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ANALYSIS OF FINANCIAL PERFORMANCE IN VARIOUS SECTORS: APPLICATION OF THE BENEISH M-SCORE MODEL IN CASABLANCA STOCK EXCHANGE MOROCCO

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Abstract:
This paper evaluates the financial performance of companies from different sectors on the Moroccan financial market, using the Beneish M-Score model. Initially developed to detect financial anomalies, the M-Score has evolved into a tool for assessing companies' overall financial performance and earnings quality. By analyzing financial indicators such as profitability, liquidity and operational efficiency, this study compares the financial dynamics of companies in sectors such as food, technology and transportation. The results highlight significant differences in performance, revealing both strengths and weaknesses in companies' financial management. The study also provides a comparison with industry standards, and offers recommendations for improving the assessment of financial performance using financial indicators and the M-Score.

JEL: G32, M41, L25

Keywords: financial performance, M-Score, accounting manipulation, financial indicators, profitability, liquidity

1. Introduction

Assessing a company's financial performance is a crucial issue for investors, financial analysts and decision-makers. Understanding a company's financial health through analysis of its financial indicators not only enables us to track its growth, but also to predict its long-term future. In this context, sophisticated measurement tools have been developed to provide an overview of companies' financial performance, based on key

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indicators such as profitability, liquidity, operating efficiency and asset growth. The M-Score, introduced by Beneish in 1999, was initially designed to detect certain financial anomalies. However, its use has evolved, and it is now widely used to assess the quality of a company's earnings and analyze its overall financial performance. By combining several financial ratios, this tool provides a detailed picture of a company's ability to generate profits, use its assets efficiently, and manage its receivables and liquidity. Analysis of these financial indicators provides valuable information on a company's internal dynamics and its performance compared with that of competitors in the same sector. In this article, we focus on evaluating the financial performance of several companies from different sectors, such as agrifood, technology and transport. The aim is to understand how these companies measure up against industry standards and to analyze their growth and financial efficiency trajectories. Through the application of the M-Score model and the analysis of various financial indicators, this study highlights the differences in performance between the companies and identifies the main strengths and weaknesses in their financial management. The structure of this article is as follows: a literature review that explores previous work on assessing financial performance using key indicators and the M-Score model. Next, the methodology will detail the financial indicators used and the M-Score calculation process. The analysis section will look at the performance of companies in the sectors studied, highlighting the most significant results. Finally, the conclusion will provide a summary of the results and propose recommendations on the use of financial indicators for a better assessment of corporate performance.

2. Literature Review

The M-Score is an innovative statistical tool designed to detect financial manipulation in corporate financial statements. This model was motivated by financial scandals and the need for regulators, auditors and investors to have a tool capable of identifying anomalies resulting from fraudulent accounting practices (Beneish, 1999). Using a statistical approach based on the analysis of eight financial ratios, the M-Score assesses the likelihood of a company manipulating its financial statements. These ratios include indicators such as change in receivables, sales growth and asset quality, each of which plays a key role in detecting questionable accounting practices. This method generates a score reflecting the probability of accounting manipulation. If the score exceeds a certain threshold, the company is considered likely to falsify its financial results (Hakim *et al.*, 2024). Since its development, the M-Score has become a valuable tool for regulators and financial auditors, as it provides a quantitative framework for detecting potential misstatements in financial statements (Valaskova & Fedorko, 2021). Regulators have been quick to adopt this tool to strengthen oversight of listed companies, particularly in the wake of financial scandals such as Enron and WorldCom, where the manipulation of financial results had severely impacted capital markets. Thanks to its effectiveness in detecting manipulative practices, the use of the M-Score has been integrated into financial

audits to better target accounting risks and prevent fraud (Gbadebo *et al.*, 2023). The tool has also evolved to meet the needs of financial analysts and investors. It is now commonly used to assess the quality of companies' earnings and identify those at risk of falsifying their financial results (Xu *et al.*, 2023). For example, in the agri-food sector, companies such as Cosumar and Lesieur Cristal have had their financial performance analyzed using the M-Score. This application identified patterns of accounting manipulation, such as receivables and cash flow management, demonstrating the effectiveness of M-Score in detecting fraud in sectors under constant pressure to generate high-profit margins (Maulida *et al.*, 2024). In the technology sector, where rapid growth is often a priority, M-Score has played a key role in detecting companies likely to manipulate their results to meet investor expectations. Technology companies, often in fierce competition to attract capital, are sometimes tempted to distort their financial reports to maintain an image of strong growth. The M-Score provides regulators and investors with a reliable tool to assess the financial transparency of companies in this sector and make more informed decisions (Hakim *et al.*, 2024). In addition, the application of the M-Score has been extended to sectors such as trade and transport, two industries characterized by significant economic volatility. Comparative analysis of financial performance using the M-Score has made it possible to distinguish companies with solid results from those whose financial results can be manipulated. This approach is particularly valuable for investors seeking to assess risk in sectors where profit margins can fluctuate sharply with economic conditions (Rianggi & Novita, 2023). One of the most recent applications of the M-Score has been in financial and banking institutions. For example, a study of listed financial institutions in Nigeria revealed that 26.67% of companies were likely to manipulate their financial statements, underlining the importance of monitoring in the financial sector, where investor confidence is crucial (Gbadebo *et al.*, 2023). Similarly, research carried out on listed companies in Greece showed that the M-Score could identify companies likely to falsify their results, with 17.5% of companies studied scoring above the risk threshold (Maniatis, 2021). Finally, another recent study of listed companies in Malaysia showed that the M-Score, applied in parallel with market capitalization analyses, could reveal earnings manipulation and the correlation between accounting manipulation and stock market performance (Boni *et al.*, 2024). These studies underline the continuing importance of M-Score in protecting investors and regulating financial markets worldwide.

3. Methodology

3.1 Introducing the M-Score Concept

The M-Score, or Manipulation Score, is an indicator developed to detect the probability that a company has manipulated its financial results. The concept, introduced by Beneish in 1999, is based on a statistical model that analyzes several financial variables to identify anomalies likely to reflect aggressive or fraudulent accounting practices. The M-Score is mainly used to assess the quality of earnings reported by companies and to identify those

with a high risk of accounting manipulation. The M-Score calculation is based on a combination of eight financial ratios covering different aspects of a company's financial performance, such as changes in trade receivables, gross margins, sales growth, asset depreciation, and other indicators related to liquidity and solvency. These ratios are integrated into a linear regression model to generate an overall score. A high M- Score suggests a high probability of earnings manipulation, while a low score indicates a low probability. The importance of the M-Score lies in its ability to provide an early warning of the reliability of financial information published by companies. As a detection tool, it is widely used by financial analysts, auditors and regulators to assess the risk of accounting fraud. In addition, it contributes to greater financial transparency by encouraging companies to maintain accounting practices that comply with ethical and regulatory standards. The M-Score has become an invaluable tool in today's environment, where the growing complexity of financial operations and the pressure to meet investor expectations can lead some companies to manipulate their results. A sound understanding and rigorous application of the M-Score not only helps to protect investors, but also to maintain confidence in the financial markets.

3.2 M-Score Calculation Methodology

Calculating M-Scores for companies is a complex procedure that aims to provide a synthetic measure of financial performance, taking into account multiple financial dimensions. This section details the methodological process in three main stages: the selection of financial indicators, the calculation of intermediate mkm scores, and the aggregation of these scores to obtain the final M- Score. Finally, an analysis of the results is performed to interpret the scores obtained.

3.2.1 Selection of Financial Indicators

The choice of financial indicators is a decisive step in the calculation of M-Scores, as they must provide an overall view of a company's financial health. For this study, several indicators were selected for their relevance in assessing different aspects of financial performance. Change in book value (BV) measures the evolution of a company's book assets, reflecting the management of assets and liabilities over time. The change in operating cash flow (OCF) assesses the company's ability to generate cash from its core activities, an essential element in assessing liquidity. Return on equity (ROE) measures the return on funds invested by shareholders, revealing the company's profitability for its owners. Return on assets (ROA) quantifies the efficiency with which the company uses its assets to generate profits. Finally, the size of assets (TVE) is a key indicator of a company's growth, representing its total economic resources. These indicators have been selected for their ability to comprehensively capture profitability, liquidity and asset management efficiency, offering a comprehensive assessment of corporate financial performance.

3.2.2 Calculation of Intermediate Scores m_k for Each Indicator

Once the indicators have been selected, each indicator is transformed into a normalized score, noted $m_k$using a formula designed to capture the relative variation of the indicator in relation to a reference value:

$$m_k = 100 - \left(\frac{100}{1 + \left(\frac{Change}{v} \right)^v} \right)$$

Where v is a normalization parameter, set here at 0.5. This formula, inspired by logistic curve models, converts absolute variations into scores between 0 and 100, while attenuating the effects of extreme values. In this way, significant variations in one indicator will not dominate the others, ensuring a balance between the different aspects of financial performance.

For example:

- A significant increase in Book Value (BV) will result in a high score, indicating m_k, indicating positive management of the company's assets.
- Similarly, a substantial improvement in Return on Equity (ROE) will result in a high score, signalling increased profitability for shareholders. m_k score, signalling increased profitability for shareholders.

3.2.3 Aggregation of Intermediate Scores to Obtain the M-Score

The final M-Score for each company is obtained by calculating the arithmetic mean of the scores
m_k for all selected indicators:

$$M_{Score} = \frac{1}{n} \sum_{i=1}^{n} m_{ki}$$

Where n represents the number of financial indicators used (in this case, 5 indicators: BV, OCF, ROE, ROA, TVE). This aggregation makes it possible to synthesize performance on several dimensions into a single score, facilitating comparison between companies.

3.2.4 Analysis and Interpretation of M-Scores

The final stage of this methodology consists of analyzing the M-Scores obtained for the different companies. These scores are then compared to identify the companies with the best overall performance, as well as those showing signs of weakness in certain financial aspects. The M- Scores provide an overview that can be used to:

- Comparing performance between companies: A high M-Score indicates robust financial performance, while a low score may signal underlying issues requiring attention.

- Identify temporal trends: By analyzing the evolution of M-Scores over time, it is possible to detect trends of growth or decline in a company's financial performance.
- Guide strategic decisions: Companies and investors can use M-Scores to identify opportunities for improvement or potential risks in financial management.

3.2.5 Analysis Tools Used

In this study, financial analysis was carried out entirely using the Python programming language, due to its powerful libraries dedicated to data manipulation and statistical analysis. First and foremost, the Pandas library was used to manage and analyze data structures, enabling efficient processing of financial data in the form of time series and multidimensional tables, an essential element for comparing the performance of the companies studied. For data visualization, tools such as Matplotlib and Seaborn were used to create a variety of graphs, including stacked histograms and heat maps. These visualizations made it possible to highlight the evolution of companies' M-Scores over several years, making it easier to understand accounting manipulation trends. In parallel, NumPy played a crucial role in advanced mathematical operations and data matrix manipulation. It accelerated the calculation of the financial ratios underlying the M-Score model. Libraries such as SciPy and Statsmodels were used to perform statistical tests and analyze relationships between financial indicators. These helped to highlight significant relationships between certain financial variables, thereby reinforcing the study's conclusions. Finally, the Beneish M-Score algorithm was implemented in Python to calculate the score of each company according to predefined financial ratios. This implementation automated the process of assessing the risk of financial manipulation and produced accurate, reproducible and transparent results for all the companies and sectors analyzed. The use of these tools was crucial in guaranteeing the methodological rigor and consistency of the results obtained.

4. Analysis Results

4.1 The Agri-food Sector

4.1.1 M-score Statistics for the Sector Agri-food

The M-Scores results for the agri-food sector, represented by the companies COSUMAR, DARI COUSPAT, LESIEUR CRISTAL, OULMES, and UNIMER, provide a detailed analysis of the financial performance of these companies. Evaluating results from a Sharia-compliant perspective requires taking into account not only financial performance but also the alignment of these companies with Islamic ethical and financial standards.

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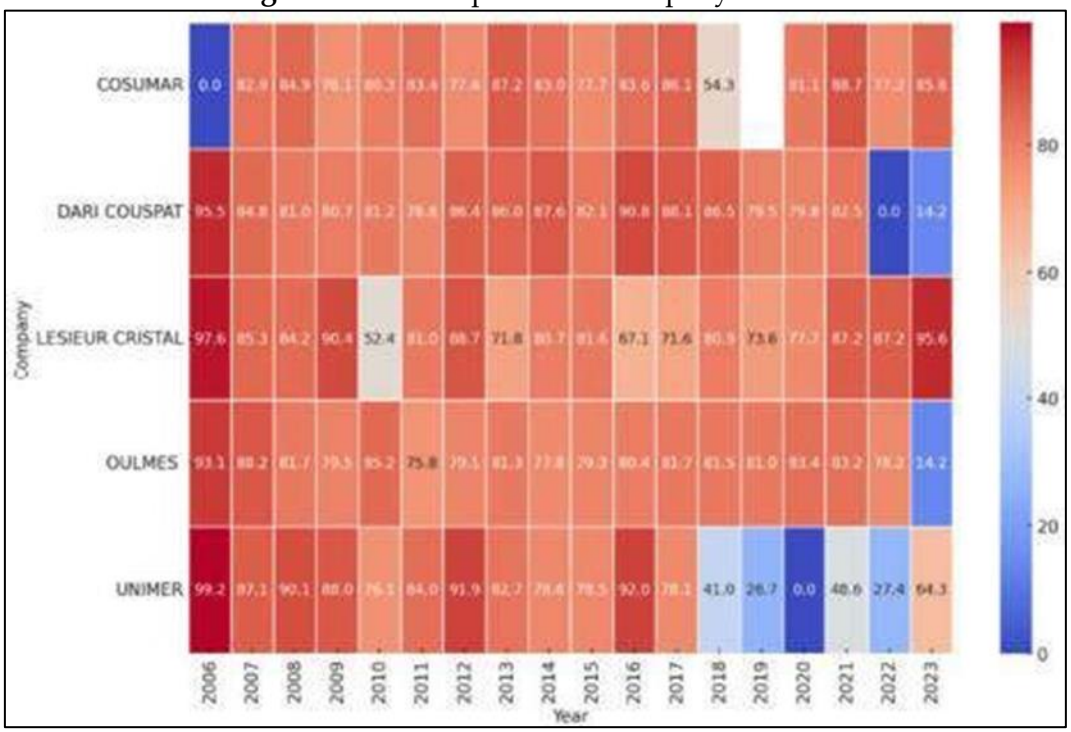
Table 1: M-score Statistics for the Agri-food Sector

ST	count	mean	std	min	25%	50%	75%	max
COSUMAR	17.0	75.863	21.0182	0.0	77.444	82.896	84.870	88.740
DARI COUSPAT	18.0	75.861	25.507	0.0	80.020	82.286	86.487	95.523
LESIEUR CRISTAL	18.0	80.824	10.814	52.411	74.663	81.323	87.238	97.550
OULMES	18.0	78.018	16.420	14.196	79.145	81.145	82.800	93.068
UNIMER	18.0	68.574	28.004	0.0	52.500	78.584	87.779	99.181

Source: Produced by the Authors.

The M-Scores reveal significant variations between companies, reflecting differences in financial performance. UNIMER has the lowest average score at 68.574 and the highest volatility with a standard deviation of 28.004, raising concerns about its management, particularly with a minimum score of 0.0. LESIEUR CRISTAL, with the highest average score at 80.824 and low variation (standard deviation 10.814), shows a stable and resilient performance. COSUMAR has an average score of 75.863 with moderate variation (standard deviation 21.018), but a minimum of 0.0 indicates periods of underperformance. DARI COUSPAT has a similar average score of 75.861, but greater volatility (standard deviation 25.507), suggesting fluctuations in its results. OULMES, with an average score of 78.018 and a standard deviation of 16.420, shows financial stability, although challenges are apparent with a minimum score of 14.196.

Figure 1: Heat-map of Food Company's Sector

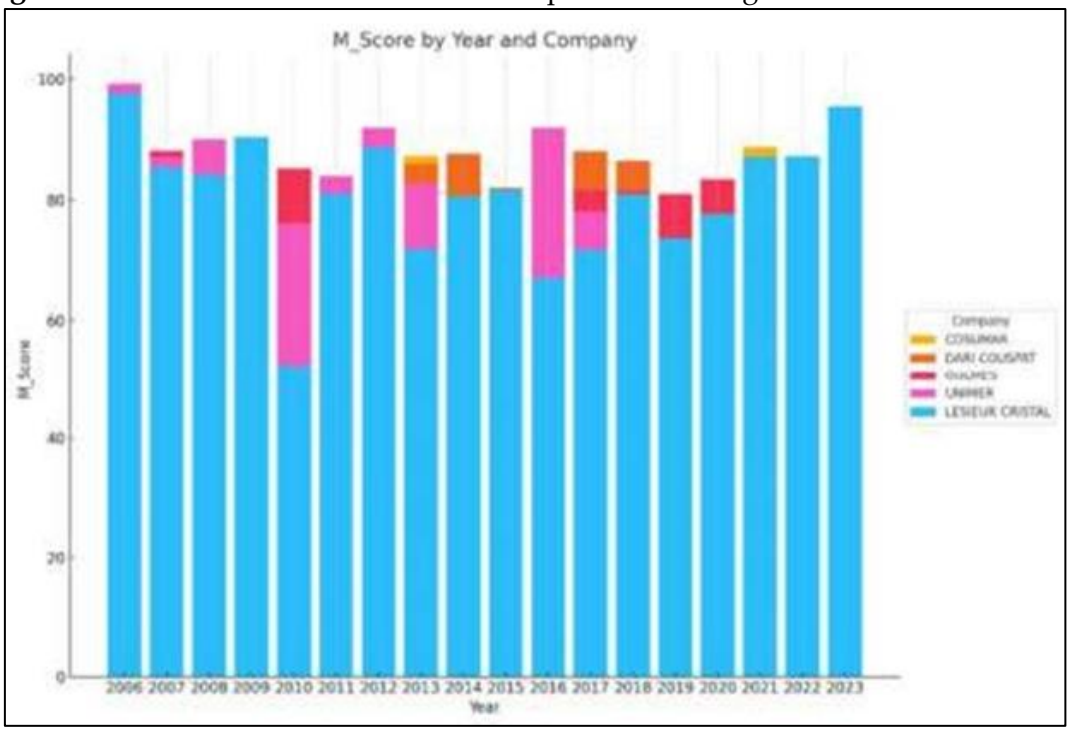


Source: Produced by the Authors.

Analysis of M-Scores from 2006 to 2023 for companies in the agri-food sector shows varied financial trends. COSUMAR shows improvement after a zero score in 2006, maintaining stable scores of 80 to 87 until 2016, before a drop to 54.3 in 2017 and a decline

to 14.2 in 2023, suggesting recent challenges. DARI COUSPAT shows stability with scores between 80 and 90, but a sharp drop to 0.0 in 2023 questions exceptional events. LESIEUR CRISTAL, after peaking at 97.6 in 2006 and dropping to 52.4 in 2010, reaches 95.6 in 2023, showing effective management. OULMES remains stable, with a slight drop after 2017 and a worrying score of 14.2 in 2023. UNIMER is highly volatile, dropping from 99.2 in 2006 to 0.0 in 2019, but showing signs of recovery with 64.3 in 2023. Overall, these results reveal a range of performances, with marked declines in 2023 that call for an in-depth analysis of the underlying causes, whether external or internal.

Figure 2: Evolution of the M-Scores of Companies in the Agri-food Sector in Morocco



Source: Produced by the Authors.

An analysis of the M-Scores of companies in the agri-food sector from 2006 to 2023 reveals a variety of trends. LESIEUR CRISTAL stands out for its remarkable consistency with high M- Scores throughout the period, outperforming its competitors thanks to stable and efficient financial management. UNIMER experiences marked fluctuations, particularly between 2014 and 2019, but shows signs of recovery in 2023 with more competitive scores. COSUMAR and OULMES also show stable performances despite a few dips, notably for COSUMAR in 2010, followed by a rapid recovery. DARI COUSPAT has similar stability to COSUMAR and OULMES, although some fluctuations, as in 2016, suggest internal adjustments. Overall, LESIEUR CRISTAL stands out for its robustness, while the other companies show more volatile performances, requiring closer attention to understand the causes of variations.

Table 2: Correlations between Financial Variables for Companies in the Agri-food Sector

	BV	OCF	ROE	ROA	TVE
BV	1.0				
OCF	0.972	1.0			
ROE	-0.216	-0.215	1.0		
ROA	-0.180	-0.164	0.637	1.0	
TVE	0.604	0.626	-0.305	-0.296	1.0

Source: Produced by the Authors.

Analysis of the correlations between M-Scores and financial variables shows significant relationships between several indicators. Book value (BV) and operating cash flow (OCF) are highly correlated (0.972), indicating a close relationship between a company's financial strength and its ability to generate cash flow. Return on equity (ROE) and return on assets (ROA) are moderately correlated (0.637), suggesting that companies that are efficient in the use of their assets also tend to offer a good return to shareholders. However, ROE shows negative correlations with BV, OCF, and value of equity (TVE), which may indicate that high returns on equity are not always associated with proportional increases in these other financial indicators. These results reveal complex dynamics between the different financial aspects of agribusiness companies.

Table 3: Correlations of Financial Changes in the Agri-food Sector

	Sector Return Change	Book Value Change	Cash Flow Change	Equity Return Change	Asset Return Change	Asset Size Change	Enterprise Value Change
Sector Return Change	1.0						
Book Value Change	-0.0298	1.0					
Cash Flow Change	-0.0312	0.996	1.0				
Equity Return Change	-0.0304	-0.0226	-0.0121	1.0			
Asset Return Change	-0.064	-0.0389	-0.0137	0.382	1.0		
Asset Size Change	-0.035	-0.017	-0.015	-0.019	-0.035	1.0	
Enterprise Value Change	-0.053	-0.285	-0.283	-0.349	-0.178	0.003	1.0

Source: Produced by the Authors.

Correlation analysis shows that changes in sector returns are largely independent of other financial variables, suggesting an external or sector-specific influence. Changes in book value and cash flow are highly correlated (0.996), indicating a close relationship between these two variables. Return on equity and return on assets are moderately related (0.382), showing that efficiency in the use of assets can improve returns to shareholders. Finally, changes in enterprise value are negatively correlated with book value and cash flow, suggesting that increases in these areas do not always translate into a proportional increase in overall enterprise value.

4.2 The Telecommunications and New Technologies Sector

4.2.1 M-score Statistics for the Sector

Interpretation of the descriptive statistics for the telecoms and new technologies sector, as presented in the table, reveals varied performance between the different companies in the sector. These data provide information on the distribution of values within each company, with key indicators such as the mean, standard deviation and percentiles (25%, 50%, 75%).

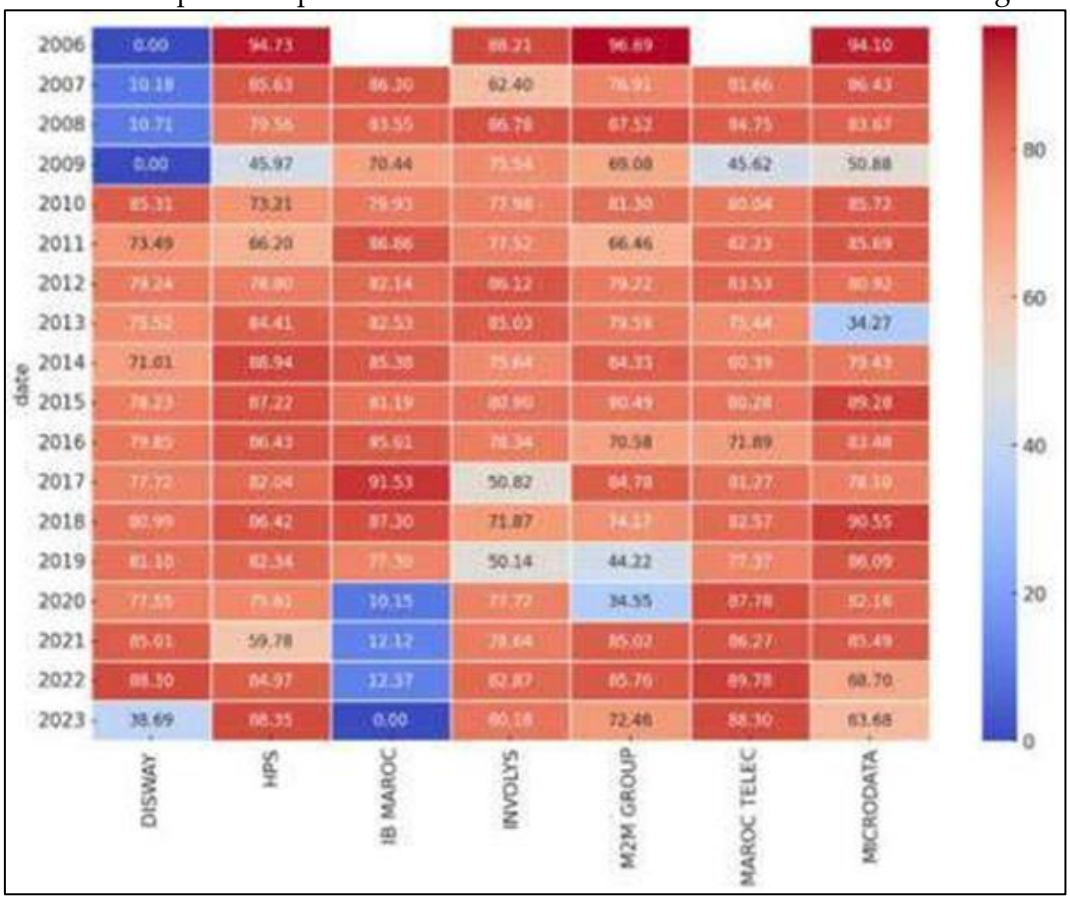
Table 4: M-score Statistics for the Telecommunications and New Technologies Sector

ST	count	mean	std	min	25%	50%	75%	max
DISWAY	18.0	60.715	32.333	0.0	46.768	77.635	80.704	88.304
HPS	18.0	79.477	11.896	45.970	76.409	83.372	86.431	94.728
IB MOROCCO	17.0	65.570	32.955	0.0	70.436	82.140	85.605	91.525
INVOLYS	18.0	75.926	11.018	50.142	75.566	78.159	82.373	88.213
M2M GROUP	18.0	75.173	15.059	34.552	71.049	79.402	84.663	96.685
MAROC TELEC	17.0	79.949	9.972	45.616	80.035	81.658	84.754	89.776
MICRODATA	18.0	78.256	15.113	34.274	78.432	83.576	85.996	94.095

Source: Produced by the Authors.

DISWAY has a mean of 60.715 with a high standard deviation of 32.333, indicating high variability. A minimum value of 0.0 suggests periods of total loss or lack of performance. Although the median is 77.635, the high standard deviation shows significant dispersion. HPS, with a mean of 79.477 and a moderate standard deviation of 11.896, shows a stable performance, with values concentrated around a maximum of 94.728. IB MAROC, with a mean of 65.570 and a standard deviation of 32.955, shows significant variability, but often achieves good performance despite periods of zero results. INVOLYS, with an average of 75.926 and a low standard deviation of 11.018, shows a stable performance with a consistency around 78.159 and a maximum of 88.213. M2M GROUP, with a mean of 75.173 and a standard deviation of 15.059, shows high performance with more variability. MAROC TELECOM stands out for its stability, with a mean of 79.949 and a low standard deviation of 9.972, with constant results around 81.658 and a maximum of 89.776. Finally, MICRODATA, with a mean of 78.256 and a standard deviation of 15.113, performed well, reaching a maximum of 94.095 while maintaining moderate stability.

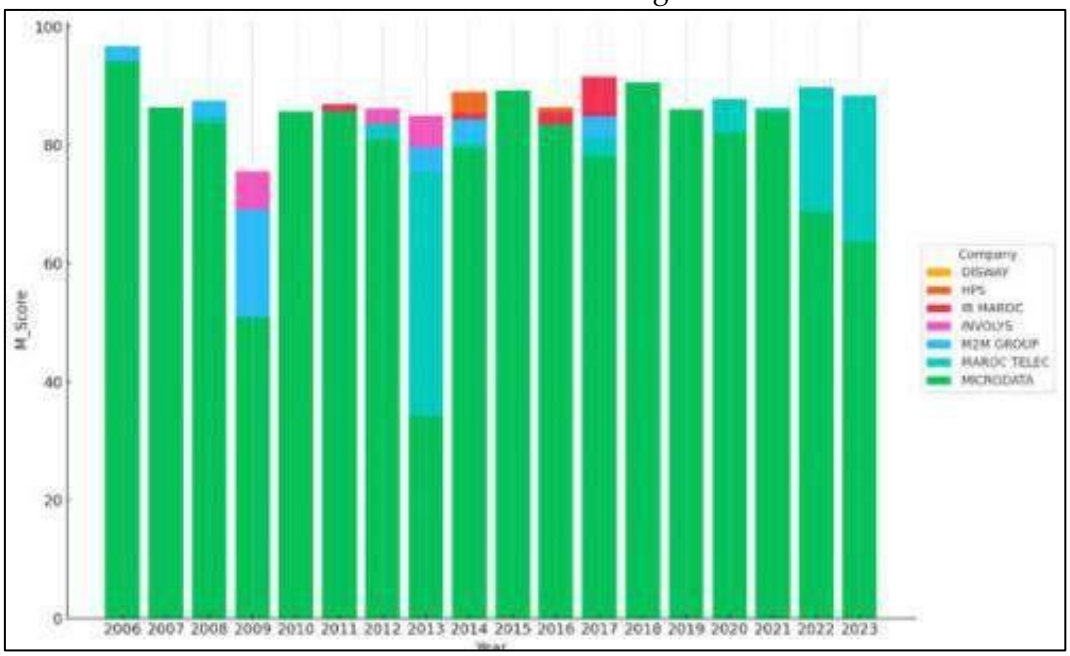
Figure 3: Heat-map of Companies in the Telecommunications and New Technologies Sector



Source: Produced by the Authors.

The heat map of M-Scores from 2006 to 2023 for companies in the new technologies sector shows significant variations in the risk of financial statement manipulation. DISWAY shows strong variability, with a low score of 0.0 in 2006 and a peak of 85.01 in 2021, signalling fluctuations between low and high risk. HPS shows high M-Scores in 2006 (94.73) and 2007 (85.63), but a drop to 59.78 in 2023 suggests a gradual improvement. IB MAROC has high scores at the beginning of the period, but shows significant improvements in 2017 (12.12) and 2019 (7.30). INVOLYS shows high scores overall, but drops to 34.27 in 2023, indicating risk management that remains high. M2M GROUP sees a steady decline from 2017, with a score of 34.55 in 2020, suggesting a reduction in risk. MAROC TELECOM maintains high and stable scores, often above 80, indicating a constant risk. MICRODATA shows peaks at 94.10 in 2006 and moderation to 63.68 in 2023, revealing variability in manipulation risk. Overall, some companies, such as IB MAROC and M2M GROUP, have improved their transparency, while others, such as MAROC TELECOM, remain at high risk, requiring ongoing vigilance.

Figure 4: Evolution of the M-Scores of Companies in the Telecommunications and New Technologies Sector in Morocco



Source: Produced by the Authors.

The stacked bar chart shows the M-Scores per year and per company in the new technologies sector, from 2006 to 2023, reflecting the risk of financial statement manipulation. MAROC TELECOM stands out with consistently high M-Scores, suggesting a high and stable risk of manipulation. DISWAY, HPS, and IB MAROC have high scores at the beginning of the period, but these companies seem to reduce their risk of manipulation in subsequent years. M2M GROUP and MICRODATA also show recent improvements, with M-Scores gradually decreasing. Overall, the graph illustrates that some companies maintain a high risk, while others manage to improve their financial transparency over time.

4.2.2 Correlations between M-Scores and Financial Variables

Table 5: Correlations between Financial Variables for Companies in the Telecommunications and New Technologies Sector

	BV	OCF	ROE	ROA	TVE
BV	1.0				
OCF	0.715	1.0			
ROE	0.739	0.853	1.0		
ROA	-0.248	-0.044	-0.038	1.0	
TVE	0.071	0.059	0.037	0.215	1.0

Source: Produced by the Authors.

The table shows that book value (BV), operating cash flow (OCF), and return on equity (ROE) are highly correlated, suggesting a significant interconnection between these performance measures.

In contrast, return on assets (ROA) shows weak and negative correlations with the other variables, indicating an inverse but weak relationship. Total equity value (TVE) shows very low correlations with all other variables, suggesting that it is influenced by other factors.

Table 6: Correlations of Financial Changes in the Telecommunications and New Technologies Sector

	Sector Return Change	Book Value Change	Cash Flow Change	Equity Return Change	Asset Return Change	Asset Size Change	Enterprise Value Change
Sector Return Change	1.0						
Book Value Change	0.084	1.0					
Cash Flow Change	0.030	-0.079	1.0				
Equity Return Change	0.034	-0.079	0.998	1.0			
Asset Return Change	0.024	-0.079	0.999	0.998	1.0		
Asset Size Change	-0.380	-0.028	-0.002	-0.008	0.021	1.0	
Enterprise Value Change	0.382	0.072	0.0253	0.026	0.032	0.146	1.0

Source: Produced by the authors.

For this sector, Table 6 shows correlations between different financial changes in the sectors. Correlations are low between changes in variables, except for Cash-Flow Change and Equity Return Change, which are almost perfectly correlated (0.998). Asset Size Change is negatively correlated with Sector Return Change (-0.380), while Enterprise Value Change is positively correlated with Sector Return Change (0.382), indicating that these factors are somewhat related.

4.3 The Trade and Transport Sector

4.3.1 M-score Statistics for the Sector Trade and Transport

The table presents descriptive statistics for three companies in the Trade & Transport sector: AUTOHALL, FENIE, and STOKVIS NORD.

Table 7: M-score Statistics for the Trade and Transport Sector

ST	count	mean	std	min	25%	50%	75%	max
AUTOHALL	17.0	72.144	23.079	0.0	63.7042	82.337	84.012	92.728
FENIE	15.0	84.915	7.534	68.199	80.461	85.777	88.832	96.649
STOKVIS NORD	18.0	75.598	16.460	40.1622	69.039	79.993	86.853	94.748

Source: Produced by the Authors.

The table shows statistics for companies in the Trade & Transport sector. AUTOHALL has a mean of 72.144 with notable variability (standard deviation of 23.079) and performance ranging from 0 to 92.728. FENIE shows a higher average at 84.915 with less variability (standard deviation 7.534), suggesting a more stable performance. STOKVIS NORD has a mean of 75.598 and a standard deviation of 16.460, indicating some volatility, with performances ranging from 40.162 to 94.748.

Figure 5: Heat-map of Companies in the Commerce, Transport Morocco Sector

Source: Produced by the Authors.

The M-Scores heat map for AUTOHALL, FENIE, and STOKVIS NORD from 2006 to 2023 shows significant variations in the risk of financial statement manipulation for each company over the years. AUTOHALL shows great variability in its M-Scores, with an exceptionally low score in 2006 (0.00), indicating a very low risk of manipulation in that year. However, subsequent years show much higher scores, suggesting an increase in risk. This fluctuation could reflect changes in accounting practices or in the company's financial management. FENIE shows fairly consistently high M-Scores throughout the period, with a particularly high score in 2006 (96.65). This consistency in high scores indicates a high and sustained risk of financial statement manipulation, which may require increased vigilance in the analysis of its financial performance. STOKVIS NORD also shows a trend towards overall high M-Scores, but with notable variations. For example, in 2016, the score fell to 40.16, suggesting a temporary reduction in the risk of manipulation. Nevertheless, this drop is followed by a recovery in risk in subsequent years.

Figure 6: Evolution of the M-Scores of Companies in the Trade and Transport Sector in Morocco

Source: Produced by the Authors.

The graph shows the M-Scores of AUTOHALL, FENIE, and STOKVIS NORD from 2006 to 2023, indicating their risk of financial statement manipulation. FENIE and STOKVIS NORD show consistently high M-scores, reflecting a high and stable risk of manipulation over the years. AUTOHALL, on the other hand, shows variability, with high risks mainly between 2010 and 2016, followed by a noticeable decline after 2016. This suggests that FENIE and STOKVIS NORD have a constant risk, while AUTOHALL has managed to reduce its manipulation risk in recent years.

4.3.2 Correlations between M-Scores and Financial Variables

Table 8: Correlations between Financial Variables
for Companies in the Trade and Transport Sector

	BV	OCF	ROE	ROA	TVE
BV	1.0				
OCF	0.609	1.0			
ROE	0.3255	-0.353	1.0		
ROA	-0.160	0.641	-0.541	1.0	
TVE	0.867	0.843	-0.0758	0.2145	1.0

Source: Produced by the Authors.

The table shows the correlations between several financial variables in the Trade & Transport sector. Book value (BV) is strongly correlated with total equity value (TVE) (0.867) and moderately with cash flow (OCF) (0.609). Return on equity (ROE) and return

on assets (ROA) show negative correlations with some variables, indicating inverse relationships. Cash flow (OCF) is positively correlated with ROA (0.641), suggesting a link between operating performance and asset efficiency.

Table 9: Correlations of Financial Changes in the Trade and Transport Sector

	Sector Return Change	Book Value Change	Cash Flow Change	Equity Return Change	Asset Return Change	Asset Size Change	Enterprise Value Change
Sector Return Change	1.0						
Book Value Change	0.0150	1.0					
Cash Flow Change	0.025	-0.167	1.0				
Equity Return Change	0.0105	-0.0210	0.986	1.0			
Asset Return Change	0.025	-0.032	0.990	0.996	1.0		
Asset Size Change	-0.015	-0.979	0.176	0.028	0.044	1.0	
Enterprise Value Change	0.624	0.013	-0.034	-0.063	-0.034	-0.021	1.0

Source: Produced by the Authors.

The table shows the correlations between various financial changes in the Trade & Transport sector. Sector Return Change is moderately correlated with Enterprise Value Change (0.624), suggesting a positive relationship between these two variables. Other correlations are generally low, with the exception of the strong correlation between Cash-Flow Change and Asset Return Change (0.990), and between Equity Return Change and Assets (0.996), indicating a close relationship between these performance measures.

4.4 The Other Sector

4.4.1 M-score Statistics for the Sector Other Table: M-score Statistics for Sector (Other)

The statistical results for companies in the "Other" sector reveal a notable diversity in their financial performance. ADDOHA shows stable performance, with a high mean of 84.611 and a low standard deviation of 5.382, reaching a maximum of 95.915. AFRIC INDUSTRIES SA shows high variability (standard deviation 31.900) and a mean of 61.849, with periods of zero performance. AFRIQUIA GAZ and ALUMINIUM DU MAROC show high averages (82.425 and 82.898) and moderate standard deviations, indicating solid, consistent performance. BALIMA and CIMENT DU MAROC have stable averages around 73.556 and 74.092, despite some fluctuations. DELTA HOLDING and DLM show high variability (standard deviations of 27.537 and 32.684), with contrasting performances. JET CONSTRUCTOR and MAGHREB OXYGENE also show high variability, with JET CONSTRUCTOR's average (61.323) lower than MAGHREB OXYGENE's (67.978). MANAGEM turned in a solid performance, with an average of 76.631 and moderate variability. MED PAPER's performance was less consistent, with a mean of 59.775 and a high standard deviation. NEXANS MAROC and SNEP show averages of 70.530 and 80.287, with relative stability despite some fluctuations. SONASID and SOTHEMA have averages around 75.312 and 73.431, with some variability. Alience stands out for its high variability, with a mean of 66.775 and a standard deviation of 32.431, reflecting highly fluctuating performance.

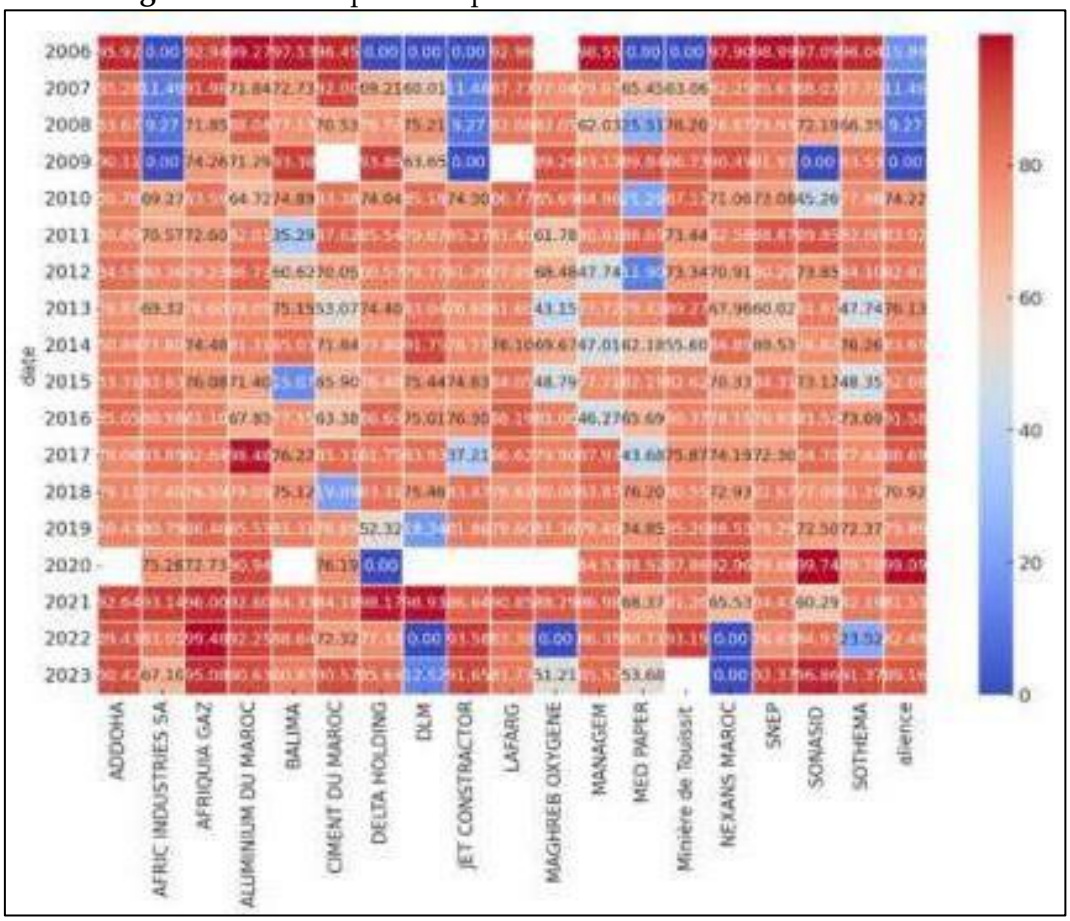
Table 10: M-score Statistics for the Other Sector

ST	count	mean	std	min	25%	50%	75%	max
ADDOHA	17.0	84.611	5.382	76.870	80.777	83.672	89.432	95.915
AFRIC INDUSTRIES SA	18.0	61.849	31.900	0.0	67.640	76.343	80.931	93.139
AFRIQUIA GAZ	18.0	82.425	9.096	71.847	74.881	80.161	90.587	99.480
MOROCCAN ALUMINUM	18.0	82.898	10.449	64.717	73.390	83.769	90.859	99.269
BALIMA	17.0	73.556	20.385	15.071	74.888	77.131	84.325	97.533
CEMENT FROM MOROCCO	17.0	74.092	18.027	19.891	70.048	76.191	85.313	96.446
DELTA HOLDING	18.0	70.758	27.537	0.0	74.132	77.557	84.978	98.167
DLM	17.0	62.229	32.684	0.0	60.011	75.435	83.0355	98.934
JET CONSTRACTOR	17.0	61.323	34.365	0.0	37.214	76.600	83.466	93.576
LAFARG	16.0	83.559	4.985	76.101	80.946	82.730	87.011	92.955
MAGHREB OXYGENE	16.0	67.978	23.127	0.0	59.135	78.471	81.533	89.259
MANAGEM	18.0	76.631	15.326	46.271	77.712	81.867	85.378	98.552
MED PAPER	18.0	59.775	27.909	0.0	46.181	67.028	79.941	89.842
TOUISSIT MINE	17.0	74.801	21.498	0.0	73.435	80.548	86.728	93.190
NEXANS MOROCCO	18.0	70.530	27.215	0.0	70.478	76.168	84.314	97.9018
SNEP	18.0	80.287	8.7621	60.020	76.705	80.065	84.397	98.986
SONASID	18.0	75.312	23.008	0.0	72.669	79.260	87.252	99.737
SOTHEMA	18.0	73.431	17.480	23.520	72.703	77.864	82.142	96.042
ALIENCE	18.0	66.775	32.431	0.0	71.746	81.807	83.491	99.086

Source: Produced by the Authors.

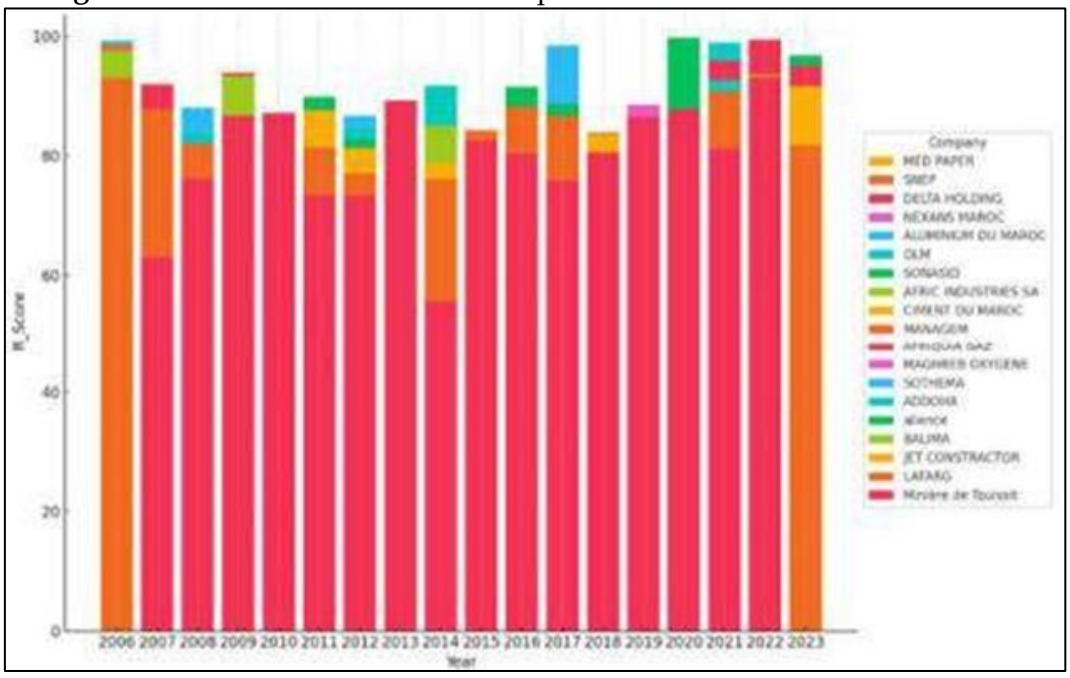
Analysis of the M-Scores of companies in the "Other" sector from 2006 to 2023 reveals significant variations in the risk of financial statement manipulation. ADDOHA shows a consistently high risk, with peaks in 2006 (95.92) and 2007 (93.27), suggesting aggressive accounting practices. AFRIC INDUSTRIES SA shows great variability, with low risks in 2009 and 2015, but high in 2006 (92.94) and 2010 (93.89), signalling instability. AFRIQUIA GAZ and ALUMINIUM DU MAROC generally maintain high risks, with some temporary declines. BALIMA and CIMENT DU MAROC also show variations, with BALIMA reducing its risk in 2020 (5.28) after peaking in 2007 (83.02). DELTA HOLDING and DLM show fluctuations, with near-zero risks in some years, as in 2016 for DELTA (0.00), followed by recoveries. JET CONSTRUCTOR and MAGHREB OXYGENE show similar trends, with risks generally high, but occasionally reduced. MANAGEM maintains a stable, high risk, while MED PAPER shows notable declines, as in 2010 (0.00), followed by recoveries. NEXANS MAROC and Minière de Touissit experienced risk reductions, but returned to high scores. SNEP and SONASID remain at high risk throughout the period. SOTHEMA and Alience experience temporary declines, but rapid recoveries. These results show the importance of monitoring consistently high-risk companies, such as ADDOHA and SNEP, while taking account of fluctuations in others, such as AFRIC INDUSTRIES SA and DELTA HOLDING, which experience periods of high and low risk.

Figure 7: Heat-map of Companies in the Other Sector in Morocco



Source: Produced by the Authors.

Figure 8: Trends in M-Scores for Companies in the Other Sector in Morocco



Source: Produced by the Authors.

The graph shows the annual M-Scores of companies in the "Other" sector from 2006 to 2023, indicating the risk of financial statement manipulation. SNEP dominates the chart with consistently high M-scores, indicating a sustained risk of manipulation throughout the period. Other companies, such as DELTA HOLDING and NEXANS MAROC, show occasional peaks, with a notable drop in 2015 for NEXANS MAROC. MED PAPER and ALUMINIUM DU MAROC show variable contributions, with periods of increased risk followed by declines. Overall, the graph illustrates that some companies maintain a high risk, while others experience more marked variations over time.

4.4.2 Correlations between M-Scores and Financial Variables

Table 11: Correlations between Financial Variables for Companies in the Other Sector

	BV	OCF	ROE	ROA	TVE
BV	1.0				
OCF	0.540	1.0			
ROE	0.289	0.246	1.0		
ROA	0.201	0.434	0.222	1.0	
TVE	-0.0456	-0.037	-0.082	-0.032	1.0

Source: Produced by the Authors.

The table shows the correlations between several financial variables for the "Other" segment. Book value (BV) is moderately correlated with operating cash flow (OCF) (0.540) and weakly correlated with return on equity (ROE) (0.289) and return on assets (ROA) (0.201). Total equity value (TVE) shows weak negative correlations with all other variables, indicating that it is largely independent of other financial measures. These results suggest a moderate relationship between cash flow and overall performance, while total equity value seems little influenced by these variables.

Table 12: Correlations of Financial Changes in the Other Sector

	Sector Return Change	Book Value Change	Cash Flow Change	Equity Return Change	Asset Return Change	Asset Size Change	Enterprise Value Change
Sector Return Change	1.0						
Book Value Change	-0.017	1.0					
Cash Flow Change	-0.035	0.116	1.0				
Equity Return Change	-0.015	-0.002	0.0144	1.0			
Asset Return Change	-0.029	-0.006	0.692	0.216	1.0		
Asset Size Change	-0.021	-0.001	0.125	-0.004	-0.005	1.0	
Enterprise Value Change	0.222	-0.003	-0.007	-0.003	-0.007	0.009	1.0

Source: Produced by the Authors.

The table shows the correlations between changes in various financial variables in the "Other" sector. The correlations are generally low, indicating relative independence between the variables. Notably, Asset Return Change is moderately correlated with Cash Flow Change (0.692), suggesting a link between these two measures. Enterprise Value Change shows a weak positive correlation with Sector Return Change (0.222), but remains independent of the other variables. In summary, the relationships between these variables are weak, indicating distinct influences on overall financial performance.

5. Discussions and Interpretation of Results

Analysis of the M-Scores revealed significant differences between sectors, both in terms of the level of risk of manipulation and financial stability. The results suggest that certain sectors, such as telecommunications and new technologies, are characterized by higher risks of accounting manipulation, with companies like MAROC TELECOM posting consistently high M-Scores. This consistency could indicate internal or external pressures to engage in aggressive accounting practices to maintain perceived high performance. In contrast, the agri-food sector shows generally more moderate M-Scores, with companies such as LESIEUR CRISTAL and COSUMAR showing signs of financial stability. This may reflect a more cautious approach to financial management, perhaps due to the relatively stable nature of this sector compared to other, more volatile sectors. However, the volatility seen in companies like UNIMER highlights that even in seemingly stable sectors, there are significant risks that need to be monitored closely. The Trade & Transport sector shows great variability in M-Scores, indicating uneven handling risks among companies. FENIE and STOKVIS NORD stand out with consistently high M-Scores, suggesting sustained risk, while AUTOHALL shows a more fluctuating trajectory, with periods of reduced risk after years of high scores. This variation indicates that management practices in this sector can vary considerably from company to company. The "Other" sector illustrates extreme diversity, with M-Scores ranging from very low to very high, reflecting heterogeneous financial practices. For example, ADDOHA and SNEP show constant risk, while others, such as AFRIC INDUSTRIES SA and DELTA HOLDING, show wide fluctuations, which may indicate periods of financial reform or responses to changing market conditions. The correlations between the various financial variables and the M-Scores offer insight into the mechanisms underlying companies' financial performance. Strong positive correlations, such as those between book value (BV) and cash flow (OCF), indicate that companies that manage their assets well are also those that generate strong liquidity, a crucial factor for their long-term financial stability. On the other hand, the negative correlations observed between return on equity (ROE) and other financial variables such as BV and OCF raise concerns. These negative correlations could indicate that some companies are sacrificing financial stability to maximize shareholder returns, potentially through aggressive accounting practices. These dynamics are of particular concern in sectors with high M-Scores, as they may indicate a broader trend towards earnings manipulation. Low or no correlations

between certain variables, such as those observed in the "Other" sector, suggest that some companies are failing to effectively align their asset growth with their overall financial performance. This could indicate internal inefficiencies or a lack of consistency in management strategy, presenting both risks and opportunities for investors. For investors, M-Scores and financial correlations provide valuable tools for assessing company risk and performance. Companies with high but stable M- Scores may represent calculated risks, while those with fluctuating scores or negative financial correlations may require careful consideration before investing. Investors can use this information to build balanced portfolios that maximize returns while minimizing risk.

6. Conclusion

This article explored in depth the analysis of M-Scores and financial correlations in various economic sectors. The aim was to assess the risks of accounting manipulation within companies and to examine the underlying financial dynamics influencing their performance. The results revealed significant differences between sectors in terms of financial stability, asset management, and risk of manipulation of financial results. Firstly, the M-Scores analysis highlighted specific sectors, such as telecommunications and new technologies, where the risk of manipulation is higher. This finding underlines the importance of vigilance and transparency in these sectors, where the pressure to maintain high financial performance can encourage aggressive accounting practices. Next, the correlations between the various financial variables offered a glimpse into the complex relationships between asset management, cash generation and corporate profitability. Strong positive correlations, notably between book value and cash flow, suggest that companies that manage their assets effectively are also those that manage to maintain financial strength. On the other hand, the negative or weak correlations observed in certain sectors reveal potential inefficiencies and increased risks of manipulation. Finally, this study highlights the need for regulators to step up oversight in sectors where high M-Scores persist, in order to prevent dubious accounting practices and protect the integrity of financial markets. For investors, M-Scores and financial correlations are essential tools for assessing risk and identifying companies likely to deliver stable returns. This study has provided a detailed and comparative analysis of the risks of financial manipulation across different sectors, while highlighting the implications of these dynamics for companies, regulators, and investors. These results provide a solid basis for future discussions on improving financial transparency and promoting accounting practices within companies.

Conflict of Interest Statement
I certify that I have NO affiliation or involvement with any organization or entity having a financial interest (such as honoraria, educational grants, participation in speakers bureaus, membership, employment, consulting, stock ownership or other ownership interests, and expert testimony or patent licensing agreements), or a non-financial interest

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