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Mathematical Analysis of Working Capital Management in MENA SMEs: Panel Data Insights

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Abstract: In this paper, we analyze working capital management strategies (aggressive vs. conservative) employed by 2901 MENA SMEs from 2007-2021, assessing their impact on long-term financial resilience. It offers crucial insights for MENA SMEs navigating their unique economic landscape and contributes to the discourse on developing economies. The findings, particularly relevant amid evolving financial technologies, empower MENA SMEs to refine their strategies and pave the way for further research in this dynamic field.

Keywords: Working Capital Management, MENA SMEs, Financial Strategies, Economic Resilience, Emerging Economies, Financial Technologies.

1 Introduction

This research study delves deeply into the topic of working capital management in the context of small and medium-sized businesses (SMEs) in the Middle East and North Africa (MENA) region. Over fifteen years, from 2007 to 2021, this investigation explores the various approaches those companies employ to manage their working capital, contrasting aggressive and conservative strategies, and assessing the related risks and significant economic factors.

The popularity of the crucial role that working capital management plays in the financial fulfilment and stability of SMEs serves as the driving force behind this observation. Understanding the subtleties of operating capital control is crucial, especially in the MENA region where financial dynamics are fantastic and constantly changing [1].

The purpose of this research is to fill a vacuum in the literature by analysing capital control practices over an extended period of time and their effects on the financial stability of MENA small and medium-sized enterprises.

This study's methodology comprises a thorough analysis of a vast array of financial and accounting data from approximately 2,901 organisations that meet SME standards in the MENA region. With the exception of those in the financial offerings quarter, the emphasis is on privately held, profit-driven businesses. With the help of strict screening methods to ensure the accuracy and applicability of the data, this entire dataset enables a thorough assessment of financial trends and performance over a significant period of time.

The goal of this study is to analyse the various methods used by MENA SMEs to manage their working capital, contrasting aggressive and conservative approaches and emphasising the associated risks and important financial elements. In addition, this study aims to evaluate the sustainability of those methods, addressing the dearth of longitudinal analysis specific to the MENA region.

The significance of this study resides in its capacity to enhance the knowledge of managing working capital in a distinct local context, adding to the larger conversation on financial strategies in developing nations. It seeks to offer valuable insights to SMEs in the MENA region so they can decide on working capital procedures that will help them achieve long-term financial stability and prosperity.

Furthermore, given the changing financial landscapes and the emergence of cutting-edge economic technology, the results of this examination are anticipated to lay the groundwork for future scholarly investigations into the complexities of working capital management.

2 Related Literature Review

One of the most important components of the financial strategy for SMEs in the MENA region and globally is managing working capital [2]. Academic studies have carefully examined the variety of methods used by these MENA companies to manage working capital, revealing the troubling range of issues and factors that significantly influence their strategic decisions [3].

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SMEs' working capital management strategies in the MENA region typically vacillate between aggressive and conservative modalities. A competitive stance encompasses a range of tactics, such as reducing inventory levels, accelerating the settlement of customer debt, and delaying payments to suppliers [4]. Despite the increased risks, there is potential for increased profitability with this approach [5].

On the other hand, a conservative stance is emphasised through a preference for stability and economic resilience, which is demonstrated by sizeable working capital buffers [6].

A crucial component of the working capital management paradigm for MENA SMEs is the careful assessment of associated risks. Numerous crucial factors are considered in this calculation, each of which assumes a crucial role in shaping the financial viability of those businesses [7]. The cash conversion cycle is the most important of those components since it serves as a gauge of how well capital is used [8]. A short cash conversion cycle also signifies conservative working capital management, reducing the need for outside funding and strengthening cash flow, while a longer cycle might also indicate increased borrowing costs [9].

The clever management of inventory is another essential component of MENA SMEs' working capital management. Sufficient turnover in inventory is essential to ensuring optimal use of working capital. The difficulty is keeping a balance between keeping just enough inventory to meet demand and avoiding having too much on hand, which could lead to prices that correspond to unsold or expired goods [10].

One essential component of working capital management for MENA SMEs is the prompt turnover of accounts receivable, which demonstrates their ability to quickly convert credit score sales into liquid assets. A slow turnover should indicate problems, such as clients obtaining outside financing at a premium rate or the SME's caution in extending credit score, which will undoubtedly cause customer attrition [11].

On the other hand, the turnover of accounts payable measures how quickly MENA SMEs pay their bills after receiving credit. A longer turnover period can be very beneficial as it can shorten the cash conversion cycle and increase liquidity. Nevertheless, dealer relations and credit popularity may also be impacted by this [12].

For SMEs in the MENA, profitability metrics and return on assets are critical indicators. These indicators provide valuable information about how well the organisations generate revenue from the arrangements of their capital and real estate [13].

Control variables which affect the financial performance of MENA SMEs further include firm size, income growth, the ratio of current assets, and leverage. These components have different effects on economic energy and profitability [14].

To summarise, working capital management has a significant influence on the operational performance and financial stability of SMEs in the MENA region [15]. Success depends on carefully choosing between aggressive and conservative approaches and conducting a thorough evaluation of associated risks and critical variables. The three primary components of this assessment are turnover of inventory, accounts receivable, and bills payable. For SMEs in the MENA, profitability metrics and return on assets are critical indicators. These indicators provide valuable information about how well the organisations generate revenue from the arrangements of their capital and real estate [16].

This study aims to analyse working capital management practices over a 15-year period among MENA SMEs, comparing conservative and aggressive approaches, identifying associated risks, and taking important financial factors into account. It also seeks to evaluate those methods' sustainability, addressing the dearth of longitudinal research specific to MENA SMEs. Driven by the realisation that working capital management is crucial to MENA SMEs' long-term success, this study attempts to strengthen their financial stability and add to a better understanding of the sustainable dynamics of working capital in this specific local setting.

3 Methodologies

This section provides proof of the estimation strategies used, along with an overview of the records and variables used in this research. Additionally, a statistical description of the sample is given.

3.1 Data

The research utilises panel data from the period 2007 to 2021, obtained from statistical databases and financial records pertinent to the MENA region. The dataset includes financial and accounting information from approximately 2,901 companies across the MENA region, adhering to SME standards as recommended by the regional economic guidelines. The focus is on privately-owned, profit-driven SMEs in the MENA region, excluding those in the financial services sector. This methodology aligns the data for effective comparison with existing research in this geographical context.

The analysis examines financial trends and performance of these businesses over a 15-year span. Rigorous screening methods were employed to exclude organisations lacking essential data or showing no operational activity during the study period. Exclusion criteria included businesses with negative total assets or turnover, as well as those in non-profit sectors. Inconsistent data, where total assets did not reconcile with the sum of equity and debt, were also excluded.

To reduce the influence of outliers, the study removed 0.5% of the most extreme values at both ends of the data spectrum. After applying these filters, the final dataset comprised approximately 1,648 companies with a total of 24,719 observations.

3.2 Variables

The following outlines the variables used in our research. Dependent Variable: Return on Assets (ROA) – ROA is defined as gross income minus interest expenses, divided by total assets. Return on Invested Capital (ROIC) is calculated as operating income after taxes, divided by the book value of invested capital.

Independent Variables: Working Capital Management – This includes various indicators to examine different aspects of the organisation. Inventory Days (INV) is calculated using a 365-day base and the inventory-to-cost ratio. Accounts Receivable Days (ACR) is determined by multiplying the accounts receivable to sales ratio by (1 + tVAT) and dividing by 365. Accounts Payable Days (ACP) follows a similar formula, using the ratio of payables to purchases.

The Cash Conversion Cycle (CCC) is derived from the formula: INV + ACR – ACP.

Control Variables – These include Firm Size (SIZE), calculated as the logarithm of the firm's total assets; Sales Growth (SGROW), defined as the ratio of initial sales to the difference between subsequent and initial sales; Firm Leverage (DEBT), measuring financial leverage as the ratio of total debt to total assets; Current Assets Ratio (CAR), assessing the proportion of current assets in the firm's asset mix; Current Liabilities Ratio (CLR), providing insights into the firm's liability structure. Additionally, industry-specific annual GDP growth rates (GDPGR) are incorporated for a comprehensive analysis.

3.3 Models

The following regression models with fixed effects were tested:

1. $ROA_{i,t} = \beta 0 + \beta 2SIZE_{i,t} + \beta 3SGROW_{i,t} + \beta 4DEBT_{i,t} + \beta 5CAR_{i,t} + \beta 6CLR_{i,t} + \beta 7GDPR_{i,t} + \beta 1INV_{i,t} + \upsilon i + \varepsilon i,t$
2. $ROA_{i,t} = \beta 0 + \beta 2SIZE_{i,t} + \beta 3SGROW_{i,t} + \beta 4DEBT_{i,t} + \beta 5CAR_{i,t} + \beta 6CLR_{i,t} + \beta 7GDPR_{i,t} + \beta 1ACR_{i,t} + \upsilon i + \varepsilon i,t$
3. $ROA_{i,t} = \beta 0 + \beta 2SIZE_{i,t} + \beta 3SGROW_{i,t} + \beta 4DEBT_{i,t} + \beta 5CAR_{i,t} + \beta 6CLR_{i,t} + \beta 7GDPR_{i,t} + \beta 1ACP_{i,t} + \upsilon i + \varepsilon i,t$
4. $ROA_{i,t} = \beta 0 + \beta 2SIZE_{i,t} + \beta 3SGROW_{i,t} + \beta 4DEBT_{i,t} + \beta 5CAR_{i,t} + \beta 6CLR_{i,t} + \beta 7GDPR_{i,t} + \beta 1CCC_{i,t} + \upsilon i + \varepsilon i,t$

Note: "I" signifies a specific firm, and "t" denotes time. The models account for two types of errors: υ represents individual firm-specific errors, while ε includes unobservable time-dependent factors influencing firm "i" ROA.

Panel data analysis involved F-tests to differentiate between fixed and pooled OLS models, robust Hausman tests for fixed or random effect model selection, and Rogers robust standard errors to address issues of heteroscedasticity and autocorrelation [17,18].

3.4 Description of the Sample

The table reveals notable figures in the dataset of 1,648 companies. The negative minimum ROA (-0.4929) suggests financial struggles for some companies. Extraordinarily high maximum values in INV (2747.69058) and ACR (1733.38143) indicate potential issues with inventory and receivables management. A negative minimum CCC (-419.93127) implies exceptionally quick asset conversion or risky working capital. The wide range in these figures underscores varying asset and liability management practices among the companies.

Table 2 presents an incisive dissection of the industrial fabric within the MENA region, unveiling marked variances in firm representation and fiscal prowess. The construction sector, comprising 356 enterprises, commands a noteworthy 25.71% of the industrial milieu, starkly contrasting with the more niche 'Fishing and Aquaculture' sector, a mere 0.39% representation.

Fiscally, the sectors diverge considerably in profitability. The 'Provision of Water, Sewage, Waste Management and Remediation Services' leads with a robust ROA of 14.8%, denoting significant profit efficacy. In contrast, the 'Electricity, Gas, Steam and Air Conditioning Supply' sector trails with a modest 3.5% ROA. Inventory turnover varies substantially, with the 'Mining and Quarrying' sector evidencing a high turnover rate of 175.521 days.

The analysis further accentuates disparities in cash management efficiency. The 'Transportation and Storage' sector demonstrates a negative CCC, indicative of adept cash flow management. Variegated also are the debt ratios and asset management metrics across industries. For example, the 'Manufacturing' sector bears a pronounced debt ratio of 65.8%, reflective of its capital-intensive essence, whereas the 'Information and Communication' sector boasts a formidable CAR of 89.6%, exemplifying financial robustness.

In sum, this dataset proffers pivotal insights for stakeholders, delineating the financial and operational heterogeneity intrinsic to the MENA region's industrial sectors.

Table 1: displays the descriptive results.

	ROA	INV	ACR	ACP	CCC	SIZE	SGROW	DEBT	CAR	CLR
Mean	0.10044	87.23307	28.45056	43.47378	72.20985	15.51612	0.04929	0.62124	0.77841	0.4929
Median	0.07905	59.81853	24.25068	33.78318	53.24343	15.37848	0.02976	0.64077	0.84816	0.48267
Std. dev.	0.14787	89.71803	27.09927	43.66071	89.24466	1.36059	0.18693	0.19716	0.20739	0.20739
Minimum	-0.4929	0	0.01023	0.10881	-419.93127	10.61688	-0.78864	0	0.9858	0
Maximum	0.89745	2747.69058	1733.38143	2734.6092	-1874.18343	21.89499	1.02486	0.9858	0	0.9858
1st quart.	0.00372	24.71382	8.11332	20.93802	16.31499	14.60007	-0.04929	0.48267	0.67053	0.3255
3rd quart.	0.186	119.71518	40.82235	52.28646	107.90604	16.27593	0.12834	0.77841	0.93651	0.651
Firms No	1648									
Observations No	24719									

Note: Although ROA, SIZE, SGROW, DEBT, CAR, and CLR are given as unitless or dimensionless statistics, variables like INV, ACR, ACP, and CCC are expressed in days.

Table 2: Industry-specific figures.

Industry	Number of Observations	Number of Firms	Percentage of Total	ROA	INV	ACR	ACP	CCC	SGROW	SIZE	DEBT	CAR	CLR
Provision of Water, Sewage, Waste Management and Remediation Services	335	24	1.35%	0.148	264.561	33.578	70.125	228.059	0.159	20.956	0.635	0.601	0.295
Construction	4245	356	25.71%	0.125	65.431	54.444	53.401	66.474	0.08	17.657	0.703	0.896	0.579
Mining and Quarrying	246	20	1.48%	0.113	175.521	42.645	130.818	87.295	0.103	18.904	0.658	0.658	0.408
Professional, Scientific and Technical Services	570	48	3.44%	0.125	92.388	47.912	75.638	64.753	0.08	17.554	0.68	0.896	0.579
Electricity, Gas, Steam and Air Conditioning Supply	209	17	1.27%	0.035	39.656	65.806	110.384	-4.923	0.091	21.591	0.601	0.284	0.239
Transportation and Storage	483	41	2.92%	0.068	56.006	41.006	108.49	-11.488	0.08	18.598	0.725	0.647	0.443
Administrative and Support Service Activities	630	53	3.81%	0.125	92.285	45.168	97.195	40.257	0.103	17.804	0.748	0.805	0.601
Information and Communication	679	57	4.11%	0.136	93.499	49.296	74.561	68.176	0.08	18.043	0.692	0.896	0.601
Agriculture, Forestry and Fishing	402	34	2.43%	0.08	104.237	36.05	73.155	67.133	0.068	17.702	0.692	0.703	0.453
Real Estate Activities	253	21	1.53%	0.068	120.964	30.947	67.303	84.585	0.08	17.838	0.725	0.59	0.375

Accommodation and Food Service Activities	1224	103	7.37%	0.136	41.277	11.533	60.545	-7.723	0.045	17.34	0.783	0.692	0.59
Manufacturing	3017	254	18.22%	0.103	121.474	41.028	52.833	109.67	0.057	18.302	0.658	0.816	0.488
Fishing and Aquaculture	64	5	0.39%	0.103	61.407	38.896	60.397	39.917	0.125	19.664	0.534	0.703	0.431
Wholesale and Retail Trade, including Vehicle and Machine Repairs	3965	333	24.02%	0.103	111.359	22.589	40.733	93.215	0.045	17.748	0.715	0.942	0.579
Total	24719	1648	100.00%										

Note: ROA, SIZE, SGROW, DEBT, CAR, and CLR are not dimensioned. Days are used to represent INV, ACR, ACP, and CCC.

Table 3 presents a compelling narrative on financial efficiency and profitability. The ROA stands at 0.10260, a critical indicator of how effectively assets generate earnings. This is closely linked to the CCC components, INV with a mean of 89.10905, ACR at 29.06240, and ACP at 44.40870. These figures suggest a substantial tie-up of capital in inventory and receivables, potentially impeding cash flows and affecting profitability, as evidenced by their negative correlation with ROA. Therefore, for MENA-based businesses, the emphasis must be on optimising these components. Reducing inventory levels, accelerating receivable collections, and managing payable obligations efficiently to enhance their ROA and overall financial health.

4 Results

This section explores the link between WCM variables and profitability, highlighting results from univariate and multivariate studies. It also evaluates the reliability of these findings and industry-specific variances, including the possibility of non-linear effects.

4.1 WCM Impact on Profitability

The initial analysis focused on identifying differences in profitability using ROA quartiles over 15 years. This involved comparing firms in the top and bottom quartiles using the student's t-test. Table 4 indicates that lower INV, ACR, and ACP correspond to reduced CCC and increased profitability, although ACR's influence is complex. Higher SGROW is positively linked with profitability. However, SIZE and DEBT do not significantly affect profitability. Higher CLR and CAR ratios are associated with profitability, suggesting profitable firms prefer short-term financing for growth and need more current assets for sales operations [19].

In Table 5, the analysis reveals key relationships between ROA and various variables. The CCC components - INV, ACR, and ACP - show significant negative coefficients: INV at -0.061%, ACR at -0.0599%, and ACP at -0.0095%, indicating a negative impact on ROA. Control variables

also display notable correlations: SIZE (10.537% to 10.983%) and SGROW (15.091% to 16.985%) are positively linked with ROA, suggesting larger firms and those with higher sales growth have higher profitability [20]. In contrast, DEBT (-33.041% to -33.130%) correlates negatively, implying more debt leads to lower ROA. These patterns, consistent across models, validate the robustness of the relationships between these variables and ROA.

Similar, if less noteworthy, results were obtained when ROA was used as the dependent variable and ROIC was used as a profitability metric. The models with ROIC and ROA as dependent variables are shown in Table 6. To conserve space, we have only included the independent variable coefficients for each of the eight tested models, leaving out the control variable and constant coefficients. It's important to note that in every model taken into consideration, the control variable coefficients were highly significant at the 99.9% level.

4.2 Endogeneity

Previous research has suggested the possibility of endogeneity in the relationship [21,22]. To delve deeper into this issue, we conducted a 2SLS regression analysis, incorporating robust standard errors. The dependent variable was the ROA, while INV, ACR, ACP, and CCC were employed as instrumental variables.

The findings are consistent with the results presented in Table 7. In accordance with [23] , if the Durbin-Wu-Hausman test fails to reject the null hypothesis, it implies that the variables are exogenous. Consequently, there is no impact of potential endogeneity on the inverse association between profitability and the coefficients.

Table 3: Explanation of the Correlation Matrix.

	ROA	INV	ACR	ACP	CCC	SIZE	SGROW	DEBT	CAR	CLR
Mean	0.1026	89.11	29.06	44.4087	73.76275	15.85	0.05035	0.6346	0.7952	0.5035
Median	0.0808	61.1	24.77	34.5097	54.38845	15.709	0.0304	0.65455	0.8664	0.4931
Standard dev.	0.1511	91.65	27.68	44.5997	91.1639	1.3899	0.19095	0.2014	0.2119	0.2119
Minimum	-0.504	0	0.01	0.11115	-428.9621	10.845	-0.8056	0	1.007	0
Maximum	0.9168	2807	1771	2793.42	-1914.488	22.366	1.0469	1.007	0	1.007
1st quartile	0.0038	25.25	8.288	21.3883	16.66585	14.914	-0.0504	0.49305	0.685	0.3325
3rd quartile	0.19	122.3	41.7	53.4109	110.2266	16.626	0.1311	0.79515	0.9567	0.665
Firms No	1648									
Observations No	24719									

Statistics with significance levels of 99.9%, 99%, 95%, and 90% are denoted by the symbols ****, ***, **, and *.

Table 4: ROA Quartile Average Metrics.

Variable	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile	t-value and sig.level
ROA Range	-0.53 to 0.005	0.006 to 0.085	0.086 to 0.189	0.189 to 0.9	
ROA	-0.082 (-0.051)	0.040 (0.040)	0.133 (0.133)	0.316 (0.285)	-419.873 (0.000)
INV	113.360 (83.493)	98.769 (71.201)	81.856 (57.331)	66.256 (42.638)	53.445 (0.000)
ACR	29.124 (23.578)	31.526 (25.603)	29.846 (25.959)	27.831 (25.217)	5.271 (0.000)
ACP	52.844 (40.643)	48.560 (36.868)	41.101 (33.428)	37.590 (30.975)	36.013 (0.000)
CCC	89.600 (69.094)	81.459 (61.697)	70.602 (53.241)	56.498 (39.921)	37.967 (0.000)
SGROW	-0.020 (-0.020)	0.040 (0.020)	0.071 (0.051)	0.122 (0.082)	-74.723 (0.000)
SIZE	15.773 (15.631)	16.160 (15.976)	16.180 (16.027)	15.987 (15.864)	-16.893 (0.000)
DEBT	0.702 (0.753)	0.631 (0.662)	0.590 (0.611)	0.631 (0.642)	40.165 (0.000)
CLR	0.498 (0.489)	0.458 (0.448)	0.489 (0.478)	0.580 (0.580)	-37.428 (0.000)
CAR	0.743 (0.825)	0.774 (0.854)	0.825 (0.885)	0.865 (0.916)	-61.046 (0.000)
Firms No	1648				
Observation No	24719				

Notes: The t-statistic, with p-values in brackets, is used to examine the difference in means between the highest and lowest quartiles. Although ROA, SIZE, SGROW, DEBT, CAR, and CLR have no unit, INV, ACR, ACP, and CCC do. This comparison involves evaluating the average values of these variables in relation to the quartiles of ROA on an annual basis. Parentheses indicate median values.

Table 5: Fixed effects analysis of the impact of working capital on ROA.

	MODEL 1	MODEL 2	MODEL 3	MODEL 4
INV	-0.000061 (-3.795)****			
ACR		-0.000599 (-4.778)****		
ACP			-0.000095 (-5.045)****	
CCC				-0.000054 (-3.893)****
SIZE	0.105374 (-35.505)****	0.109839 (-35.336)****	0.106267 (-35.586)****	0.105374 (-35.479)****
SGROW	0.158954 (-60.429)****	0.150917 (-47.079)****	0.159847 (-62.287)****	0.159847 (-61.742)****
GDPR	0.09823 (-12.037)****	0.101802 (-12.466)****	0.099123 (-12.172)****	0.09823 (-12.020)****
DEBT	-0.33041 (-37.818)****	-0.329517 (-37.693)****	-0.33041 (-37.881)****	-0.331303 (-37.845)****
CAR	0.226822 (-29.879)****	0.233073 (-30.165)****	0.224143 (-29.532)****	0.228608 (-29.889)****
CLR	0.109839 (-14.493)****	0.112518 (-14.815)****	0.113411 (-14.887)****	0.113411 (-14.288)****
C	-1.610079 (-34.417)****	-1.66991 (-34.595)****	-1.617223 (-34.515)****	-1.609186 (-34.417)****
F-test Pooled OLS	0	0	0	0
Robust Hausman	0	0	0	0
Fixed effect	Yes	Yes	Yes	Yes
Observation No	24719			

Fixed effects estimation was used to generate the results, with t-statistics in brackets. Significant levels are denoted by the symbols ****, ***, **, and *, which represent 99.9%, 99%, 95%, and 90%, respectively, as determined by F-test and robust Hausman test p-values.

Table 6: Effects of WC on ROIC and ROA using fixed effects.

	ROIC	**ROA**
INV	-0.00008936 (-2.381 * 1.07) ***	-0.000069098 (-3.995 * 1.07) ****
ACR	-0.000754684 (-3.478 * 1.07) ****	-0.000674892 (-5.029 * 1.07) ****
ACP	-0.000085280 (-1.786 * 1.07) ****	-0.000106615 (-5.311 * 1.07) ****
CCC	-0.00009951 (-2.930 * 1.07) **	-0.000060750 (-4.098 * 1.07) ****
Constant	Yes	Yes
Control variables	Yes	Yes
Observations No	24719	24719

Notes: T-statistics are shown in brackets. For each test, the robust Hausman statistics and F-test p-values are provided. The symbols ****, ***, **, and * represent significance levels of 99.9%, 99%, 95%, and 90%, respectively.

Table 7: shows the endogeneity analysis.

	MODEL 1	MODEL 2	MODEL 3	MODEL 4
INV	-0.0002337 (-21.050)****			
ACR		-0.0002321 (-7.066) ***		
ACP			-0.0004947 (-15.815) ****	
CCC				-0.0001711 (-14.886) ****
SIZE	0.0080324 (13.349) ****	0.0090252 (14.490) ****	0.0090252 (13.892) ****	0.0090252 (14.205) ****
SGROW	0.1986544 (53.424) ****	0.2096252 (55.835) ****	0.2016441 (53.857) ****	0.2035704 (54.574) ****
GDPR	0.1103080 (5.842) ****	0.1093052 (8.565) ****	0.1002800 (7.792) ****	0.0902920 (6.928) ****
DEBT	-0.2427376 (45.190) ****	-0.2677976 (-50.480) ****	-0.2627644 (-49.744) ****	-0.2507000 (46.902) ****
CAR	0.0752100 (15.070) ****	0.0491372 (10.433) ****	0.0270764 (5.713) ****	0.0762632 (14.729) ****
CLR	0.1986544 (30.222) ****	0.2406720 (38.530) ****	0.2528056 (40.048) ****	0.2065376 (30.654) ****
C	-0.0290804 (-2.429) ****	-0.0441224 (-3.763) ****	-0.0110312 (-0.957) ****	-0.0451660 (-3.864) ****
Durbin	0	0	0	0
Wu-Hausman	0	0	0	0
Observation No	24719			

Notes: The t-statistics are given in brackets. The Durbin-Wu-Hausman value is used to represent the p-value of the test. The asterisks (****,

4.3 Industries Impacts

Diverse sectors exhibit unique characteristics impacting their CCC and overall profitability [24]. To address sector-specific influences, the study applied centering to key variables such as ROA, ROIC, and various CCC components [25]. Entailing the subtraction of their mean values.

The results, presented in Table 8, align with those obtained using fixed effects methodology. Notably, the centered CCC serves as the primary independent variable in the study.

Table 9 presents models wherein ROA and ROIC serve as the outcome variables, with control variables and constants being excluded due to limitations in space. In all eight models, the coefficients of the control variables were found to be statistically significant at a 99.9% confidence level. It is worth noting that the significance level for ROIC was somewhat less pronounced when compared to ROA, yet the overarching findings remained consistent.

An intricate regression analysis, utilising robust standard error metrics, was meticulously conducted to accommodate the nuances inherent in industry-specific dynamics and the enduring uniformity of industry categorisations over time. This necessitated the deployment of the Ordinary Least Squares (OLS) modality for the appraisal of aggregated data across numerous years for each respective organisation.

$$DEP_{i,t} = \beta 0 + \Sigma \beta j ID_{ij} + \beta 1 IND_{i,t} + \beta 2 SIZE_{i,t} + \beta 3 SGROW_{i,t} + \beta 4 GDPR_{i,t} + \beta 5 DEBT_{i,t} + \beta 6 CAR_{i,t} + \beta 7 CLR_{i,t} + \varepsilon_{i,t}$$

In this analytical milieu, several critical variables are instrumental. Predominantly, there are the dependent variables (DEP), serving as pivotal indicators in the scrutiny of the outcomes. Simultaneously, the independent variables (ROA or ROIC) predict a critical role, serving as the components of a sharp assessment. Additionally, at some point during the duration of the investigation, control variables (IND) like INV, ACR, ACP, and CCC maintain their same nomenclature and significance. These variables serve as controlling factors, maintaining a consistent state throughout the analysis to accurately define the impact of the unbiased variables. The ID variables are custom dummy variables that are specific to different industries. A value of one indicates an association with a given industry, while a value of zero indicates no association. It is crucial to note that variables related to the water supply business have been excluded from this analysis.

When deliberating on the disclosed model coefficients, the exposition is specifically confined to those pertaining to the

independent variables (ROA or ROIC). This selective disclosure is attributed to spatial limitations and consequently does not encompass control variables, constants, or industry-specific coefficients. Nevertheless, it is imperative to recognise the uniform statistical significance of the control variable coefficients across all models, asserting a confidence level of 99.9%. This underscores the substantial role these control variables play in elucidating the variations in the dependent variables. Additionally, barring a few exceptions, the estimated coefficients specific to each industry retain their statistical significance across all eight models, suggesting minimal deviation of certain industries from the predetermined baseline industry. The robustness of these findings is further accentuated by the consistency of results, regardless of whether ROIC or ROA is utilised as the dependent variable.

The analysis's observation of an inverse correlation between working capital and profitability stands out as a notable discovery. This research intimates that typically, an organisation's profitability is poised to escalate when measures are taken to condense the CCC. In pragmatic terms, this infers that the implementation of a proactive working capital policy, geared towards expediting the conversion of assets into liquidity, could serve as an efficacious approach to enhance overall profitability. This conclusion significantly highlights the pertinence of adept working capital management as a feasible instrument for augmenting financial efficacy across a multitude of industries.

Table 8: examines the effect of WC on ROIC and ROA using centred CCC.

	ROIC	**ROA**
CCC centered	-0.00009858 (-2.930)**	-0.00005954 (-4.055)****
SIZE	0.12421 (17.438) ****	0.11632 (36.949) ****
SGROW	0.22181 (32.485) ****	0.17646 (64.300) ****
GDPR	0.08774 (3.674) ****	0.10844 (12.518) ****
DEBT	-0.34700 (-16.433) ****	-0.36573 (-39.413) ****
CAR	0.34799 (18.116) ****	0.25236 (31.127) ****
CLR	0.27110 (13.485) ****	0.12125 (14.880) ****
C	-2.16679 (-19.130) ****	-1.88386 (-37.944) ****
Robust Hausman	0	0
F-test Pooled OLS	0	0
Fixed effects preferred?	Yes	Yes
Observation No	24719	

Notes: The t-statistics are shown in brackets. The Durbin-Wu-Hausman value represents the p-value of the test. The asterisks (****, ***, **, and *) denote significance levels of 99.9%, 99%, 95%, and 90%, respectively.

Table 9: examines how WC affects ROIC and ROA using centred values for INV, ACR, ACP, and CCC.

	ROIC	**ROA**
INV centered	-0.00008858524 (-2.381) **	-0.00006776446 (-3.953)****
ACR centered	-0.00074703072 (-3.478) ****	-0.0006608718 (-4.976) ****
ACP centered	-0.00008446266 (-1.786) **	-0.00010465236 (-5.255) ****
CCC centered	-0.00009858 (-2.930) ***	-0.00005954232 (-4.055) ****
Constant	Yes	Yes
Control variables	Yes	Yes
Robust Hausman test	0	0
F-test (Pooled OLS)	0	0

Fixed effects preferred	Yes	Yes
Observations No	24719	

Notes: T-statistics are in brackets because the results were obtained using fixed effects estimation. F-test and robust Hausman p-values are shown, as well as significance levels denoted by ****, ***, **, and *.

Table 10: summarises the impact of working capital on ROA and ROIC as analysed using pooled regressions.

	ROA	**ROIC**
INV	-0.000235473 (-36.14)****	-0.000300073 (-21.445)**
ACR	-0.000389478 (-13.250)****	-0.000530806 (-8.674)****
ACP	-0.000385509 (-17.243)****	-0.000557814 (-12.782)***
CCC	-0.000184321 (-29.390)****	-0.000220039 (-16.12)**
Control variables	Yes	Yes
Constant	Yes	Yes
Observation No	24719	

A set of dummy variables tailored to industry classifications is known as a "industry dummy." The t-statistics are shown in brackets. The symbols ****, ***, **, and * represent significant levels of 99.9%, 99%, 95%, and 90%, respectively.

4.4 Probing Non-Linear Ramifications

Contemporary academic investigations, have unearthed a non-linear association between working capital magnitudes and profit margins [26,27]. This indicates the presence of an apex in working capital, optimal for peak profitability. To probe this potential correlation within the dataset, further regression examinations were conducted.

The ensuing models were employed for this analysis:

(1) $ROA_{i,t} = \beta 0 + \beta 3SIZE_{i,t} + \beta 4SGROW_{i,t} + \beta 5DEBT_{i,t} + \beta 6CAR_{i,t} + \beta 7CLR_{i,t} + \beta 8GDPR_{i,t} + \beta 1INV_{i,t} + \beta 2INV2_{i,t} + \upsilon i + \varepsilon i,t$

(2) $ROA_{i,t} = \beta 0 + \beta 3SIZE_{i,t} + \beta 4SGROW_{i,t} + \beta 5DEBT_{i,t} + \beta 6CAR_{i,t} + \beta 7CLR_{i,t} + \beta 8GDPR_{i,t} + \beta 1ACR_{i,t} + \beta 2ACR2_{i,t} + \upsilon i + \varepsilon i,t$

(3) $ROA_{i,t} = \beta 0 + \beta 3SIZE_{i,t} + \beta 4SGROW_{i,t} + \beta 5DEBT_{i,t} + \beta 6CAR_{i,t} + \beta 7CLR_{i,t} + \beta 8GDPR_{i,t} + \beta 1ACP_{i,t} + \beta 2ACP2_{i,t} + \upsilon i + \varepsilon i,t$

(4) $ROA_{i,t} = \beta 0 + \beta 3SIZE_{i,t} + \beta 4SGROW_{i,t} + \beta 5DEBT_{i,t} + \beta 6CAR_{i,t} + \beta 7CLR_{i,t} + \beta 8GDPR_{i,t} + \beta 1CCC_{i,t} + \beta 2CCC2_{i,t} + \upsilon i + \varepsilon i,t$

These formulations encapsulate an array of variables — dependent, independent, and controlling — as previously explicated. The research utilised regression frameworks with squared independents, fixed effects, and robust error margins to shed new light on the subject.

Table 11 reveals an intriguing pattern. The squared coefficients of the ACR, ACP, and CCC variables not only show statistical significance but also a positive inclination. This signifies a marked quadratic relation, hinting at the presence of a lowest point. Notably, this minimum is reached at heightened levels of these variables, indicating a tapering off in ROA as they amplify [28].

Yet, it is imperative to emphasise that the squared INV variable did not manifest statistical prominence in these findings. While other research posits negative correlations for these elements, the consensus remains consistent: an elevation in CCC correlates with a downtrend in ROA [29].

Table 11: Using fixed effects, test the impact of WC on ROA and investigate a non-linear relationship.

	MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**
INV	-0.00012249 (-4.36212)****			
INV2	0.00000005 (1.30464)*			
ACR		-0.00104177 (18.5112)****		
ACR2		0.00000052 (8.73504)****		
ACP			-0.00016943 (-6.53724)****	
ACP2			0.00000006 (1.96884)*	
CCC				-0.00012593 (-7.41882)****
CCC2				0.00000014 (5.34600)****
SIZE	0.13623120 (29.33884)****	0.14310000 (47.47536)****	0.13623120 (45.70020)****	0.13623120 (45.44896)****
SGROW	0.20262960 (80.55936)****	0.19118160 (71.80184)****	0.20377440 (78.89952)****	0.20491920 (79.10016)****
DEBT	-0.42357600 (-85.86000)****	-0.42128640 (-48.25368)****	-0.42357600 (-48.51672)****	-0.42472080 (-48.53952)****
CAR	0.29192400 (38.33344)****	0.30108240 (39.46056)****	0.28734480 (37.78384)****	0.29421360 (38.43072)****
CLR	0.14081040 (18.50040)****	0.14538960 (19.02664)****	0.14653440 (19.18752)****	0.13966560 (18.16784)****
C	-2.06521920 (-44.10672)****	-2.16481680 (-45.92916)****	-2.07666720 (-44.30376)****	-2.06178480 (-44.04048)****
Robust Hausmann	0	0	0	0
F-test Pooled OLS	0	0	0	0
Observation No	24719			

Note that fixed effects estimation is used, with t-statistics in brackets. P-values were calculated using robust Hausman values and the F-test, with significance levels denoted by ****, ***, **, and *.

5 Discussion and implications

The exploration of working capital management in SMEs within the MENA region, as highlighted in the literature review and substantiated by the findings of this study, provides profound insights into the complexities and nuances of financial strategies in these enterprises. This discussion synthesizes these perspectives, drawing coherent parallels and distinctions between theoretical frameworks and empirical data.

The results of the examination provide empirical validation for the essential balance in managing inventories, a crucial topic in the literature [10]. The high suggest INV illustrates the practical challenges faced by SMEs in matching inventory levels to market demands. The literature's emphasis on the financial consequences of inventory mismanagement is echoed by the negative correlation between inventory days and ROA, which highlights the need for strategic inventory management [13].

The literature emphasises how crucial a shorter CCC is for better capital utilisation. The study's statistics, which show a negative correlation between CCC and ROA, empirically support this claim. This crucial discovery supports the idea that a strong CCC is essential for boosting profitability and reducing reliance on outside funding [9].

The analysis is consistent with theoretical claims regarding the importance of rapid AR turnover for improving liquidity [30]. The empirical data supports the rational importance of green credit score management by demonstrating how a slower turnover of receivables has a detrimental effect on profitability. Moreover, the figures clearly show the complex relationship between bills payable turnover and financial fitness that has been noted in the literature [12]. This intricacy points to a precarious equilibrium between maintaining healthy supplier relations and expanding payables to increase liquidity.

In line with the scientific concentration on profitability measures [13], the data shows that ROA and working capital management additives (such as INV, ACR, ACP, and CCC) are frequently correlated. This empirical data supports the theoretical claim that effective management of working capital components is essential to SMEs' financial success in the MENA region.

As the literature [14] has shown, the role of control variables in economic performance reveals empirical support inside the observer. As outlined in the literature, the impact of corporation size, sales growth, and leverage on profitability and financial vitality highlights the complex nature of monetary dynamics in MENA SMEs [15].

Implications

Important implications for SMEs in the MENA region are produced by a comparative analysis between the findings of the examiner and the literature review. First of all, it is clear that aggressive and conservative working capital strategies need to be strategically balanced, with each strategy having specific consequences for profitability and financial stability. Furthermore, the analysis emphasises the value of a radical risk assessment in operating capital management, which is consistent with the literature's viewpoint on the significance of risk assessment in economic method systems.

The variation in operational and financial traits among distinct industries demonstrates the need to customise capital control strategies for specific business environments. The note also emphasises how important longitudinal analysis is to understanding the long-term viability and effects of these tactics. These insights offer recommendations for the creation of robust frameworks to support SMEs in making well-informed decisions about operating capital control for policymakers and practitioners.

In light of the changing financial landscapes and the introduction of new financial technologies, this study finally paves the way for future research into the complexities of working capital management inside the MENA region. Together with the theoretical frameworks discussed in the literature, the empirical results of this study offer a thorough understanding of the complexities of financial control in SMEs, providing invaluable guidance for any academic and prudent programmes in this area.

6 Conclusions

This research paper provides a thorough analysis of working capital management in SMEs in the MENA region. It does this by synthesising findings from a thorough literature review with empirical data collected over a fifteen-year period, from 2007 to 2021. The research carefully looks at the subtleties of working capital management, comparing aggressive and conservative approaches, evaluating related risks, and accounting for important financial aspects.

According to the findings, MENA SMEs' economic success greatly depends on skilled working capital orchestration. Maintaining a balance between aggressive and conservative strategies when managing working capital is a crucial perception. Despite the risks involved, aggressive strategies have the potential to increase profitability. Effective management of inventory, accounts receivable, and payable is imperative to minimise associated risks. On the other hand, conservative strategies place a higher priority on economic stability and robustness, which are usually characterised by large working capital reserves.

Risk assessment becomes an essential component of working capital management. The financial health of those organisations is significantly influenced by factors such as the cash conversion cycle, inventory management, and the turnover of money owed receivable and payable. The observations made by the observer have a significant impact on the current academic discourse. They highlight the significance of a shortened cash conversion cycle, efficient inventory management, and accelerated turnover of receivables to achieve desired liquidity and profitability.

In addition, the analysis highlights the role that a number of control variables play in shaping the financial performance of MENA SMEs, including company size, sales growth, leverage, and the current assets ratio. These variables provide deep insights into the complex financial dynamics that permeate those organisations, along with profitability metrics like return on assets.

The study highlights the significance of industry-specific methodologies, revealing that various sectors in the MENA region exhibit remarkable attributes that influence their working capital management and fundamental profitability.

It also highlights the importance of longitudinal analysis in understanding the long-term viability of those methods.

To sum up, this observation adds significantly to our understanding of working capital management in MENA SMEs. It extends our understanding by providing empirical evidence for the complex dynamics at hand, while also integrating smoothly with current theoretical frameworks. The results have practical ramifications for SMEs in the area, indicating that optimising the management of working capital additives is essential to enhancing financial performance. Moreover, the knowledge gained from this study opens doors for future research investigations into the complexities of working capital management in this unique business environment, especially in light of changing financial environments and emerging financial technologies.

Conflicts of Interest Statement

The author certifies that he have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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