Appendix 2

Regressions with net income instead of EBITDA as dependent variable in the profitability analyses. As we see in the table below, the coefficients are not significant different from the primarily analyze with EBITDA as a measurement of profitability. The results indicate the same conclusion, that firms with positive excess NWC should decrease their NWC level and firms with negative excess NWC should increase their NWC level.

Variable	(1) ROA Net Income		(2) Net Income margin		(3) ROA Net Income		(4) Net Income margin	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
Excess NWC	0.0049	0.269	1.5289	0.000				
Positive excess NWC					-0.0499	0.000	-1.5695	0.000
Negative excess NWC					0.0155	0.002	2.1763	0.000
Cash	0.0149	0.424	-0.5721	0.204	0.0110	0.555	-0.8057	0.067
Intangible Assets	-0.0644	0.001	0.6136	0.179	-0.0706	0.000	0.2587	0.553
Sales growth	0.0076	0.000	0.1683	0.008	0.0061	0.002	0.0833	0.185
Size	0.0230	0.000	0.1149	0.019	0.0230	0.000	0.1167	0.013
Leverage	0.0594	0.000	1.0489	0.000	0.0588	0.000	1.0317	0.000
Fixed Assets	0.0018	0.240	-0.0007	0.984	0.0025	0.155	0.0364	0.269
R&D	-0.2394	0.000	-0.8751	0.435	-0.2428	0.000	-1.0803	0.316
Financial distress dummy	-0.0300	0.000	-0.2041	0.095	-0.0299	0.000	-0.2015	0.091
Risk	0.0001	0.780	-0.0003	0.468	0.0001	0.815	-0.002	0.560
R-squared	0,029		0,049		0,036		0,069	
Firm- and year-fixed effects	Yes		Yes		Yes		Yes	

Appendix 3

Regressions with profitability (ROA) and share performance as dependent variables in the period before IFRS 16 (2005 to 2018)

Variable	(1) ROA EBITDA		(2) Excess return	
	Coef.	p-value	Coef.	p-value
Positive excess NWC	-0.0595	0.0000	-0.0051	0.857
Negative excess NWC	0.02156	0.0000	-0.0089	0.500
Cash	-0.0320	0.085	0.1711	0.000
Intangible Assets	0.0265	0.150	-0.0318	0.465
Sales growth	0.0046	0.014	0.0107	0.027
Size	0.0184	0.000	-0.2777	0.000
Leverage	0.0175	0.210	-0.1201	0.000
Fixed Assets	0.0028	0.023	0.0048	0.201
R&D	-0.2575	0.000	0.3539	0.002
Financial distress dummy	-0.0207	0.002	-0.1308	0.000
Risk	0.0001	0.977	-0.0001	0.358
R-squared	0,029		0,049	
Firm- and year-fixed effects	Yes		Yes	

Appendix 4
Regression with EBITDA margin as dependent variable.

Variable	(1) EBITDA margin		(2) EBITDA margin	
	Coef.	p-value	Coef.	p-value
Excess NWC	1,6973	0,000		
Positive excess NWC			-1,3336	0,000
Negative excess NWC			2,3412	0,000
Cash	-0,4697	0,270	-0,6955	0,095
Intangible Assets	1,0448	0,017	0,6952	0,093
Sales growth	0,1287	0,025	0,0459	0,423
Size	0,0601	0,198	0,0617	0,167
Leverage	0,8113	0,001	0,7833	0,001
Fixed Assets	0,0316	0,538	0,0170	0,588
R&D	1,1590	0,336	-1,3228	0,234
Financial distress dummy	0,1166	0,026	-0,2482	0,030
Risk	0,0002	0,327	-0,0002	0,421
R-squared	0,049		0,069	
Firm- and year-fixed effects	Yes		Yes	

Appendix 5

Correlation among variables

	ROA	Profit margin	Excess return	Excess NWC	Positive excess NWC	Negative excess NWC	Cash	Intangible assets	Sales growth	Firm size	Leverage	Fixed assets	R&D
ROA	1.0000												
Profit margin	0.4014	1.0000											
Excess return	0.1742	0.0307	1.0000										
Excess NWC	0.2065	0.4930	0.0111	1.0000									
Positive excess NWC	-0.1104	-0.0580	-0.0226	0.4702	1.0000								
Negative excess NWC	0.2829	0.5828	0.0227	0.9179	0.0813	1.0000							
Cash	-0.2828	-0.2274	0.0283	-0.1844	-0.0421	-0.1893	1.0000						
Intangible assets	0.0575	0.0381	-0.0118	-0.0319	-0.1337	0.0241	-0.1893	1.0000					
Sales growth	-0.1225	-0.0806	-0.0091	-0.0296	0.0026	-0.0347	0.1077	0.0441	1.0000				
Firm size	0.3270	0.0913	-0.0010	0.0211	-0.1026	0.0700	-0.1114	0.1115	-0.0447	1.0000			
Leverage	-0.0194	0.0881	-0.0245	-0.0199	-0.0565	0.0029	-0.2812	-0.0276	-0.0746	-0.0104	1.0000		
Fixed assets	-0.0330	-0.0239	-0.0152	-0.0213	0.0196	-0.0329	0.0427	0.1125	0.2561	0.0005	-0.0554	1.0000	
R&D	-0.3120	-0.2158	0.0254	-0.1710	-0.0080	-0.1895	0.3301	-0.0219	0.0462	-0.0638	-0.0685	-0.0059	1.0000
Financial distress dummy	-0.2067	-0.0434	-0.0504	-0.0588	0.0263	-0.0783	-0.0548	-0.0566	0.0012	-0.2231	0.4720	-0.0315	0.0714
Risk	-0.0111	-0.0065	-0.0052	-0.0059	-0.0004	-0.0065	0.0144	-0.0104	0.0131	-0.0133	-0.0046	0.0102	-0.0037
Book-to-market	0.0236	0.0284	0.0630	0.0855	0.1057	0.0490	-0.1554	-0.0295	-0.0535	-0.2045	-0.2450	-0.0548	-0.1344

	Financial distress dummy	Risk	Book-to-market
Financial distress dummy	1.0000		
Risk	0.0056	1.0000	
Book-to-market	-0.1703	-0.0105	1.0000

Appendix 6

Excess net working capital and share performance excluding all industries except Healthcare, Pharmaceutical Products, Computer Hardware, Computer Software and Electronic Equipment in Fama French 49 industries classification.

Variable	(1) Excess return	
	Coef.	p-value
Positive excess NWC	-0.0553	0.291
Negative excess NWC	0.0202	0.211
Cash	0.0645	0.328
Intangible Assets	-0.0485	0.504
Sales growth	0.0164	0.063
Size	-0.2743	0.000
Leverage	-0.0714	0.096
Fixed Assets	-0.0038	0.523
R&D	0.4100	0.001
Financial distress dummy	-0.0452	0.250
ROA	0.2687	0.000
Risk	0.0001	0.480
R-squared	0,049	
Firm- and year-fixed effects	Yes	

Appendix 7

Excess net working capital and firm risk

The table reports the results of a fixed effect regression with risk as the dependent variable. As stated before, we define risk as the annualized standard deviation of companies daily returns. The independent variables and control variables are lagged with one year with respect to the dependent variable. As the table presents, we do not report statistically significant variables for excess NWC.

Variable	(1) Risk		(2) Risk	
	Coef.	p-value	Coef.	p-value
Excess NWC	-0,0584	0,644		
Positive excess NWC			-0,0353	0,912
Negative excess NWC			-0,0630	0,636
Cash	1,1719	0,066	1,1737	0,069
Intangible Assets	0,8646	0,303	0,8673	0,302
Sales growth	-0,0320	0,472	-0,0314	0,460
Size	-0,4295	0,000	-0,4296	0,000
Leverage	0,6760	0,024	0,6766	0,025
Fixed Assets	-0,0518	0,126	-0,0521	0,120
R&D	-0,5923	0,578	-0,5886	0,577
Financial distress dummy	0,1622	0,498	0,1623	0,498
ROA	0,0667	0,884	0,0698	0,879
Book-to-market	0,0029	0,968	0,0028	0,969
R-squared	0,0095		0,0095	
Firm-and year-fixed effects	Yes		Yes	