

A Non-Linear relation between Working Capital Management and Stock Liquidity**Tiago Coelho¹****Célia Oliveira²****Inês Lisboa³****Abstract**

Purpose – Working capital management (WCM) is related to how the firm manages its credits and inventories to achieve a trade-off between its benefits and costs. It shows the manager and the firm's efficiency, which impacts its profitability and risk. The higher the firm's efficiency, the better investors' perception about the firm which can impact stock liquidity. This study aims to analyze if there is an optimal point between WCM and stock liquidity.

Design/Methodology/Approach – For this purpose, a panel of 1,145 firms listed on five Euronext exchanges (Amsterdam, Brussels, Dublin, Lisbon, and Paris), between 2011 and 2019, is analyzed. Stock liquidity is captured using two alternative measures – Amihud (2002) and Fong et al. (2017). Working capital management is measured through the cash conversion cycle (CCC), and its components (days sales outstanding, DSO; days sales inventory, DSI; and days payable outstanding, DPO). Non-linear relations are estimated using fixed effects models.

Findings – Results reveal an inverse U-shaped relation between cash conversion cycle, and its specific component days sales inventory, and stock liquidity, suggesting that there is an optimal value of CCC and DSI that maximize stock's liquidity.

Originality/Value – Most studies focus on the impact of WCM on operational profitability or stock's return. The impact on stock's illiquidity is less explored, so this study contributes to the debate whether being efficient in managing working capital can influence the transaction of stocks. Two alternative measures of liquidity are used since there is no consensus about which is better. This allows us to have different perspectives of liquidity, and to capture not only the breadth and depth of stocks, but also stock rigidity. Finally, instead of analyzing a single market, this work focuses on five European stock exchanges. The study insights are important for managers, investors, and shareholders, emphasizing the potential improvement in stock liquidity through effective WCM.

Keywords: Working Capital Management, Stock Liquidity, Cash Conversion Cycle, Inventories, Accounts Payable, Accounts Receivable.

JEL Classification: G11, G15, G31, G32

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Declaration of Competing Interest

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1. Introduction

Firms should efficiently manage working capital as it affects both profitability and accounting liquidity (Padachi, 2006; Shin & Soenen, 1998). An optimal Working capital management (WCM) reduces cash flow problems, increasing accounting liquidity and performance. This, in turn, affects firms' value, making it a significant factor in attracting investments (Salawu & Alao, 2014), which can impact stocks' liquidity.

Despite the significant role that WCM plays in the firm's value, there is limited knowledge on how investors perceive WCM and whether it affects their stock investments. Most works focus on the relation between WCM and accounting profitability (e.g., Jaworski & Czerwinka, 2024; Kayani et al., 2025; Özkaya & Yaşar, 2023). Limited attention has been given to the role of WCM in asset pricing. Nevertheless, some research analyses the impact of WCM on stock returns (Almeida & Eid, 2014; Baños-Caballero et al., 2014; Coelho et al., 2024b; Duong et al., 2023; Shin & Soenen, 1998, among others), and on stock risk (Aktas et al., 2015; Coelho et al., 2024a; Shawar & Muzammil, 2025; Wang, 2019, among others). To the best of our knowledge, only a few studies analyze the impact of WCM on stock liquidity (e.g., Perobelli et al., 2016; Maina, 2019). This work aims to study the relation between WCM and stock liquidity, contributing to the ongoing debate on the existence of a relation between WCM and stock liquidity.

WCM is subject to multiple trade-offs. On the one hand, pursuing a lower cash conversion cycle (CCC) guarantees that firms can meet their short-term obligations (Jose et al., 1996) and reduces the need to resort to external financing (Almeida & Eid, 2014). Although, firm's profitability decreases, lowering investors' perceptions about its performance, which leads to a negative impact on stock's marketability. On the other hand, firms can enhance their profitability by practicing a higher CCC that allows them to grant credit to clients to boost their sales, avoiding the risk of stockout, and taking advantage of early payment discounts from suppliers (Blinder & Maccini, 1991; Deloof, 2003; Jose et al., 1996). Although it reduces the firm's accounting liquidity, which can not only destroy the firm's value, but ultimately lead to bankruptcy, making investors less willing to trade the firm's stock without a price reduction.

Charoenwong et al. (2014) and Gopalan et al. (2012) show that the link between asset (or accounting) and stock liquidity is related to uncertainty and agency problems: a greater asset liquidity shows manager efficiency, reducing agency costs and the uncertainty regarding the valuation of assets in-place, but it also increases future investments and the associated uncertainty. Building on the market efficiency hypothesis, it is reasonable to expect a non-linear relation between WCM and stock liquidity, as an optimal WCM is a signal of the firm efficiency, and investors are more likely to trade its stocks.

Previous works focus on a linear relationship, but the trade-offs of WCM suggest the existence of an optimal WCM that maximizes stock liquidity. Therefore, this study analyses a non-linear relationship between WCM and stock's liquidity. Moreover, we analyze not only the impact of CCC on stock liquidity, as in previous studies, but we also study the impact of each of its components: days sales outstanding (DSO), days sales inventory (DSI), and days payable outstanding (DPO). This disaggregation provides further reasoning on whether the optimal point of CCC occurs due to the simultaneous management of all its components, or it occurs due to the optimal management of any of its components, which are also subject to multiple trade-offs already acknowledged by scholars (e.g., Coelho et al., 2024b; Deloof, 2003; Duong et al., 2023; Padachi, 2006; Jose et al., 1996).

Finally, liquidity is analyzed using two alternative measures: the Amihud (2002) and Fong et al. (2017) measures. While the Amihud (2002) measure emphasizes stock breadth, the Fong et al. (2017) measure focuses on stock rigidity. Using two measures we can have different perspectives of liquidity as both measures capture different effects, helping us to understand which effects are more relevant in what concerns to WCM.

This paper is structured in 5 sections. After this introductory section, where the study's aim is presented, section 2 presents the main literature review on the topic. In section 3 the research methodology, sample selection, and definition of variables are described. The empirical results are presented and discussed in section 4, and the last section presents the conclusions, the limitations of the study, and suggestions for future research.

2. Literature review

2.1. Working capital management

Working capital management refers to the firm's ability to identify and finance an efficient level of investment in inventories and accounts receivable that is not covered by accounts payable (Lefebvre, 2022). By effectively managing these elements, WCM aims to guarantee that the firm meets its short-term obligations while ensuring profitability (Padachi, 2006). Therefore, WCM is vital for the overall strategy of firms as it helps to maximize investment efficiency (Yilmaz, 2024), and shareholders' value by ensuring that the firm's resources are used efficiently (Almeida and Eid, 2014; Shin and Soenen, 1998). The cash conversion cycle (CCC) is the most widely used measure to capture WCM since it offers an integrated approach of WCM components (Deloof, 2003; Shin & Soenen, 1998; Ukaegbu, 2014; Wang, 2019). It refers to the time span between the outlay of cash for purchase of raw materials and the collect of sales of finished goods or provision of services (Deloof, 2003; Wang, 2019). Firms are encouraged to pursue a lower CCC, i.e., have less inventories, receive early from customers and have a larger period of credit from suppliers, since it increases the ability to meet their short-term obligations (Jose et al., 1996). Additionally, it contributes to increasing firms' accounting liquidity, allowing for making new investments in viable projects (Almeida & Eid, 2014; Baños-Caballero et al., 2014; Deloof, 2003; Yilmaz, 2024).

However, too much focus on accounting liquidity can have a negative impact on firms' profitability (Padachi, 2006; Mathuva, 2010). Firms can improve their profitability by practicing a larger CCC, as sales increase when trade credit policy also increases and a higher level of inventories not only minimizes the risk of stockout, but also provides hedge against price fluctuations (Aktas et al., 2015; Altaf & Shah, 2018; Afrifa & Tingbani, 2018; Deloof, 2003; Blinder & Maccini, 1991; Lefebvre, 2022). Moreover, extending payment to suppliers is a source of financing, but it may also have a higher implicit cost if it results in the loss of early payment discounts (Deloof, 2003; Jose et al., 1996; Padachi, 2006). Thus, there is a trade-off between these two objectives, liquidity and profitability (Duong et al., 2023; Jose et al., 1996; Padachi, 2006), being managers responsible for achieving an appropriate equilibrium that maximizes the firms' value (Padachi, 2006). By attaining this equilibrium, managers are more efficient, reducing the agency cost that may occur (Jensen & Meckling, 1976).

There are also several cost-benefit trade-offs presented in trade credit and inventory management literature. Trade credit in sales is a way for firms to promote their sales by facilitating dealings with customers and giving them a chance to check the quality of the product before paying (Long et al. 1993; Smith, 1987). Moreover, it allows firms to practice price discrimination between customers (Ng et al., 1999; Petersen & Rajan, 1997; Schwartz, 1974; Smith, 1987). The flip side of assigning trade credit is that it locks resources in working capital, which could be invested elsewhere and could contribute to

increase the firm's value (Afrifa & Tingbani, 2018; Deloof, 2003). In addition, providing credit to customers can cause cash flow problems if they delay paying their bills (Ukaegbu, 2014), increasing the likelihood of uncollectible accounts (Altaf & Shah, 2018). Thus, there may be an optimal point where the benefits and costs of giving credit to customers are in equilibrium.

Efficient accounts payable management is also crucial to ensure cordial relations with suppliers (Altaf & Shah, 2018). Extending payment to suppliers can result in the loss of flexibility to get future credit and the loss of early payment discounts (Jose et al., 1996; Deloof, 2003; Padachi, 2006). However, it represents a flexible and low-cost source of finance available to firms (Deloof, 2003), which allows them to plan their payments to reduce late payment penalty costs and order costs (Ferris, 1981), but without damaging the relation with suppliers (Mathuva, 2010; Ukaegbu, 2014). Thus, firms should reach a trade-off between the benefits of delaying their payments and the benefits of paying early. Inventory management also involves trade-offs. On the one hand, firms are encouraged to decrease inventories through leveled production, and by keeping finished goods inventories in warehouse for as little time as possible, having the advantage of reducing storage costs, insurance, and the likelihood of having obsolete inventories (Altaf & Shah, 2018; Afrifa & Tingbani, 2018; Blinder & Maccini, 1991; Kim & Chung, 1990). Additionally, more inventories in stock increase stocks' risk (Shawar & Muzammil, 2025) since it limits the firm's liquidity (Deloof, 2003). However, this approach can lead to lost sales if inventories are kept below a feasible level (Altaf & Shah, 2018), resulting in stockouts and production disruptions (Blinder & Maccini, 1991; Deloof, 2003; Mathuva, 2010; Ukaegbu, 2014). Moreover, buying more inventories allows firms to obtain quantity discounts and reduces costs per order (Afrifa & Tingbani, 2018; Blinder & Maccini, 1991; Mathuva, 2010).

To summarize, firms are faced with multiple trade-offs within each working capital component, that simultaneously impact their accounting liquidity and profitability, and consequently their value to shareholders.

2.2. Stock liquidity

The most used definition of stock liquidity refers to the ability of investors to buy and sell significant amounts of assets quickly and at low cost without having a high impact on the price (Liu, 2006). From this definition, it is possible to delineate four dimensions of liquidity: depth, rigidity, immediacy, and breadth. Depth refers to the existence of several orders around the equilibrium price of the asset (Sarr & Lybek, 2002). Rigidity is related to transaction costs, which can be broken down into explicit (brokerage fees and commissions) and implicit (costs borne by immediacy) (Sarr & Lybek, 2002). Immediacy represents the time that the financial instrument takes to be executed from the moment the order is submitted. Breadth demonstrates the ability of a security to be traded without having to drastically reduce its price (Breen et al., 2002; Sarr & Lybek, 2002).

Multiple studies prove the existence of a direct relation between liquidity and stock price (e.g., Amihud, 2002; Demsetz, 1968), resulting from the fact that investors demand to be remunerated for investing in less liquid assets. Firms are thus encouraged to increase the liquidity of their shares to increase their market value (Amihud & Mendelson, 1988).

2.3. Relation between WCM and stock liquidity

In an efficient market, stock prices incorporate all relevant information, including that reflected in the financial statements (Fama, 1991). Consequently, information about WCM should influence stock marketability and stock liquidity.

Moreover, Almeida and Eid (2014) suggested that working capital integrates operating cash flows, which are part of free cash flows, thus impacting the value of firms to

shareholders, making WCM a way to attract investors (Salawu & Alao 2014) and, as a result, improving stock liquidity. In the same vein, Gopalan et al. (2012) advocated that with higher accounting liquidity, firms recover cash quicker, reducing the uncertainty of cash flows and thus increasing stock liquidity.

Fazzari and Petersen (1993) argued that working capital acts as an internal funding, enabling firms to implement viable projects despite having cash flows and financial difficulties (Almeida & Eid, 2014; Fazzari & Petersen, 1993). However, in the case of firms that do not have financial difficulties, too much cash tied up in working capital might also hamper firms' ability to implement value enhancing projects, as firms have few self-funding to invest (Almeida & Eid, 2014; Baños-Caballero et al., 2014; Deloof, 2003). Therefore, for these firms, it is expected that, in an efficient market, greater investment in working capital will have a negative impact on their stock liquidity (Maina, 2019; Perobelli et al., 2016).

Perobelli et al. (2016) conducted one of the first empirical studies on the relation between working capital and market liquidity, using a sample of 872 Brazilian listed firms, between 1994 and 2013. The results show the existence of a negative relation between working capital and stock liquidity (measured by the turnover rate and the transaction volume), suggesting that working capital can be representative of an expense that affects the performance of firms. Furthermore, lowering the investment in working capital frees up resources for projects with a positive present value, which can improve firms' stock liquidity in an efficient market.

Maina (2019) analyzed a sample of 22 Kenyan listed firms, between 2007 and 2017, and found a negative relation of CCC and DSO with liquidity (measure of Roll (1984)), as found by Perobelli et al. (2016), but the opposite relations for the DPO and DSI.

Although indirectly, Filbeck et al. (2017) and Wang (2019) analyzed the relation between WCM and stock liquidity in the US. Wang (2019) found a positive correlation between the CCC and stock illiquidity, measured by the Amihud (2002) ratio, which implies that the higher the CCC the less liquid the firm's stock is. Nevertheless, the author showed that the stocks in the first and the last deciles of the CCC have, on average, greater illiquidity compared to the intermediate deciles. In turn, Filbeck et al. (2017) tested the relation between WCM and stock liquidity, using turnover, Amihud (2002) and Liu (2006) measures. The study analyzed a sample of 15,019 US listed firms, between 1997 and 2012, and found that the 25% of the firms in the sample with shorter CCC values have more liquid stocks, compared to the 25% of firms with longer CCC.

Table 1 synthesizes the main results of the previous empirical studies on the relation between WCM and stock liquidity.

Table 1 – Summary of empirical results on the relation between WCM and stock liquidity

Author(s)	Countries	Years	Liquidity Measure(s)	WCM Measure(s)	Impact in Liquidity
Perobelli <i>et al.</i> (2016)	Brazil	1995-2013	Turnover and transaction volume	WC	Negative
Maina (2019)	Kenya	2007-2017	Effective Bid-ask spread	CCC DSO DSI DPO	Negative Negative Positive Positive
Filbeck <i>et al.</i> (2017)	USA	1997-2012	ILLIQ, Liu (2006) and Turnover	CCC	Negative
Wang (2019)	USA	1976-2015	ILLIQ	CCC	Negative

Source: Author's elaboration.

From the empirical literature analyzed, it can be noted that only Maina (2019) and Perobelli *et al.* (2016) directly studied this relation, in listed firms in Kenya and Brazil, respectively. Both authors found the existence of a negative relation, but they apply different measures of WCM and liquidity, making the comparison of the results more difficult. Maina (2019) also presents as a limitation the analysis of a small sample of only 22 firms.

The previously mentioned studies assume a linear relation between WCM and stock liquidity. Although based on the literature presented before, there is a trade-off of WCM and each of its components, suggesting that companies can find an optimal point of WCM that reach the equilibrium between the costs and benefits of increasing CCC and its components (e.g., Almeida & Eid, 2014; Baños-Caballero *et al.*, 2014; Deloof, 2003). Additionally, being more efficient in managing working capital allows managers to reduce agency costs (Jensen & Meckling, 1976), which is also a benefit for looking for an optimal point of WCM. Therefore, this study focuses on the analysis of a non-linear relation to investigate the existence of an optimal point of the CCC and its components that maximize stock liquidity, instead of using a linear relationship as in previous works in the area. In this sense, the hypotheses that this paper aims to answer are:

H1: There is an optimal point of the CCC that maximizes stock liquidity.

H1a: There is an optimal point of the DSO that maximizes stock liquidity.

H1b: There is an optimal point of the DSI that maximizes stock liquidity.

H1c: There is an optimal point of the DPO that maximizes stock liquidity.

3. Methods

3.1. Sample and sources of information

A sample of firms listed on Euronext between January 1st, 2011, and December 31st, 2019, is used. Daily market data and annual accounting data were obtained from the Eikon-Datastream and Orbis databases, respectively. European firms are analyzed because, to the best of our knowledge, there are no studies that examine the impact of WCM on stock liquidity in the European context. It is important to explore this relation in different empirical contexts, since working capital differs across regions due to cultural norms and

differences in payment methods (PwC, 2019), which can influence how investors perceive WCM and, consequently, can affect stock liquidity in different ways.

Regarding the period analyzed, the initial idea was to include a large panel data. For it, a ten-year period is analyzed. We have limited the analysis until the year 2019, as after it the financial markets suffered severe impacts and fluctuations, first due to the Covid-19 pandemic (2020), then due to global conflicts, such as Russia-Ukraine war (2022), and more recently the US tariffs (2025) (Martona & Mistak, 2025). These phenomenon impact inflation and interest rates, as well as stocks prices, risk and liquidity. Therefore, excluding more recent years allows us to avoid biased results.

To obtain the final sample, three criteria were applied. First, firms should be listed on Euronext in the period analyzed. Second, firms belonging to the financial sector were excluded due to different accounting and WCM practices, as done by Deloof (2003) and Wang (2019). Third, firms with no data in Eikon-Datastream and Orbis databases were also excluded. Finally, a 5% winsorization was performed to eliminate outliers, as applied in several studies (e.g., Deloof, 2003; Le, 2019; Mathuva, 2010; Shin and Soenen, 1998). To avoid the survivorship bias, firms that during the period ceased to be listed on the stock exchange or went bankrupt were included in the sample.

The final sample is composed of 1,145 firms listed on 5 Euronext exchanges (the ones in the group until 2019): Amsterdam, Brussels, Dublin, Lisbon, and Paris.

3.2. Variables

To capture different dimensions of liquidity and provide robustness to the results, two alternative measures are used: Amihud (2002), ILLIQ, and Fong et al. (2017), FHT.

The Amihud (2002) illiquidity measure is applied due to its comparative advantages, namely it is a widely used measure in literature; it has the advantage of simultaneously capturing the breadth and depth of stocks, it is easy to compute, it only requires daily data on stock returns and volume traded, it can be calculated for long periods and thus covers the whole sample period. This measure is calculated as follows:

$$ILLIQ_{it} = \frac{1}{D_{it}} \sum_{d=1}^{D_{it}} \frac{|R_{idt}|}{P_{idt} \times V_{idt}} \quad (1)$$

where D_{it} represents the number of trading days of stock i in month t ; $|R_{idt}|$ symbolizes the absolute value of the return of stock i on day d of month t ; P_{idt} is the closing price in euros of stock i on day d of month t ; V_{idt} corresponds to the number of traded shares of stock i on day d of month t .

The Fong et al. (2017) measure is also used and it captures simultaneously the depth and rigidity of stocks. This last dimension is not captured by the Amihud (2002) measure. Its calculation is simple, requiring only data on stock returns, and it can also be calculated for long periods. Additionally, Fong et al. (2017) and Marshall et al. (2013) have shown that this measure has a higher predictive ability for transaction costs than most of the liquidity measures. Finally, the measure is used because there is a growing number of authors who applied it as a proxy for stock illiquidity (Marshall et al., 2013; Schestag et al., 2016, among others). The Fong et al. (2017) measure is calculated as follows:

$$FHT_{it} = 2\sigma N^{-1}\left(\frac{1 + \#ZR_{it}}{2}\right) \quad (2)$$

where σ represents the standard deviation of non-zero returns of stock i during month t ; $N^{-1}()$ is the cumulative inverse function of the normal distribution; $\#ZR_{it}$ corresponds to the proportion of days with zero returns of stock i during month t .

The paper applies the CCC as a proxy for the WCM, as it is a commonly used measure in the literature (e.g., Deloof, 2003; Shin & Soenen, 1998; Ukaegbu, 2014; Wang, 2019). Furthermore, CCC intuitively disaggregates the different components of working capital, as it is calculated as follows:

$$CCC_{it} = DSO_{it} + DSI_{it} - DPO_{it} \quad (3)$$

where CCC_{it} reflects the time between paying suppliers, selling inventories, and receiving customers for firm i in year t ; DSO_{it} is the average number of days customers take to pay firm i in year t ; DSI_{it} is the average number of days inventories remain in warehouse for firm i in year t ; DPO_{it} is the average number of days firm i takes to pay its suppliers in year t .

An analysis of each of the CCC components is also carried out individually: DSO, DSI, and DPO.

Control variables are used to validate the relation between WCM and stock liquidity. Leverage is controlled by the ratio of the firms' liabilities to assets. According to Frieder and Martell (2006), an increase in leverage can lead to a reduction in agency costs between managers and shareholders, since it is an external mechanism for controlling managers opportunism. It allows for a reduction of information asymmetry, and thus improving stock liquidity, so a negative relation with stock illiquidity is expected. The stock price is controlled by the natural logarithm of the inverse of the stock price, as applied by Prommin et al. (2016). According to Chordia et al. (2000) and Harris (1994), the stock price exerts a positive impact on stock illiquidity, since the higher the stock price, the higher the associated transaction costs. Also, low stock prices make it easier for investors to buy stocks. Firm size is controlled by the natural logarithm of assets. Larger firms experience less risk of adverse selection, because there is more information available, reducing information asymmetry, which in turn has a negative impact on illiquidity (Diamond & Verrecchia, 1991; Harris, 1994; Irfan et al., 2002). Age is controlled by the natural logarithm of the age of the firms, as performed by Ali et al. (2016). Older firms exhibit lower levels of asymmetry of information between managers and shareholders, thus a negative relation with illiquidity is expected. Tangible fixed assets are controlled through the ratio between tangible fixed assets and total assets. The level of tangible fixed assets contributes to the reduction of information asymmetry, as the benefits associated with these assets are easy to observe, which may have a negative impact on stock illiquidity (Ali et al., 2016; Prommin et al., 2016).

3.3. Models

The research hypotheses are examined using unbalanced panel data, which allows the analysis of different firms over time while controlling unobservable heterogeneity. Panel data regression can be performed in several ways: ordinary least squares (OLS), fixed effects, and random effects. The F-test, the Breusch-Pagan test and the Hausman test are used to assess which of these methods best fits the sample.

The existence of a WCM that maximizes stock liquidity is analyzed using the following models:

$$LIQ_{it} = \beta_0 + \beta_1 CCC_{it} + \beta_2 CCC_{it}^2 + \beta_3 Leverage_{it} + \beta_4 Price_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \beta_7 Tangibles_{it} + \varepsilon_{it} \quad (4)$$

$$LIQ_{it} = \beta_0 + \beta_1 DSO_{it} + \beta_2 DSO_{it}^2 + \beta_3 Leverage_{it} + \beta_4 Price_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \beta_7 Tangibles_{it} + \varepsilon_{it} \quad (5)$$

$$LIQ_{it} = \beta_0 + \beta_1 DSI_{it} + \beta_2 DSI_{it}^2 + \beta_3 Leverage_{it} + \beta_4 Price_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \beta_7 Tangibles_{it} + \varepsilon_{it} \quad (6)$$

$$LIQ_{it} = \beta_0 + \beta_1 DPO_{it} + \beta_2 DPO_{it}^2 + \beta_3 Leverage_{it} + \beta_4 Price_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \beta_7 Tangibles_{it} + \varepsilon_{it} \quad (7)$$

where LIQ_{it} represents either the Amihud (2002) measure or the Fong *et al.* (2017) measure.

4. Results

Table 2 presents the main descriptive statistics (mean, standard deviation, maximum, median, minimum, and interquartile range) of the dependent and independent variables. From the analysis of the standard deviation of CCC, it can be concluded that there is a high degree of heterogeneity in WCM practices, being the DSI the component that mostly contributes to the heterogeneity of the CCC. This can be justified as the level of inventories in stock depends on the sector where the firm belongs. Some industries have no inventories, justifying DSI equal to 0, while others need higher levels of inventories. The maximum is greater than two years. Regarding credit management, the average duration of credit of customers is 93.6 days (DSO), which is greater than the credit given by suppliers (DPO is 67.3 days), suggesting that firms in the sample take longer to collect payments from clients than to pay to suppliers, which can lead to liquidity problems.

Regarding the dependent variables, ILLIQ has an average value of 1.532, which means that for each euro of traded volume, there is an average change of 1.532 in the absolute percentage of the price. This result is lower than the average value obtained by Wang (2019). The FHT has a value of 2.016, meaning the average volatility of the probability of zero returns occurring is 2.016. Similar average value was obtained by Marshall *et al.* (2013). Both variables present a high dispersion, suggesting that there are different levels of liquidity between the stock exchanges in which the firms are listed.

Table 3 displays Pearson's correlation matrix. The illiquidity measures, ILLIQ and FHT, show a negative and statistically significant relation with the CCC, suggesting that the higher the CCC, the greater the stock liquidity. There is also a positive and statistically significant relation with all CCC components, that is, by increasing the DSO, the DSI, and the DPO, the stock liquidity is reduced.

The analysis of the variance inflation factor (VIF) (presented in Table A.1 of the Appendix), allows us to conclude that there are no multicollinearity problems.

Table 2 – Descriptive statistics

Variables	ILLIQ	FHT	CCC	DSO	DSI	DPO	Leverage	Price	Size	Age	Tangibles
Mean	1.532	2.016	90.417	93.664	128.200	67.303	57.855	-2.280	11.770	3.355	1.964
Standard Deviation	6.599	4.704	125.790	96.492	167.971	79.527	24.390	1.819	2.169	0.826	4.844
Maximum	85.433	31.793	468.280	402.240	776.570	540.380	165.061	2.937	16.334	4.812	20.763
Median	0.032	0.504	63.927	65.019	76.753	46.103	57.172	11.673	11.673	3.295	0.505
Minimum	0.000	0.000	-104.820	1.329	0.000	3.785	3.432	8.584	8.584	1.791	0.007
Q3-Q1	0.279	1.324	122.830	64.755	123.73	41.759	27.642	3.367	3.367	1.216	0.580

Notes: **ILLIQ** is Amihud (2002) illiquidity measure of firm *i* in month *t*; **FHT** is Fong et al. (2017) illiquidity measure of firm *i* in month *t*; **CCC** corresponds to firm *i* cash conversion cycle in year *t*; **DSO** represents firm *i* average customer receivable term in year *t*; **DSI** reflects firm *i* average inventory turnover term in year *t*; **DPO** represents firm *i* average supplier payment term in year *t*; **Leverage** is the leverage ratio of firm *i* in year *t*; **Price** is the inverse of the stock price of firm *i* in month *t*; **Size** is the Ln (Assets) of firm *i* in year *t*; **Age** is the Ln (Age) of firm *i* in year *t*; **Tangibles** represents the level of tangible fixed assets of firm *i* in year *t*.

Source: Author's elaboration.

Table 3 – Correlation matrix

Panel B - Correlation Coefficients											
Variables	ILLIQ	FHT	CCC	DSO	DSI	DPO	Leverage	Price	Size	Age	Tangibles
ILLIQ	1	0.536***	-0.022***	0.084***	0.002	0.036***	0.064***	0.312*	-0.135***	-0.027***	0.046***
FHT		1	0.037***	0.099***	0.010**	0.070***	0.064***	0.394***	-0.185***	-0.027***	0.046***
CCC			1	0.123***	0.062***	-0.210***	-0.040***	-0.055***	0.035***	0.141***	-0.034***
DSO				1	0.011***	0.279***	0.006	0.106***	-0.185***	-0.097***	0.041***
DSI					1	0.024***	0.017***	-0.009**	0.005	0.022***	0.017***
DPO						1	0.055***	0.100***	-0.143***	-0.162***	0.012***
Leverage							1	0.112***	0.043***	-0.22***	-0.050***
Price								1	-0.198***	-0.270***	0.015***
Size									1	0.190***	-0.172***
Age										1	-0.031***
Tangibles											1

Notes: ILLIQ is Amihud (2002) illiquidity measure of firm *i* in month *t*; FHT is Fong *et al.* (2017) illiquidity measure of firm *i* in month *t*; CCC corresponds to firm *i* cash conversion cycle in year *t*; DSO represents firm *i* average customer receivable term in year *t*; DSI reflects firm *i* average inventory turnover term in year *t*; DPO represents firm *i* average supplier payment term in year *t*; Leverage is the leverage ratio of firm *i* in year *t*; Price represents the inverse of the stock price of firm *i* in month *t*; Size is the Ln (Assets) of firm *i* in year *t*; Age is the Ln (Age) of firm *i* in year *t*; Tangibles represents the level of tangible fixed assets of firm *i* in year *t*. The p-values of each coefficient are represented in parentheses. *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively.

Source: Author's elaboration.

The models from equations (4) to (7) were regressed with fixed effects, which showed the best fit to the sample. The models were also estimated with robust standard errors, to avoid heteroscedasticity problems. The results are shown in Table 4, with the Amihud (2002) illiquidity measure, and in Table 5, with the Fong et al. (2017) measure.

As can be seen in Table 4, when applying the illiquidity measure of Amihud (2002), the coefficient associated with CCC^2 in model (4) is positive and statistically significant. This validates hypothesis H1, indicating the existence of an inverse U-shaped relation, and conveying the idea that there is an optimal CCC point that firms should reach to maximize the liquidity of their stocks. From the break-even point analysis (calculated through $-\beta_1/(2\beta_2) \cdot 365$), this optimal duration is 261.3 days when the dependent variable is the illiquidity measure of Amihud (2002). Figure 1 presents the relation found between the CCC and the Amihud (2002) measure.

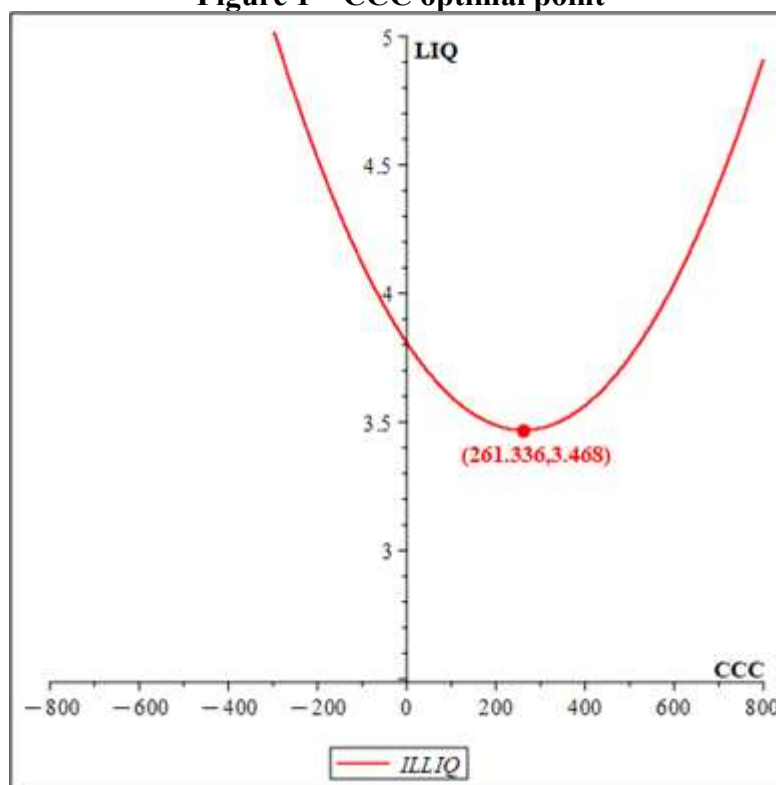
Table 4 – Regression results between ILLIQ and WCM

<i>Dependent variable: ILLIQ</i>				
	(4)	(5)	(6)	(7)
<i>CCC</i>	-0.948*** (0.004)			
<i>CCC</i> ²	0.662*** (0.008)			
<i>DSO</i>		-0.446 (0.530)		
<i>DSO</i> ²		0.515 (0.449)		
<i>DSI</i>			0.153 (0.668)	
<i>DSI</i> ²			-0.142 (0.364)	
<i>DPO</i>				2.503*** (0.000)
<i>DPO</i> ²				-1.219*** (0.005)
<i>Leverage</i>	0.866** (0.040)	1.029** (0.013)	0.796* (0.081)	0.799* (0.061)
<i>Price</i>	0.767*** (0.000)	0.787*** (0.000)	0.710*** (0.001)	0.778*** (0.000)
<i>Size</i>	-0.026** (0.020)	-0.028** (0.016)	-0.032*** (0.006)	-0.017 (0.120)
<i>Age</i>	-0.243 (0.173)	-0.207 (0.240)	-0.194 (0.336)	-0.250 (0.168)
<i>Tangibles</i>	0.019*** (0.000)	0.022*** (0.007)	0.013* (0.056)	0.019*** (0.000)
β_0	3.808*** (0.000)	3.684*** (0.000)	2.938*** (0.000)	3.244*** (0.000)
<i>N. of observations</i>	64,000	64,119	48,713	63,508
<i>F</i>	0.000***	0.000***	0.000***	0.000***
<i>Hausman</i>	0.000***	0.000***	0.000***	0.000***
<i>Breusch-Pagan</i>	0.000***	0.000***	0.000***	0.000***

Notes: ILLIQ is Amihud (2002) illiquidity measure of firm *i* in month *t*; CCC corresponds to firm *i* cash conversion cycle in year *t*; DSO represents firm *i* average customer receivable term in year *t*; DSI reflects firm *i* average inventory turnover term in year *t*; DPO represents firm *i* average supplier payment term in year *t*; Leverage is the leverage ratio of firm *i* in year *t*; Price represents the inverse of the stock price of firm *i* in month *t*; Size is the Ln (Assets) of firm *i* in year *t*; Age is the Ln (Age) of firm *i* in year *t*; Tangibles represents the level of tangible fixed assets of firm *i* in year *t*; β_0 represents the constant of the regression models. The p-values of each coefficient are represented in parentheses. *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively.

Source: Author's elaboration.

Figure 1 – CCC optimal point



Source: Author's elaboration.

In equation (5) the coefficients of DSO and DSO^2 , and in equation (6) the coefficients of DSI and DSI^2 are not statistically significant. Therefore, neither DSO nor DSI seem to impact stock liquidity nor contribute to its maximization, leading to the rejection of the hypotheses H1a and H1b.

The results of equation (7) allow us to observe the existence of a negative and statistically significant relation between DPO^2 and stock illiquidity, which is the opposite to the expected by hypothesis H1c, so this hypothesis is rejected. Firms that want to maximize their liquidity should seek to practice a very short or a very long DPO, benefiting or for discounts of early payments, or for a type of financing with less cost. Firms may not be able to achieve a DPO that allows them to simultaneously obtain cash discounts and enjoy lower WC investment and greater flexibility in planning their payments. Thus, a moderate DPO may suggest an inefficient WCM or even financial difficulties, and investors may not be interested in trading stocks of these firms. On the other hand, these results may be due to the practice of heuristics by investors who consider a short DPO or an extensive DPO to be advantageous.

Regarding the control variables applied in the models of equations (4) to (7), it can be seen a positive and statistically significant relation between the leverage variable and stock illiquidity, in line with the results of Frieder and Martell (2006). The coefficient associated with the stock price variable is also positive and statistically significant in all equations, which may suggest that lower-priced stocks are less traded, negatively affecting their liquidity, a result contrary to that suggested by Chordia et al. (2000) and Harris (1994). Firm size contributes negatively to stock illiquidity, meaning that larger firms have higher stock liquidity, which can be justified by the greater availability of information about these firms (Diamond & Verrecchia, 1991; Irfan et al., 2002). Finally, it can be concluded that the coefficient of the variable Tangibles is positive and statistically significant, which means that firms with higher levels of tangible fixed

assets have lower stock liquidity, contrary to what was suggested by Prommin et al. (2016). The remaining control variables are not statistically significant.

Results presented in Table 5 show the relationship between WCM and illiquidity measured using the Fong et al. (2017) measure. Results are singular compared with the previous ones, which can be explained as both measures focus on different dimensions of liquidity.

The coefficient associated with CCC^2 in model (4) is positive but not statistically significant, so hypothesis H1 is rejected.

However, it is observed in equation (5) that the coefficient associated with DSO^2 is negative and statistically significant. Contrary to our expectations in hypothesis H1a, results suggest that there is a DSO that minimizes stock liquidity. Results suggest that investors apply heuristics with respect to DSO duration, leading to a positive or a negative clientele effect. This means that investors are more willing to trade firms with a longer or shorter DSO. This may occur because it might be difficult for investors to perceive an optimal point of DSO that allows firms to simultaneously promote their sales while trying to minimize the investment in working capital.

Table 5 – Regression results between FHT and WCM

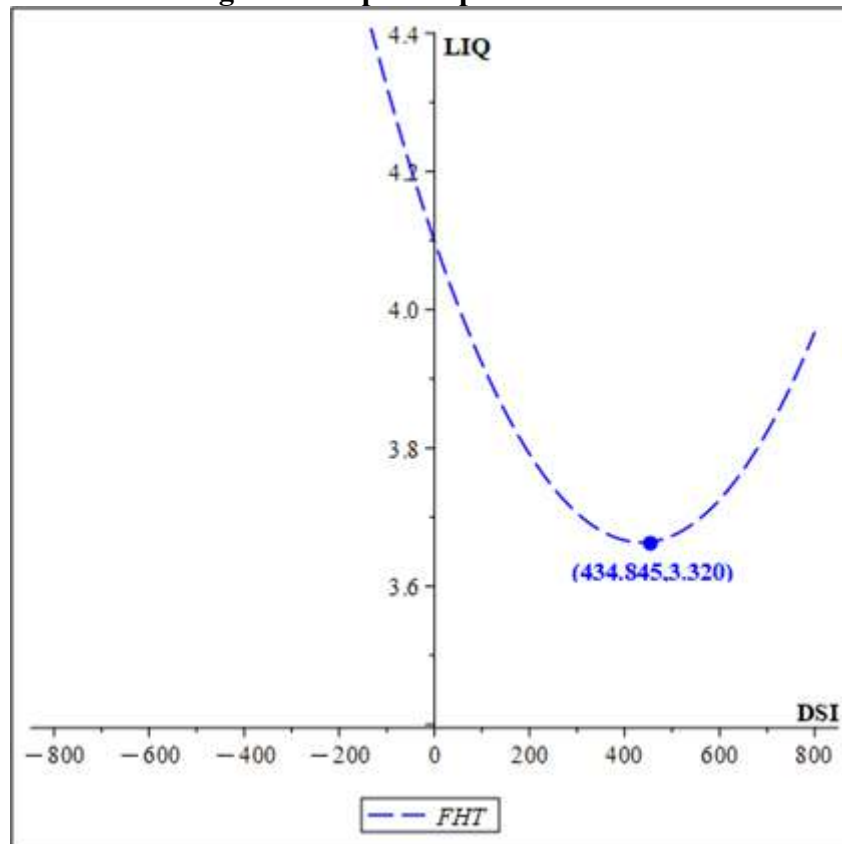
<i>Dependent variable: FHT</i>				
	(4)	(5)	(6)	(7)
<i>CCC</i>	-0.200 (0.288)			
<i>CCC</i> ²	0.075 (0.620)			
<i>DSO</i>		1.349*** (0.001)		
<i>DSO</i> ²		-1.105*** (0.002)		
<i>DSI</i>			-0.731*** (0.000)	
<i>DSI</i> ²			0.306*** (0.000)	
<i>DPO</i>				0.370 (0.304)
<i>DPO</i> ²				-0.024 (0.926)
<i>Leverage</i>	0.008*** (0.000)	1.009*** (0.000)	0.759*** (0.000)	0.798*** (0.000)
<i>Price</i>	0.004*** (0.000)	0.502*** (0.000)	0.506*** (0.000)	0.486*** (0.000)
<i>Size</i>	-0.001*** (0.000)	-0.105*** (0.000)	-0.101*** (0.000)	-0.102*** (0.000)
<i>Age</i>	-0.001 (0.422)	-0.134 (0.294)	-0.086 (0.525)	-0.107** (0.020)
<i>Tangibles</i>	0.001 (0.771)	0.002 (0.408)	-0.005** (0.020)	0.000 (0.941)
β_0	4.073*** (0.000)	3.911*** (0.000)	4.100*** (0.000)	4.003*** (0.000)
<i>N. of observations</i>	66,925	68,026	50,765	66,434
<i>F</i>	0.000***	0.000***	0.000***	0.000***
<i>Hausman</i>	0.000***	0.000***	0.000***	0.000***
<i>Breusch-Pagan</i>	0.000***	0.000***	0.000***	0.000***

Notes: FHT is Fong et al. (2017) illiquidity measure of firm *i* in month *t*; CCC corresponds to firm *i* cash conversion cycle in year *t*; DSO represents firm *i* average customer receivable term in year *t*; DSI reflects firm *i* average inventory turnover term in year *t*; DPO represents firm *i* average supplier payment term in year *t*; Leverage is the leverage ratio of firm *i* in year *t*; Price represents the inverse of the stock price of firm *i* in month *t*; Size is the Ln (Assets) of firm *i* in year *t*; Age is the Ln (Age) of firm *i* in year *t*; Tangibles represents the level of tangible fixed assets of firm *i* in year *t*; β_0 represents the constant of the regression models. The p-values of each coefficient are represented in parentheses. *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively.

Source: Author's elaboration.

On the other hand, there is an optimal DSI point, which is 434.9 days, that maximizes stock liquidity (equation (6)), validating hypothesis H1b. Figure 2 shows the positive concave relation between DSI and the Fong et al. (2017) measure.

Figure 2 – Optimal point of the DSI



Source: Author's elaboration.

DPO (equation (7)) is not statistically significant, suggesting that stock liquidity is not influenced by DPO, and thus rejecting hypothesis H1c.

As with the previous analysis, in all equations, the coefficients of the leverage and price control variables are positive and statistically significant, and the coefficients of firm size are negative and statistically significant. The coefficients of the remaining control variables are not statistically significant.

The results differ depending on the illiquidity measure applied, as the Amihud (2002) measure emphasizes stock breadth, while the Fong et al. (2017) measure focuses on stock rigidity. Therefore, focusing on a different dimension of liquidity impacts results and the way WCM influences investors' perceptions about the firm.

5. Discussion

In aggregate, this paper evidences a non-linear relation between CCC and DSI and firms' stock liquidity, suggesting that investors perceive the WCM trade-offs documented in the literature and incorporate them into stock liquidity. There is an optimal point of WCM that maximizes stocks liquidity. This optimal point contributes to understand managers' efficiency in managing the business, reducing agency costs, and reaching the equilibrium between accounting liquidity and profitability. These results highlight that optimal WCM occurs due to the simultaneous management of all CCC components, or alternatively, due to the optimal management of a single component – inventories in stock.

Specifically, a too high or too low CCC may signal to investors that firms are inefficient, whether because firms are less profitable or because they lack accounting liquidity, making investors less likely to trade firms' stocks without reducing stocks' price. In the same vein, firms that adopt an optimal WCM, maximizing their profitability while ensuring accounting liquidity, may maximize their value, and consequently investors may be more interested in trading stocks of these firms, which improves firms' stock liquidity.

Additionally, a high DSI allows firms to not only avoid the stockout risk and production disruption but also allows them to obtain quantity discounts. However, a higher DSI implies higher storage costs. As such, the underlying reason for the results may be that investors find it more attractive to trade stocks of firms capable of extending their DSI to an optimal point that might maximize firms' value, which consequently maximizes firms' stock liquidity. In the same line of thought, firms that mismanage their inventories destroy value, being, therefore, less likely to be traded.

Contrary to our expectations, a negative relationship between DSO and DPO on stock liquidity is found. Our results suggest that investors are not concerned with an optimal DSO and DPO points because it may depend on the firm strategy and business model.

6. Conclusion

Managing working capital is crucial to sustaining the firm's value and marketability. This work aims to determine if there is an optimal point of WCM that maximizes the firm's liquidity. For it, a panel of 1,145 firms listed on 5 Euronext exchanges between 2011 and 2019 is analyzed. Most studies focus on the impact of working capital management on the firm's performance, and some on stock valuation. Only a few focus on its impact on stock liquidity, but if the firm value and stock price are influenced, as well as its uncertainties, WCM may also impact investors' intention to acquire stocks. This work aims to contribute to the debate of WCM on stock liquidity.

The few researchers who have attempted to link WCM and stock liquidity have analyzed it through a linear relationship. However, there are multiple trade-offs in WCM, which aim to balance the firm's accounting liquidity and profitability. Likewise, this study explores the existence of an optimal point of the WCM that maximizes firm's stock liquidity. We analyze the quadratic function of the CCC and its components to understand the effect on stock liquidity, which is estimated using two alternative measures: Amihud (2002) and Fong et al. (2017), that capture different dimensions of liquidity.

The results confirm the existence of optimal points of CCC and DSI that maximize stock liquidity, indicating that investors are more interested in trading stocks of firms with an efficient WCM. These results are consistent with the theoretical literature that suggests that firms are faced with trade-offs associated with WCM in day-to-day operations. Moreover, an efficient WCM reflects managers' efficiency, which in turn reduces agency costs.

Besides the contribution to literature, these results also have implications for practitioners. Managers can understand how to improve firm's stock liquidity by practicing an optimal CCC and DSI that maximizes firm's stock liquidity. By demonstrating how WCM impacts stock liquidity, it gives relevant insights to shareholders. From the investors' perspective, the implications are that they can improve the stock liquidity of their portfolio, by including firms whose CCC and DSI durations are close to the optimal point that has been found. Finally, the relationship between working capital management and stock liquidity highlights the importance of transparency and information quality in fostering a liquid and efficient stock market.

The main aim of this work was achieved, but it has some limitations. This study focuses on two alternative measures of stock liquidity that capture different dimensions of this concept. The results obtained are sensible to the liquidity measure employed. Although we use two

liquidity measures that focus on stock breadth and on stock rigidity, other liquidity dimensions might be relevant. For instance, future research could use other liquidity measures, such as Liu (2006) measure to capture the immediacy dimension. Moreover, the conclusions are for this sample and period analyzed and cannot be extrapolated to other samples. Further research should expand upon the results obtained in this study by examining different stock exchanges, as they may have different liquidity and WCM practices. Including more recent years can also be an important line of future research, to understand if results are corroborated in moments of high volatility on financial markets. Analyzing developed or emerging stock markets could also be interesting given that the level of development of financial markets and the risk assumed are also different. Finally, it would be pertinent to conduct the analysis by industry since all sectors have singularities regarding financial decisions, which may impact working capital and the way financial investors perceive the firm.

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Appendix 1 –VIF Analysis

Table A.1 – VIF analysis of the models of equations (4) to (7)

Dependent variables: ILLIQ and FHT							
CCC	5.246	DSO	10.804	DSI	9.275	DPO	9.275
CCC ²	5.188	DSO ²	10.766	DSI ²	9.220	DPO ²	9.220
Leverage	1.027	Leverage	1.029	Leverage	1.043	Leverage	1.043
Price	1.144	Price	1.153	Price	1.175	Price	1.175
Size	1.082	Size	1.099	Size	1.064	Size	1.064
Age	1.136	Age	1.147	Age	1.154	Age	1.154
Tangibles	1.023	Tangibles	1.038	Tangibles	1.019	Tangibles	1.037

Notes: ILLIQ is Amihud (2002) illiquidity measure of firm *i* in month *t*; FHT is Fong *et al.* (2017) illiquidity measure of firm *i* in month *t*; CCC corresponds to firm *i* cash conversion cycle in year *t*; DSO represents firm *i* average customer receivable term in year *t*; DSI reflects firm *i* average inventory turnover term in year *t*; DPO represents firm *i* average supplier payment term in year *t*; Leverage is the leverage ratio of firm *i* in year *t*; Price represents the inverse of the stock price of firm *i* in month *t*; Size is the Ln (Assets) of firm *i* in year *t*; Age is the Ln (Age) of firm *i* in year *t*; Tangibles represents the level of tangible fixed assets of firm *i* in year *t*.

Source: Author's elaboration.

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