

Does working capital management affect cost of capital?

A first empirical attempt to build up a theory for supply chain finance

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Abstract

The objective of this paper is to provide evidence on the relationship between working capital management (WCM) and cost of capital. Weighted average cost of capital (WACC), as a measure of cost of capital, illustrates an important variable in the calculation of financial performance measures such as economic value added (EVA). However, WACC is often used as an exogenous variable – independent of WCM efficiency. Several empirical studies have analysed the effect of an efficient WCM on financial performance, especially in terms of profitability. This study goes one step further and analyses the effect of WCM, implemented through the cash conversion cycle (CCC), on WACC. The empirical analysis is based on a panel of 1895 firm years from 2004 to 2009 for Germany, Austria and Switzerland. The correlation analysis conducted reveals that CCC does have an effect on WACC. Dependent on the level of leverage, this relationship can be positive or negative. Therefore, the effect of an efficient WCM can strengthen or weaken the effect of a low CCC on profitability. This study offers evidence for the use of WACC as an endogenous variable in context of WCM.

Keywords: Working capital management, Cash conversion cycle, Cost of capital, Correlation analysis

Introduction

It is generally agreed that efficient WCM increases returns while at the same time reducing net operating assets and capital employed, leading – at a constant cost of capital – to an increase in financial performance. Therefore, WCM is a source of operational and financial efficiency (Smid, 2008). In the last decade, several empirical analyses encountered a positive impact of efficient WCM on corporate profitability. The identification of WCM efficiency as an important indicator of financially successful companies by Johnson and Soenen (2003) supports this development. Their results „show that especially large, profitable companies, with efficient WCM (i.e., relative short cash conversion cycles) and a certain degree of uniqueness (measured by advertising spending relative to sales) outperform the sample average on the three performance measures" (p. 368), i.e., Sharpe ratio, Jensen's Alpha and EVA.

The cost of capital takes a prominent role within the different concepts of measuring financial performance e.g., according to EVA a company aims to achieve a return on invested capital (ROIC) greater than the minimum rate of return i.e., the financing costs, measured as WACC. This contradicts the fact that WACC is traditionally seen as an exogenous variable. WACC's usage as an exogenous factor seems to be partly caused by its components' estimation complexity (Eschenbach and Cohen 2006). This study suggests that cost of capital should be treated as an endogenous variable, because apparently there exists a connection between WCM (=operational side) and cost of capital (=financial side) through the leverage ratio and beta (β). The understanding of these relationships is essential in order to build up a theory for supply chain finance (SCF), linking operations management e.g., purchasing, with corporate finance. Emphasizing the effect of efficient WCM on the dual goals liquidity and profitability, it is the aim of this paper to go one step further and connect WCM with the concept of cost of capital.

Theory implies that the leverage ratio and β are seen as main connecting factors between WCM and cost of capital. Positive as well as negative connections between CCC – as a measurement for the operational side – and WACC – as a measurement for the financial side – are expected. The trade-off theory implies a relationship between leverage and WACC, whose correlation depends on the debt level above or below the “optimum”, in consequence, other than expected, the impact of a shorter CCC on leverage is not always positive. β which is influenced through operating and financial leverage, is suggested to be positively related to CCC. Further, it is assumed that β , although largely determined by the specific industry affiliation, can be influenced through WCM efficiency, as fundamental financial figures and business risks vary.

The purpose of this study is threefold: (i) it aims to investigate how WCM and WACC are interrelated; it aspires (ii) to analyze the impact of CCC on leverage and (iii) to make a first attempt to build a theory for the upcoming topic for supply chain finance.

The approaches relevant to WCM (especially CCC) and cost of capital (especially WACC) are developed in a conceptual model. Based on the assumed relationships, working hypotheses are formulated and empirically tested. First, it is examined whether or not there exists a relationship between CCC and WACC. Second, the crucial levers determining whether the relationship is positive or negative are identified.

The remainder of the paper follows the subsequent organisation: In Section 2, the current state of research is presented and a theoretical framework developed. Section 3 encompasses the model and hypotheses. Using the panel data methodology, the empirical study (Section 4) is based on a data set of 1895 firm years for the six-year period from 2004 to 2009 for Germany, Austria and Switzerland (“D-A-CH” region). Section 5 concludes the paper and provides a practical and empirical outlook.

Literature review

Supply chain finance

The concept of SCF was first used in the early 1990’s (e.g., Hurtrez and Salvadori, 2010), but due to the range and complexity of the subject, no uniform perception of SCF has evolved – neither in practice nor in academics. First systematic attempts to define SCF emerged in 2000 (Hartley-Urquhart, 2000). These buyer-centric understandings were extended later by defining SCF as a broad set of instruments targeting the financial supply chain (e.g., Atkinson, 2008). Recently, SCF is interpreted in a broader sense and some definitions emerged (e.g., JPMorganChase, 2007).

A constitutive element of all attempts is to build a bridge between financial and supply chain processes. A fundamental aim of SCF is to provide liquidity to international trade while adequately addressing the risks associated with the transactions (Global Business Intelligence, 2007). The concept of SCF has been seen by companies as a suitable solution to reduce counterparty risk and sustainably stabilize the different links in the supply chains, to prevent the disruption of whole production lines resulting from financial problems of one important party involved, and to reduce total costs. Pertaining to the topic, Farris II and Hutchison (2002) found out that the best SCM practices led to extended accounts payable (AP), reduced inventory (INV) days of supply and accounts receivable (AR), resulting in a 40% to 65% shorter CCC cycle time than average-performing competitors had. Yet, Seifert and Seifert (2008) suggest a moderate management of trade credit in times of financial constraints, as an aggressive one might lead to disruptions in supply. As a local improvement can have negative effects on the CCC cycle of the previous or following supply chain partners, a holistic approach has to be taken, creating a win-win situation for all involved parties. This requires that companies share their financial information concerning WACC and inventory carrying costs (ICC), in order to

leverage financial strengths throughout the supply chain. It has to be noted that the intended win-win situations are more likely for strategic business partnerships than for arm-length relationships. A portfolio approach – based on classical relationships distinction of purchasing (see especially Kraljic, 1983) – seems to be suitable for this segmentation task. The last major topic deals with additional external participants. Hameri and Hintsa (2009) recognized collaboration and networking between all players within an international supply chain as a key factor for future success. Most importantly, they concluded that logistics service providers (LSP), technology service providers (FinTechs) and financial institutions have the potential to increase their service offerings. As an example, they mention that LSPs will manage their customers' AR. Aside, the rise of SCF in academics and practice, it is the topic of WCM being the core of the concept.

Working capital management

The term working capital (WC) relates to the firm's current assets (CA), while net working capital (NWC) is generally defined as the difference between CA and current liabilities (CL) (Finnerty, 2006; Fazzari and Petersen, 1993; Hillier et al., 2010). WCM includes the management of CA, current liquidity, as well as the interrelationship between them (Finnerty, 2006).

To measure WCM, static and dynamic indicators can be differentiated (Richards and Laughlin, 1980; Gallinger, 1997; Farris and Hutchison, 2002). The current ratio (CR) is the most conventional static liquidity measure. It is based on balance sheet data, measuring the relation between CA and CL to assess the company's ability to meet obligations through the liquidation of assets (Farris and Hutchison, 2002). Emphasizing a liquidation approach rather than a going-concern understanding (Richards and Laughlin, 1980), the CR is of questionable value to assess a company's adequate liquidity position and especially, to examine a firm's efficiency in managing its WC (Emery, 1984; Kamath, 1989; Soenen, 1993; Shin and Soenen, 1998; Gallinger, 1997).

Gitman (1974) introduces the CCC, which captures the ongoing liquidity from a company's operations, measuring the interval from cash outflow to cash inflow. Hager (1976) emphasizes that „cash management begins when money is spent to begin production and ends when money is received from the sale“ (p. 19) and presents a similar approach to manage the uncertainties of operating cash cycles. The introduction of the CCC by Richards and Laughlin (1980) operationalized the cash cycle concept. The CCC is alternatively called cash-to-cash cycle (C2C) (Farris and Hutchison, 2002; Farris and Hutchison, 2003).

The CCC provides the average number of days needed to convert tied up WC into cash by measuring „the days funds are committed to inventories and receivables, less the number of days that payment to suppliers is deferred“ (Gentry et al., 1990, p. 90). CCC is an additive measure consisting of three components: days inventories hold (DIH), days sales outstanding (DSO) and days payables outstanding (DPO). The CCC is calculated as

$$CCC = DIH + DSO - DPO,$$

$$\text{while } DIH = \frac{INV}{COGS} * 365 \text{ days, } DSO = \frac{AR}{Sales} * 365 \text{ days, } DPO = \frac{AP}{COGS} * 365 \text{ days.}$$

CCC is appreciated as an adequate guide for companies' WCM and a commonly used measure. For these reasons, the CCC has been chosen as the appropriate measure for WCM efficiency in this study.

With CCC we now have an instrument at hand to manage WC efficiently. Already, Hager (1976) points out that „from a strictly detached point of view, the aim of effective cash management with respect to the cash cycle would be to shorten the cycle as much as possible and thus speed the flow of cash in and out of operations“ (p. 19). However, since WCM confronts an optimization problem – localizing a sweet spot between liquidity and profitability – minimizing the CCC utmost is not the main target. WCM is expected to support the corporate’s primary goal of profitability while at all times satisfying the company’s liquidity requirements, as emphasized by Jose et al. (1996).

On one hand, a long CCC indicates a conservative liquidity management or even excess liquidity and has a negative effect on profitability. As Skomorowsky (1988) states: „It is commonly accepted that tying up cash in excess INV has a depressing effect on net income“ (p. 84). On the other hand, it is generally agreed that a low CCC has a positive effect on profitability (Skomorowsky, 1988; Gentry et al., 1990; Farris and Hutchison, 2003). Coherently, a short CCC implies higher profitability, because this company generates more revenue per invested production unit (Hutchison et al., 2007). In consequence, a lower CCC results in a higher net present value of the net cash flows produced by the company’s assets, assuming a constant discount rate (Jose et al., 1996). In addition, an expedient WCM reduces tied up capital and often considerable financial resources are released. For each day by which CCC is lowered, less funds committed have to be financed and the need for costly external financing is reduced. The reduction of redundant WC to a minimum reduces assets and capital tied up (Finnerty, 2006; Rafuse, 1996).

Following the elementary work of Jose et al. (1996) and Shin and Soenen (1998), in the last decade several studies have empirically analysed the relationship between WCM efficiency and profitability (e.g., Wang 2002, Deloof 2003, Raheman et al. 2010). Besides traditional profitability measures such as return on assets (ROA), financial success has been measured in terms of different risk-adjusted profitability measures (especially Sharpe ratio, Jensen’s Alpha and EVA), firm value and stock performance.

Cost of capital

Extensive literature exists on long-term financial decisions, mainly emanating from the famous propositions of Modigliani and Miller (1958 and 1963). WACC reflects the cost of obtaining part of the total capital required from equity investors and the remaining part from debt investors (Groth and Anderson, 1997). WACC calculates the cost of capital using a weighted average of the cost of equity and debt. The weight of equity and debt corresponds to their share of a company's total capital. The weights are multiplied with the corresponding cost of equity or debt. Since interest expenses on debt are tax deductible in most countries, the cost of debt is multiplied with (1 - t). The resulting reduction in the cost of debt reflects the tax advantage of debt financing i.e., tax shield. The WACC is generally calculated as (Hillier et al, 2010)

$$WACC = r_E * \frac{E}{E+D} + r_D * (1 - t) * \frac{D}{E+D},$$

$$\text{while } r_E = r_f + \beta * (r_m - r_f), \quad \beta_L = \beta_U * \left[1 + (1 - t) * \frac{D}{E}\right], \quad r_D = r_f + RP$$

with E = equity; D = debt; r_E = expected return on equity; r_D = expected return on debt or interest rate; t = corporate tax rate; r_f = risk-free interest rate; r_m = expected return on the market portfolio; β = beta coefficient; β_L = levered beta; β_U = unlevered beta; RP = risk premium.

The cost of equity can be viewed as the expected or required return on equity securities. The most widely accepted measure instrument in practice for the cost of equity is the capital asset pricing model (CAPM) – a one factor model – developed by Sharpe (1963). The CAPM

assumes that a risky investment provides the investor with a reward in excess of the risk-free rate i.e., equity risk premium (ERP). The size of this risk premium is proportionate to the amount of systematic risk i.e., market risk, assumed (Ibbotson, 1999) and is not diversifiable (Lee et al., 2010). The most deterministic component of the CAPM is β which measures a stock's relative sensitivity to the market, and illustrates a universally accepted measure of systematic risk. Despite its weaknesses (e.g., Eschenbach and Cohen, 2006), „[...] CAPM is one of the most important advances in financial economy“ (Hillier et al, 2010, p. 285). Therefore, it is applied in this study because of its widespread use, its theoretical foundation and its simplicity.

Analogously, cost of debt comprises the risk-free interest rate plus a compensation for the default risk, called the risk premium (RP). RP depends on the company's risk of default. Rating agencies assess the risk of default associated with a company's debt security and assign a credit rating thereon. As default risk is largely determined by financial leverage, RP is positively correlated with leverage (Cohen, 2004, p. 89).

Modigliani and Miller (1958 and 1963) evoked an analytical controversy (Hillier et al., 2010) as their propositions imply that all firms should maximize debt, which does not predict the behaviour of firms in the real world. Baxter (1967) suggests that „once the ‘acceptable‘ amount of leverage has been passed, the rate of interest on debt will begin to rise and may cause the cost of capital for the overleveraged firm to increase“ (p. 395). According to Baxter (1967) this is caused by the risk associated with servicing outstanding debt and the impossibility of obtaining external financing without a sufficient equity cushion.

The static trade-off theory, developed by Kraus and Litzenberger (1973), suggests that a company's capital structure decision involves a trade-off between associated tax benefits and costs of financial distress. In general, WACC falls with additional debt until the point of optimal leverage is reached. After this point, additional debt increases WACC because the financial distress costs offset the tax shield benefit. The optimal amount of debt i.e., the optimal capital structure, optimizes WACC and maximizes firm value. The trade-off theory implies that there is an optimal amount of debt for any individual firm, which becomes the company's target debt level. Although „the theories of capital structure are among the most elegant and sophisticated in the field of finance [...], the practical applications of the theories are less than fully satisfying“ (Hillier et al., 2010, p. 454). One reason may be the absence of a (ex ante) formula for the calculation of the optimal leverage ratio.

Another common assumption in the context of capital structure is the pecking-order theory, attributed to Myers (1984) and Myers and Majluf (1984). The theory claims that a company initially utilizes internal financing. „If external finance is required, firms issue the safest security first. That is, they start with debt, then possibly hybrid securities such as convertible bonds, then perhaps equity as a last resort“ (Myers, 1984, p. 581). In contrast to the trade-off theory, there is no target leverage ratio. Rather, each company chooses its leverage ratio on its cumulative requirements for external financing (Hillier et al., 2010; Myers, 1984). In addition, this approach states that profitable firms employ less debt, as they generate cash internally, and that companies appreciate financial slack i.e., companies accumulate cash today to be able finance profitable projects in the future.

Résumé

WACC embodies an essential comparative value for different financial performance measures. Within the concept of EVA a company aims to achieve a ROIC that exceeds its financing costs, measured as WACC. However, WACC is depicted as an exogenous variable – isolated from WCM. In accordance with the literature review, this coherence confirms the initial assumption that the topics of WCM and cost of capital, each on its own, have been studied intensively in

the scientific literature but have not been explored in relationship to each other – whether in theory or in the area of empirical research. This is most surprising, because of the presumably existing interaction between the two research streams.

Model

Connecting working capital management with the cost of capital

Measuring financial performance with the concept of EVA illustrates the different effects of an efficient WCM on WACC particularly evident. Since a lower CCC decreases net operating assets, WCM directly impacts the financing requirements of a company and hence, its capital structure. Subsequently, the capital structure's weighting of equity and debt affect the WACC. In addition, it is generally agreed that efficient WCM increases profits as capital is released and coherently, associated costs e.g., ICC, fall. The decreasing costs alter operating leverage i.e., measuring fixed costs relative to variable costs. As part of the business risk, operating leverage is another factor influencing β . Therefore, WCM represents a source of operational as well as financial efficiency (Smid, 2008).

In contrast, the cost of capital limits WCM, as this figure depicts the minimum rate of return for investing and flowing capital through the business cycle i.e., the indifference point between investing into the cash cycle or investing elsewhere. Thereby, the cost of capital determines the total cash cycle i.e., WC. In other words, „investments in this business cycle are only rational if they generate economic returns greater than the cost of capital and higher than that available in alternative opportunities of equal risk“ (Groth and Anderson, 1997, p. 476).

This paper aims to expand the existing understanding and empirical research on the relationship between CCC and profitability, extending it to include the impact of WCM on cost of capital. This shall be interpreted as a first step towards the endogenization of WACC in the area of conflict between decisions in the supply chain (operational side) and performance (financial side).

Hypotheses

Whereas the risk-free rate and ERP are exogenously given by the market, β estimates are to a large extent indirectly determined by financial accounting measures. The weights of debt and equity as well as the RP are firm specific. Among the most apparent influences of CCC on WACC is the level of debt. With decreasing leverage the weight of equity increases; however, the effect of the weight of debt on WACC is lower as it is reduced through the tax shield than the effect of the weight of equity.

The capital structure of a company also affects the RP, rising with leverage due to an increasing default probability. The application of leverage generally enhances returns because of an accelerating effect of the tax shield, but meanwhile the risk of financial distress rises exponentially – exceeding the tax shield's benefit after the optimal level of debt has been reached. A premium is required by the investor to compensate for additional risk, indicating that financial leverage not only affects RP but also β .

Besides financial leverage there exists another risk dimension affecting β . Whereas financial risk captures the risk of taking on additional debt i.e., increasing leverage, business risk depicts the uncertainties of a company's operations i.e., the risk inherent in a firm's operations. Business risk „can also be defined as the uncertainty inherent in projections of future operating income or earnings before interest and taxes (EBIT)“ (Lee et al., 2010, p. 99). These fluctuations in EBIT can result from macroeconomic as well as from industry and firm-specific factors. Moreover, RP is negatively correlated with operational performance i.e., decreasing operational performance increases the RP because debt holders will require a higher compensation for

bearing the additional non-systematic risk. Consequently, both, the cost of equity and the cost of debt are negatively correlated with a company's operational performance. By adding the cyclicity of revenues and operating leverage as business risk to financial leverage, Hillier et al. (2010) accordingly list three determinants of β : (i) cyclicity of revenues, (ii) operating leverage, and (iii) financial leverage.

Regarding the influence of business risk and financial risk on β ; whereas the unlevered beta (β_u) measures the business risk and the debt-to-equity ratio the financial risk, levered beta (β_L) is positively correlated with business risk and financial leverage. It has been shown that efficient WCM impacts the capital structure and therefore, the leverage ratio. In addition, CCC directly influences CA and non-current assets (NCA) i.e., the asset composition of the balance sheet. The reduction of non-current assets relative to total costs results in a lower operating leverage and a lower β associated with it.

An essential assumption to illustrate the relationship between CCC and leverage is that if companies do not have the means to internally fund additional financial needs, the next level in the hierarchy of the pecking-order theory will be consulted. Therefore, it is assumed that any financial gap of WC is bridged with interest-bearing debt. Vice-versa, if WC decreases, debt does as well, assuming a constant level of equity.

An efficient WCM lowers WC tied up in operations processes which decreases the financial expenditure for this item and finally, the additional funds can be employed to reduce short-term as well as long-term obligations. Consistently, it is expected that a short CCC reduces the level of debt. In reference to a leaner balance sheet as well as to a constant equity this results in a lower leverage ratio.

Hypothesis H1a: CCC is positively related to the leverage ratio (LEV).

A second cornerstone is related to the static trade-off theory. This approach is required when examining the relationship between leverage and WACC. The trade-off theory suggests that it is not solely the level of debt which influences cost of capital, but also other costs i.e., financial distress costs. Initially, because of the tax shield, WACC decreases as leverage increases. After the optimal point of the capital structure is reached, WACC begins to rise again with increasing leverage, because financial distress costs increase faster than the tax shield benefit. Where WACC is minimized the optimal leverage ratio is reached. For hypothesis 1b it is assumed that RP comprehends these financial distress costs.

The leverage ratio has an influence on WACC through its effect on β , RP, and the weights of cost of equity, respectively debt. As RP and β comprehend the costs of financial distress, both measures are expected to rise with increasing leverage. The lower the leverage (below optimal leverage), the lower the effect of a change in leverage on RP and β and the higher the effect of the tax shield. As above the optimal leverage additional debt is added, the financial distress costs raise at an increasing rate i.e., the higher the effect of a rising leverage on RP and the lower the effect of the tax shield:

- Above the optimal point of leverage the effect of a decreasing debt level causes a diminishing WACC. First, the weight of equity increases as debt decreases with the effect of a debt reduction on the WACC being diluted by the tax shield. Second, β decreases which in accordance to the CAPM reduces the cost of equity. Third, with an overall decreasing risk level, RP decreases as well.
- Below the optimal point of leverage, β and RP are assumed to be constant; therefore the effect described above no longer apply. WACC rises with decreasing leverage because the capital structure comprehends a higher equity portion i.e, equity is more expensive than debt.

This leads to the second hypothesis:

Hypothesis H1b: Leverage is positively related to WACC above the optimal capital structure and negatively related to WACC below the optimal capital structure.

Regarding the trade-off theory, WACC is generally not positively related to leverage. Therefore, the effect of an efficient WCM i.e., shorter CCC, results in different reactions of the WACC, conditional on a company's leverage level. Whereas the CCC is positively related to WACC above the optimal point of leverage, it is negatively related to the WACC below the optimal point of leverage. The operating leverage embodies an additional factor which affects the WACC through β . Next, it has to be discussed if there exists a relationship between CCC and β with the operating leverage as the connecting link.

Several CCC-reducing levers seem to exist which influence operating leverage. First, the direct reduction of CA through a reduced CCC cause operating costs to decrease e.g., COGS diminish due to lower ICC and improved discount drawing rates. Finnerty (2006) adds the reduction of other costs such as insurance and handling e.g., unlocking savings potential through supplier network synergies. Second, through an indirect reduction of NCA, non-operating expenses might decrease as well. Despite the fact that operating leverage is largely determined by specific industry characteristics, efficient WCM lowers a firm's NCA and therefore, its operating leverage. This results in a flexible cost base which in turn lowers the overall business risk and hence, β . Therefore, it can be postulated:

Hypothesis H2: CCC is positively related to WACC through its positive relationship to the business risk and the unlevered beta in turn.

Empirical study

Methodology

The methodology applied in this study follows the empirical work on WCM of Jose et al. (1996) and Shin and Soenen (1998). Shin and Soenen (1998) performed a Pearson and Spearman correlation matrix as well as different regressions of profitability on WCM. These studies are extended by substituting profitability with the cost of capital and empirically establishing a relationship between WCM, cost of capital and profitability. Following these approaches, the data set in this study is divided along leverage quartiles in order to gain a deeper understanding of the connecting factors in the relationship between WCM and cost of capital.

The panel data collected for the analysis includes Austrian, German and Swiss listed companies over a six-year period from 2004 to 2009. Listings and delistings of any kind e.g., public-to-private buyouts, bankruptcies, were not considered to obtain a robust sample set and avoid the introduction of financial anomalies of companies in special situations. From an econometric point of view, survivorship bias was eliminated and explanatory power increased. This data set passes through a whole business cycle i.e., from a recovery phase (post "Dotcom bubble") over an expansion period (global acceleration) to a stage of contraction (beginning with the bankruptcy of Lehman Brothers) and therefore, illustrates a suitable sample set. The data was retrieved from Thomson One Banker database compiled by Thomson Reuters. For the purpose of this study, WCM is measured by CCC. The companies were divided into industry groups based on the Industry Classification Benchmark (ICB) in order to evaluate the data on the behaviour of the relationship between CCC and WACC for various industry groups. In a first step, a normal distribution of the CCC of each company was generated and each data point beyond 2-sigma was discarded to remove statistical outliers. Subsequently, in a second step, certain industries have been removed based on the CCCs presented in "The 2008 Working Capital Scorecard" (Myers, 2008, pp. 83-86), published by the CFO Magazine on an annual basis. These are utilities, financials, and other services. The industries covered in this study are

machinery, construction & building materials, electronic & semiconductor industry, chemical & pharma, retail, transportation & logistics, food & beverage as well as consumer products. The final sample consists of panel data of 1835 firm year observations and is the sum of 207 firm year observations of Austria, 1182 of Germany and 506 of Switzerland.

Following the CAPM to define the cost of equity, the risk-free rate and the ERP have to be estimated from capital markets. By comparing the return on equities with the risk-free rate, the historical rewards that investors have enjoyed for bearing systematic risk is obtained (Dimson et al., 2002, p. 8). According to Damodaran (2010, p. 20), for the estimation of the cost of equity it is vital to be consistent in the length of the time period (long-term or short-term), the risk-free security employed (government bills or bonds) and whether to use either arithmetic or geometric averages. As the various balance sheet items as well as market figures are correlated i.e., not independent events, the utilization of a geometric mean becomes necessary. The ERP is calculated as the difference between very long-term equity returns and government bonds. The calculation of the average returns is based on the index data provided by the “Credit Suisse Global Investment Returns Sourcebook 2010”. The CAPM’s third variable to be estimated is β . In this study, β of each company is directly provided by Thomson One and adjusted according to Blume (1975) to capture the mean reverting property of this value.

Variables		Assumption	Source
WACC	WoE / WoD	Weight of equity / Weight of debt	Market values (yearly average)
	t	Corporate tax rate	Country specific tax rates (same corporate tax rate for all firms in one country)
	r _D	Risk premium (RP)	RP is dependent on the interest coverage ratio (EBIT divided by Interest Expenses) and is calculated on the company level (i.e., for each firm year)
		Risk-free rate	Geometrical average return on government bonds from 1900-2009 on the country level (nominal data)
	r _E	Equity risk premium (ERP)	Geometrical average ERP (stocks compared to government bonds) from 1900-2009 on the country level
		Beta (β)	Calculated on the firm level (i.e., derived from each firm year separately)

Table 1: Assumptions on WACC

The calculation of the RP follows Cohen (2004). In theory, any company can default on its debt. The extent of this risk factor is measured by the probability of default, which leads to the credit rating. Since RP is dependent on the credit rating, the credit rating process as a classification system provides a common background for the comparison of all firms and for the calculation of RP over the risk-free rate i.e., the spread (Cohen, 2004). The spreadsheet of Damodaran (2011) allows for the estimation of a rating and the corresponding spread over the risk-free rate on the basis of the company’s interest coverage ratio. The interest coverage ratio is calculated as EBIT divided by interest expenses. As both variables are easily derived from Thomson One, the spreadsheet of Damodaran (2011) is used in this study.

Other figures which have to be estimated in the context of WACC are the weights of equity and debt as well as the corporate tax rate. Roll (1977) points out that the calculation of the weights is ideally based on market values, rather than book values. In this study the weights of equity and debt are based on market values (yearly averages) provided by Thomson One. The tax rate

is obtained from “KPMG’s Corporate and Indirect Tax Survey 2010” (KPMG, 2010, pp. 64-69). The “classical” trade-off between liquidity and profitability which efficient WCM faces is analysed as supporting and control variables. The CR depicts the classic static liquidity measure and is measured as CA divided by CL. ROA and return on equity (ROE) are common measures of profitability. Following the methodology of several empirical analyses, ROA and ROE are calculated with EBIT instead of net income (Jose et al., 1996; Wang, 2002; Padachi, 2006; Garcia-Teruel and Martinez-Solano, 2007): ROA is EBIT divided by total assets (TA) and ROE is earnings before taxes (EBT) divided by shareholders’ equity.

Table 2 provides the summary statistics of the relationship of CCC and WACC, as well as their components and control variables for the total sample as well as the individual countries.

	Total N = 1895	Austria N = 207	Germany N = 1182	Switzerland N = 506
Variable	Mean	Mean	Mean	Mean
DIH	88	72	84	102
DSO	69	67	67	73
OP	156	139	151	175
DPO	51	41	47	64
CCC	106	98	104	111
Risk-free rate	3.00	2.47	2.47	4.46
Adj. Beta	0.80	0.65	0.76	0.95
Market return	7.92	8.31	8.31	6.84
Equity risk premium	4.70	5.58	5.58	2.27
Cost of equity	6.50	5.89	6.56	6.61
Weight of equity	0.78	0.74	0.79	0.78
Risk premium	3.90	3.63	3.88	4.06
Cost of debt	6.99	6.22	6.47	8.52
Weight of debt	0.22	0.26	0.21	0.22
Tax rate	0.31	0.26	0.35	0.22
WACC	6.25	5.74	6.14	6.72
Leverage	36.84	48.13	34.72	37.17
Debt ratio	22.19	26.03	21.53	22.17
CR	2.16	1.96	2.23	2.06
ROA	5.75	8.48	6.26	3.43
ROE	5.09	8.26	5.73	2.28
Size*	13.09	12.87	13.17	12.99

Table 2: Descriptive Statistics

Notes: *Natural logarithm of sales

Analysis

In the following, the relationship between CCC and WACC is analysed. The relationship between the length of CCC and WACC is examined by calculating the Pearson linear and Spearman rank correlation coefficients for the total sample as well as the individual countries. Pearson correlation coefficients are indicated with r and Spearman rank correlation coefficients are indicated with r_s . As the Spearman rank correlation reveals more significant and higher correlations, the focus is laid on the Spearman rank correlation coefficients for the most part of the analysis. In addition, the p-values (indicated by p) report the significance of the correlation coefficients. This main analysis is supported by the evaluation of the influence of leverage.

Analysing the relationship between the two liquidity measures CCC and CR reveals a highly positive significant value for the Pearson as well as for the Spearman correlation (Table 3). However, the Spearman correlation, with coefficients ranging from $r_s = 0.289$ for Germany to $r_s = 0.431$ for Switzerland, generates higher coefficients than the Pearson correlation. These

results support the assumption of a positive relationship between efficient WCM and traditional static measures of liquidity.

	Spearman correlation				Pearson correlation			
	Total	Austria	Germany	Switzerland	Total	Austria	German	Switzerland
N	1895	207	1182	506	1895	207	1182	506
CCC – CR	.329 ** (.000)	.352 ** (.000)	.289 ** (.000)	.431 ** (.000)	.118 ** (.000)	.300 ** (.000)	.093 ** (.001)	.233 ** (.000)
CCC – ROE	.035 (.124)	.100 (.152)	.051 (.079)	-.030 (.504)	.089 (.185)	.063 (.393)	.101 (.187)	.072 (.218)
CCC – ROA	.030 (.187)	.088 (.205)	.046 (.115)	-.028 (.526)	.032 (.160)	.079 (.258)	.043 (.139)	.029 (.522)
CCC – WACC	.087 ** (.000)	.194 ** (.005)	.116 ** (.000)	-.087 (.051)	.075 ** (.001)	.098 (.160)	.096 ** (.001)	-.069 (.122)
CCC – LEV	-.060 ** (.009)	.200 ** (.004)	-.055 (.058)	-.161 ** (.000)	-.077 ** (.001)	.121 (.083)	-.064 * (.028)	-.203 ** (.000)
LEV – WACC	-.034 (.140)	.133 (.057)	-.117 ** (.000)	.123 ** (.005)	.066 ** (.004)	.295 ** (.000)	.024 (.407)	.195 ** (.000)
LEV – Beta	-.003 (.883)	.055 (.429)	-.016 (.589)	.029 (.511)	-.053 * (.021)	.044 (.532)	-.047 (.103)	-.091 (.041)
CCC – Beta	.093 ** (.000)	.190 ** (.006)	.128 ** (.000)	-.098 * (.027)	.067 ** (.003)	.105 (.133)	.105 ** (.000)	-.074 (.098)
LEV – RP	.375 ** (.000)	.480 ** (.000)	.363 ** (.000)	.380 ** (.000)	.166 ** (.000)	.329 ** (.000)	.146 ** (.000)	.132 ** (.003)
CCC – RP	-.086 ** (.000)	.018 (.799)	-.106 ** (.000)	-.067 (.123)	.001 (.968)	-.008 (.913)	-.010 (.725)	.027 (.546)
LEV – WoE / WoD	+/-1.000 ** (.000)	+/-1.000 ** (.000)	+/-1.000 ** (.000)	+/-1.000 ** (.000)	+/- .863 ** (.000)	+/- .863 ** (.000)	+/- .860 ** (.000)	+/- .887 ** (.000)
CCC – WoE / WoD	+/- .060 ** (.009)	+/- .200 ** (.004)	+/- .055 (.058)	+/- .161 ** (.000)	+/- .070 ** (.002)	+/- .214 ** (.002)	+/- .059 * (.043)	+/- .198 ** (.000)

Table 3: Summary Pearson and Spearman correlation coefficients

Notes: Summary of the most important variables of the Pearson and Spearman correlation matrices for the total sample of Austria, Germany and Switzerland; p-values in parentheses; * significant at the level $p < 0.01$; ** significant at the level $p < 0.05$; N is the number of observations in the sample.

Considering that efficient WCM increases the firm's profitability, a negative relationship between CCC and ROE as well as ROA is expected. Other than assumed, the analysis reveals insignificant and mostly positive correlation coefficients. Only Switzerland shows low negative Spearman correlations – however, they are also insignificant.

Examining the relationship between CCC and WACC (hypothesis H1b), the results for the total of 1895 firm years reveal a rather low positive Spearman correlation of $r_s = 0.087$, but at a highly significant level ($p < 0.01$). The Pearson correlation is slightly lower but still highly significant. The Spearman and Pearson correlation coefficients for the relationship between CCC and leverage are highly significant but slightly negative ($r_s = -0.060$, $p < 0.01$; $r = -0.077$, $p < 0.01$). The Spearman correlation coefficient measuring the relationship between leverage and WACC (hypothesis H1b) is negative ($r_s = -0.034$) but insignificant, whereas the Pearson correlation with $r = 0.066$ is slightly positive and significant. CCC is with $r_s = 0.093$ significant and positively correlated with β , indicating a positive relationship between CCC and WACC.

Level of leverage			
1st	2 nd	3rd	4 th

	quartile	Quartile	quartile	Quartile
N	474	474	473	474
Mean LEV	3.076	17.708	36.852	89.710
Mean WACC	6.270	6.519	5.961	6.252
Mean CCC	111	109	100	103
Mean Beta	0.727	0.821	0.747	0.753
Mean RP	3.749	3.245	3.601	5.019
CCC – WACC	.135 ** (.003)	.024 (.598)	.058 (.205)	.103 * (.025)
CCC – LEV	.043 (.352)	-.107 * (.020)	.027 (.563)	-.061 (.183)
LEV – WACC	.054 (.243)	.049 (.285)	-.015 (.743)	.083 (.070)
CCC – Beta	.124 ** (.007)	.019 (.688)	.045 (.329)	.165 ** (.000)
LEV – Beta	.095 * (.038)	.082 (.074)	-.022 (.634)	-.152 ** (.001)
Beta – WACC	.969 ** (.000)	.917 ** (.000)	.866 ** (.000)	.656 ** (.000)
CCC – RP	-.096 * (.036)	-.018 (.702)	-.047 (.303)	-.129 ** (.005)
LEV – RP	-.043 (.350)	.173 ** (.000)	.111 * (.016)	.365 ** (.000)
RP – WACC	.004 (.932)	.241 ** (.000)	.270 ** (.000)	.565 ** (.000)

Table 4: Impact of level of leverage

Notes: The total sample is divided into four quartiles according to the leverage; The cash conversion cycle measures have been rounded to the nearest number of days; Spearman rank correlation coefficients are provided; p-values in parentheses; * significant at the level $p < 0.01$; ** significant at the level $p < 0.05$; N is the number of observations in the sample.

Next, the influence of leverage on different mean variables and correlations is examined. According to hypothesis H1b and trade-off theory, the relationship between leverage and WACC is expected to be negative for the first quartile and positive for the fourth quartile. For all quartiles, low and insignificant Spearman rank correlation coefficients are provided for the relationship between leverage and WACC (Table 4). However, there is a significant positive correlation for the relationship between CCC and WACC at both ends: $r_s = 0.135$ ($p < 0.01$) for the first quartile and $r_s = 0.103$ ($p < 0.05$) for the fourth quartile.

To enhance the understanding of the interrelation between CCC and WACC, single and multiple regression analyses are conducted. The single regression regresses WACC on CCC for the total sample of 1895 firm years. Subsequently, in the multiple regression model WACC is regressed on CCC, beta, RP, leverage and size for the same sample.

$$(1) \text{ WACC} = \beta_0 + \beta_1 \text{CCC}$$

$$(2) \text{ WACC} = \beta_0 + \beta_1 \text{CCC} + \beta_2 \text{BETA} + \beta_3 \text{RP} + \beta_4 \text{LEV} + \beta_5 \text{SIZE}$$

Dependent variable: Regression model	CCC (1)	CCC (2)
R ²	0.006	0.755
Adjusted R ²	0.005	0.755
F statistic	10.643	1167.167
Significance	0.001	0.000
Durbin-Watson statistic	-	1.953

Variables	Coef.	Sig.	Coef.	Sig.	VIF
Constant	5.978	0.000	2.598	0.000	-
CCC	0.003	0.001	0.001	0.009	1.031
BETA			3.270	0.000	1.118
RP			0.145	0.000	1.174
LEV			0.002	0.000	1.050
SIZE			0.031	0.012	1.250

WACC	= Weighted average cost of capital	RP	= Risk premium
CCC	= Cash conversion cycle	LEV	= Leverage
BETA	= Beta coefficient	SIZE	= Size (nat. log. of Sales)

Table 5: Single and multiple linear regression analysis

The simple linear regression model reveals a highly significant but with $\beta_1 = 0.003$ only slightly positive and therefore, weak impact of CCC on WACC. R^2 as a measure of how much of the variability in the outcome is accounted for by the predictors (Field, 2009) is 0.006. This indicates that CCC accounts for only 0.6 percent of the variation in WACC. Therefore 99.4 percent of the variation in WACC cannot be explained by this regression model.

As CCC by itself only explains an insignificant part of the variation in WACC, a multiple regression model is conducted to locate the factors explaining a large part of the variance in WACC. The correlation coefficients provide a good indication of powerful explanatory variables. The exogenous variable WACC is regressed against the five endogenous variables CCC, beta, RP, leverage and size.

The regression coefficients reveal a positive but weak relationship of $\beta_1 = 0.001$ ($p < 0.01$) between CCC and WACC. The impact of leverage ($\beta_4 = 0.002$, $p < 0.01$) is also very small and only slightly higher than CCC. Meanwhile, the rest of the variables are higher and more importantly statistically significant. With a multiple correlation coefficient of $\beta_2 = 3.270$, beta has the largest impact on WACC, followed by the RP with a regression coefficient of $\beta_3 = 0.145$. The control variable size also has a coefficient of $\beta_5 = 0.031$ ($p < 0.05$), which is even larger than the impact of the CCC and leverage. The value of R^2 has improved and risen from 0.006 to 0.755. The five predictors in the multiple regression model therefore account for 75.5 percent of the variation in WACC. The value of the adjusted R^2 is ideally equal to, or very close to, the value of R^2 and is an indicator of how well the model generalizes (Field, 2009). For this data set the value of R^2 and the adjusted R^2 are identical, indicating that the variance in the outcome is the same regardless of whether the model is derived from the population rather than

a sample (Field, 2009). The F statistic is 1167.167 and highly significant at $p < 0.001$, revealing that the multiple regression model predicts the outcome value of WACC significantly well.

The variance inflation factor (VIF) detects the presence of multicollinearity among the predictors. Field (2009, p. 242) suggests that a VIF greater than 10 is a cause for concern. Here all predictors have a VIF in the range of 1.031 to 1.250, indicating that there is no multicollinearity between the predictors in this regression model. In addition, the Durbin-Watson statistic results in a value of 1.953 i.e., no autocorrelation.

The results of the empirical analysis do not generally confirm the hypotheses set out. Hypothesis H2 can be validated for firms with a leverage above the optimal point of leverage. For lower leverages the effect of CCC on WACC is not as clear as expected. Furthermore, the effect of CCC on leverage can be negative as well. The regression analysis shows that the impact of leverage is rather small. However, the regression analysis confirms a strong positive impact of beta on WACC.

Discussion

The following facts can be derived from the country-specific analyses:

- Hypothesis H1a, claiming a positive relationship between CCC and leverage based on the pecking-order theory, cannot be fully validated. Germany and Switzerland reveal significant negative correlations, whereas Austria shows a significant positive correlation.
- Hypothesis H1b focuses on the relationship between the leverage ratio and WACC, which according to the trade-off theory can be positive or negative, depending on the leverage ratio. Whereas Austria and Switzerland reveal positive correlations, Germany shows a negative correlation. Overall, the results support hypothesis H1b.
- As for hypothesis H2, the correlation between CCC and β is significantly positive for Austria and Germany, but negative for Switzerland. Hypothesis H2 cannot be verified in general.

From these insights, the following provides a solid fundament to establish a theoretical framework for SCF:

- *Ad H1a:* The model suggests leverage to be the most important connection between CCC and WACC. It is most surprising that the relationship between CCC and leverage is not (always) positive, but rather negative in two countries. The effect of a reduction of CCC on leverage seems to depend on the actual leverage ratio – analogous to the trade-off theory in relation to WACC. As capital released through the reduction of WC is not needed for a reduction of debt, the pecking-order theory assumed in this context has to be questioned. It is reasonable that, below the optimal level of debt, an increase in WCM efficiency seems to have an adverse effect – as it is not proper to lower the level of debt further (for Germany and Switzerland, but not for Austria).
- *Ad H1b:* Contrary to the expectation, the relationship between CCC and leverage is not always positive and coherently, the direction of the correlations between leverage and WACC does not automatically predict the direction of the relationship between CCC and WACC. This introduces new perspectives which enable us to attain a positive correlation between WCM and cost of capital from two totally different backgrounds: (i) the “rule compliant case” (Austria and Switzerland) where it is possible to influence cost of capital through the optimization of WCM efficiency. (ii) the “below leverage case” (Germany) where leverage is below the optimal level of debt. Despite negative correlation between CCC and leverage and negative correlation between leverage and WACC, there exists a

positive correlation between CCC and WACC. This insight implies that it is possible to lower cost of capital through efficient WCM if leverage and CCC are negatively related.

- *Ad H2:* The relationship between CCC and β is negative for Switzerland. One explanation could be that there is a minimum level of CCC relative to profitability, which should not be exceeded i.e., that surpassing a certain minimum level of CCC has negative effects on ROA. There is a minimum level of CCC below which it is not favourable for a business to increase the pressure on the supply chain because the business risk for the company rises as well.

Conclusion and outlook

Recent research postulates a positive relationship between WCM and financial performance measures, mostly in terms of profitability. This paper extends prior research and focuses on the impact of WCM efficiency on the cost of capital. Cost of capital is an essential factor for various financial performance measures. However, the WACC is often seen as an exogenous variable – independent of WCM. The model developed predicts a positive, respectively negative relationship between WCM and cost of capital according to the level of leverage above or below the optimal point of leverage.

The results of the empirical analysis provide evidence that WCM does impact the cost of capital. The relationship between CCC and leverage, other than modelled in theory, is not always positive but can be negative as well. The relationship between leverage and WACC is positive for Austria and Switzerland, but significantly negative for Germany. Comparing the mean leverages of the countries, the positive effect is stronger for higher levels of leverage (Austria) and not as clear as expected or even negative for firms below the optimal point of leverage.

On the one hand, it has been drawn up whether WCM can be used to optimize the capital structure and therefore, to lower WACC. On the other hand – as the effect of an efficient WCM can strengthen or weaken the effect of a low CCC on profitability – this study offers evidence for the use of WACC as an endogen variable in the context of operations management and financial performance. However, the fact that the impact of CCC on the WACC can be positive as well as negative implies that a shorter CCC does not always lead to a lower WACC as desired and commonly assumed.

Managerial implications are therefore manifold:

- Depending on the company's leverage below or above the optimal level of debt, an optimization of NWC can have a negative effect on WACC. Decision makers have to be aware of the impact of leverage while discussing decisions concerning WCM.
- At a high level of debt, efficient WCM leads to a decreasing WACC. This desired effect is achieved if the release of cash tied up in NWC is actually used to reduce the debt level.
- For companies with low leverage, there exists no clear relationship between WCM and WACC, explained by the different levers for the optimization of CCC. Whereas INV can always be modified, a reduction in AR or an increase in AP is exogenously limited. This relation implies that rather than minimizing the CCC at any rate, low leverage enables a company to provide concessions to customers and suppliers.
- When evaluating the effect of WCM on financial performance, the cost of capital should not be viewed as exogenous variable. With the influence of WCM on WACC (positive or negative), it is essential to integrate WACC as an endogenous variable.

This academic field still provides various opportunities of future research. First, the relationship between WCM and the cost of capital is especially sensitive to leverage. As the capital structure

is industry-specific, the industry's mean leverage should be considered for the definition of the optimal point of leverage. This leads to a superior differentiation between firms with leverage below or above the optimal level of leverage. Second, future research should test for differences in the relationship between WCM and the cost of capital for different industries. As not only the mean leverage varies greatly between industries, but the length of CCC and β as well, it could be of special interest to control for industry effects in general. Industries where the impact of WCM on the cost of capital is more or less pronounced might be identified. Third, the effect of profitability of CCC on β and the WACC should be addressed to allow for an effect differentiation between profitable and financially challenging industries. Finally, additional research should focus on the impact of CCC on β . On the contrary to the impact of WCM on financial leverage, the effect of CCC on operating leverage has not been studied as well. In this context, it would be interesting to compare the strength of the relationship between CCC and WACC if β is estimated by historical market data as well as if estimated bottom-up on the basis of financial accounting ratios.

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