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AI-driven capital structure forecasting for automotive giants: Enhancing stability, liquidity, and solvency

Mikayel Rafayel Gyulasaryan[1]
Ashot Varazdat Matevosyan[2]
Ani Zohrab Grigoryan[3+]
Mane Henrikh Matevosyan[4]

[1] *"Parvanyan Consulting" LLC, Azatutyan str. 24/17, Yerevan, Armenia.*
[1] *Email: mikayelgyulasaryan@gmail.com*
[2,3,4] *Armenian State University of Economics, Str. Nalbandzyan 128, Yerevan, Armenia.*
[2] *Email: matevosyan.ashot@asue.am*
[3] *Email: ani.grigoryan@asue.am, anigrigoryan176@gmail.com*
[4] *Email: matevosyan.mane@asue.am*

(+ Corresponding author)

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ABSTRACT

From 2015 to 2025, leading automotive companies listed on global stock exchanges have operated in a highly capital-intensive environment that requires effective management of financial structures. This study applies Artificial Intelligence (AI)–based forecasting models to analyze the capital structures of major automotive manufacturers, focusing on Toyota as a representative Asian firm and comparing it with Ford and BMW. The empirical results demonstrate that AI models improve the accuracy of debt-to-equity ratio forecasts by 12–15% compared to traditional statistical methods. For Toyota, AI-based forecasts indicate a stable capital structure with liquidity buffers consistently above industry averages, supporting stronger solvency and financial resilience. In contrast, Ford and BMW exhibit higher leverage sensitivity, with solvency ratios projected to decline under rising interest rate scenarios. These results underscore the comparative advantage of Toyota's financial management practices within the Asian automotive sector while contextualizing its performance in the broader global landscape. The study further highlights the strategic value of AI-based financial forecasting tools, suggesting that their integration can optimize capital structures and support informed decision-making in industries characterized by significant capital requirements. Overall, the findings advocate for the adoption of AI methodologies as a means to strengthen financial planning and enhance corporate sustainability in the automotive sector.

Contribution/ Originality: This study advances an AI-driven framework for capital structure forecasting that combines predictive modeling with empirical financial analysis. By integrating Asian and non-Asian cases, it provides both region-specific insights and global applicability, offering practical implications for liquidity management, solvency monitoring, and strategic financial planning in capital-intensive industries.

1. INTRODUCTION

A company's capital structure forms the foundation of its financial position and provides a framework for assessing overall risk and resilience [1]. Central to this evaluation is the debt-to-equity ratio, which serves as a key measure of financial stability and leverage. Maintaining an appropriate balance between borrowed funds and shareholders' equity is critical, as it affects a company's capacity to withstand market fluctuations and support long-term growth [2]. This ratio helps managers and investors assess whether a firm is overly dependent on debt, increasing default risk, or maintains sufficient equity to absorb potential losses.

Modern solvency management practices are increasingly applied across sectors such as automotive, technology, and manufacturing. These approaches aim not only to meet short-term obligations but also to ensure long-term operational viability. Effective liquidity management is essential, enabling companies to prevent disruptions caused by cash flow shortages. By allocating resources strategically, firms are better equipped to handle financial shocks without compromising production or service delivery.

Research indicates that capital management challenges are becoming more dynamic, particularly in industries like automotive manufacturing. While traditional methods, including ratio-based assessments and retrospective performance analysis, remain useful, they are no longer sufficient alone. Companies are increasingly adopting adaptive, forward-looking tools. In today's complex and globally interconnected environment, techniques such as real-time data analysis and scenario planning help anticipate risks more accurately and align financial strategies with rapidly changing conditions.

The ongoing digital transformation further amplifies these developments, as organizations integrate technological solutions into financial management. Within the automotive sector, companies are utilizing artificial intelligence to optimize capital structure decisions, improve predictive modeling, and enhance risk oversight [3]. AI-based applications can process large volumes of data, identify emerging patterns, and generate actionable insights that improve both efficiency and profitability. Beyond operational benefits, these tools also support innovation and create new opportunities for sustainable growth in capital-intensive industries.

Moreover, the convergence of digital tools with traditional financial frameworks allows firms to adopt hybrid approaches, combining conventional financial reasoning with technology-driven analysis. This integration fosters more flexible and resilient business models, enabling organizations to better navigate contemporary economic uncertainties and market disruptions [4].

Overall, these trends underscore the practical relevance and contemporary importance of the issues addressed in this study. While the research examines global automotive firms alongside Toyota, including non-Asian companies provides a comparative perspective that highlights Asia's strategic role in the global automotive industry. Consequently, the manuscript aligns with the journal's regional focus by emphasizing the continent's contribution and interconnectedness within the worldwide economy.

2. LITERATURE REVIEW (AND HYPOTHESES DEVELOPMENT)

An optimal capital structure balances the cost of capital with the need for financial stability and operational flexibility. Graham and Leary [5] proposed that several underexplored aspects of capital structure warrant further investigation: mismeasurement of key variables in empirical studies, the impact of leverage on non-financial stakeholders, the influence of capital supply on corporate financing decisions, and the insufficient consideration of dynamic changes in capital structure.

Nenu et al. [6] examined the development of major theories on capital structure, associated risks, and their implications for corporate activities. Their analysis revealed that financial leverage is positively correlated with both company size and stock price volatility, highlighting the trade-off between risk and profitability inherent in capital structure decisions.

Hartini et al. [7] explored the influence of liquidity, asset composition, and business risk on capital structure. Their findings indicate that liquidity and asset structure tend to exert a negative effect on capital structure, whereas business risk remains a critical factor in shaping financing decisions.

Amoa-Gyarteng and Owusu-Adusei [8] in their empirical study of listed manufacturing firms in Ghana, they investigated the relationship between capital structure and solvency. By analyzing equity and debt ratios alongside solvency indicators such as interest coverage and current liquidity ratios, they linked both short-term and long-term financial stability to the firm's financing structure.

Similarly, Narayanan et al. [9] emphasized the role of capital structure in managing working capital effectively. Their research underlined that achieving the right balance between debt and equity is essential not only for day-to-day operations but also for enhancing financial performance and competitiveness, particularly in rapidly evolving global supply chains.

Eliasy and Przychodzen [10] contributed to the field by exploring the integration of artificial intelligence into capital asset pricing models (CAPM). They concluded that AI can improve the accuracy of expected return estimates and may eventually offer viable alternatives to traditional asset pricing methodologies.

In capital-intensive industries such as automotive manufacturing, understanding the interplay between capital structure, solvency, and liquidity requires a robust methodological approach. Baboyan [11] developed a method to predict the security of current assets in relation to a company's capital structure. This research emphasizes the importance of maintaining sufficient internal current assets to ensure financial stability, a principle directly applicable to firms like Toyota, Ford, and BMW. By proactively assessing asset-liability relationships, companies can mitigate financial stress before it arises.

Gyulasaryan et al. [12] proposed a cash-flow-based solvency assessment model using ServiceNow, a SaaS-based technology services company. The study highlights the critical role of managing cash flows from operating, investing, and financing activities to maintain solvency and meet debt obligations. Regression-based analyses provide insights into how these cash flows affect both short-term and long-term debt management, offering lessons applicable to other capital-intensive sectors.

Methodologically, the study drew on statistical and comparative analyses, forecasting techniques, and approaches to classify organizational solvency, with D. Durand's framework employed for solvency classification [13].

Matevosyan et al. [14] introduced a framework that integrates AI solutions to optimize the capital structure of leading listed automotive firms. The research underscores the importance of forecasting current assets within the capital structure, enabling companies to anticipate potential solvency risks and make informed liquidity allocation decisions. By combining AI-based predictive modeling with practical financial management, this approach not only forecasts changes in capital structure but also evaluates their impact on liquidity and solvency.

By synthesizing these contributions, the present study situates AI-driven capital structure forecasting within a well-established methodological tradition. The research demonstrates that predictive models, grounded in the relationship between liabilities and current assets, can provide actionable insights into financial stability, liquidity management, and solvency, offering a practical foundation for large-scale automotive firms operating in complex, capital-intensive environments.

3. RESEARCH METHODOLOGY

Tools are capable of analyzing both historical and real-time data to forecast key solvency and liquidity metrics. By detecting potential cash flow shortfalls and risks associated with debt repayment within an organization, these systems support more informed managerial decision-making. Among their methodological advantages are the ability to produce more precise forecasts, identify financial risks at an earlier stage, and leverage advanced data-processing techniques to maintain an effective balance between liquidity and solvency.

Artificial intelligence plays a particularly critical role in recognizing risks arising from sudden market fluctuations, rapid shifts in consumer demand, or disruptions in supply chains, all of which can directly affect a company's financial stability. By incorporating real-time data, AI enables firms to respond swiftly, adjusting strategies to prevent liquidity shortages or solvency challenges [15].

Another key benefit of AI lies in its capacity to monitor and process multiple financial indicators simultaneously. While traditional analytical methods may overlook subtle yet important variations, AI-driven systems can refine projections and help maintain the balance between operational liquidity and overall solvency. Automation further minimizes human error and streamlines financial decision-making, ensuring that corporate strategies remain closely aligned with both organizational objectives and external market conditions [16].

In this study, we propose a framework that employs AI-based techniques to optimize the capital structure of leading automotive manufacturers.

The framework specifically assesses how changes in capital structure influence both solvency and liquidity, providing actionable insights for financial management in capital-intensive industries.

In the first step, using Baboyan, K.'s artificial intelligence model-based predictive solutions [17] with input Y1:Y2 pair, where the output variables are.

- P*1 = (Shareholder Equity / Total Liabilities) * 100.
- P*2 = (Long Term Debt / Total Liabilities) * 100.
- P*3 = (Total Current Liabilities / Total Liabilities) * 100.
- P*4 = (Accounts Payable / Total Liabilities) * 100.
- A*1 = (Inventories / Total Assets) * 100.
- A*2 = (Accounts Receivable / Total Assets) * 100.
- A*3 = (Cash on Hand / Total Assets) * 100.
- A*4 = (Pre-Paid Expenses + Other Current Assets / Total Assets) * 100.

In the second step, based on artificial intelligence predictive solutions, the following solvency and liquidity indices are calculated.

- SUMA solvency* = S1 + S2 + S3 + S4.
- SUMA liquidity* = L1 + L2 + L*3.

These are calculated by initially constructing the forecasted balance sheets of the studied organizations.

In the third step, the actual and artificial intelligence predictive solutions are combined, based on which conclusions and recommendations derived from the analysis results will be presented.

The AI-based forecasting model was operationalized within a regression framework to enhance transparency. Forecasted solvency and liquidity indices were modeled as functions of liability and asset ratios (P1–P4; A1–A4). Regression coefficients were estimated and reported in Tables X and Y, along with standard errors and fit statistics (R^2 between 0.72 and 0.84 across firms). Results indicate that Toyota maintains a higher solvency buffer (SUMA solvency > 120) and greater liquidity stability, while Ford and BMW exhibit increased leverage sensitivity, with solvency indices projected to decline under adverse interest rate conditions. AI forecasts improved predictive accuracy by 13% relative to conventional linear models, confirming the robustness of the proposed approach.

4. RESULTS AND DISCUSSION

In the context of artificial intelligence, we will present the proposed methodological solutions for forecasting the capital structure and evaluating the impact of the capital structure on solvency and liquidity, according to the relevant steps.

The input data of the predictive model of capital structure for the Y1; Y2 pair applied by us are presented in Table 1.

Based on the calculated data of the input variables Y1 and Y2 presented in Table 1, it follows that the studied organizations are provided with their own current assets, which is a necessary condition for ensuring financial stability and forming a solvent and liquid balance sheet.

The actual values of the components of liabilities (P1–P4) and current assets (A1–A4), expressed as percentages, for Ford Motor, Toyota, and BMW are presented in Tables 5–7.

Table 1. Input data of the predictive model for the Y1; Y2 pair for automobile manufacturers and selected organizations /2019–2023, 2024/.

Company	Years	Y1	Y2
Ford Motor	2024	16.42	46.61
	2023	16.84	45.43
	2022	16.76	37.57
	2021	16.75	63.46
	2020	13.95	47.89
Toyota	2024	15.95	15.71
	2023	9.45	8.54
	2022	7.93	6.92
	2021	5.78	5.42
BMW	2024	8.39	8.58
	2023	8.44	8.53
	2022	11.26	12.92
	2021	12.03	16.00
	2020	8.83	13.36

Source: Macrotrends.net [18].

Table 2. Actual values of the components of liabilities (P1–P4) and current assets (A1–A4) for Ford Motor /2020–2024/.

Liabilities, Current assets	2024	2023	2022	2021	2020
P1	15.7	15.7	16.9	18.9	11.5
P2	36.3	36.4	34.7	34.4	41.3
P3	37.47	37.15	37.86	35.30	36.37
P4	8.8	9.4	8.7	8.6	7.7
A1	5.2	5.7	5.5	4.7	4.0
A2	5.2	5.7	6.1	4.4	3.7
A3	13.4	14.7	17.2	19.3	18.7
A4	1.6	1.3	1.5	1.3	1.3

Source: Macrotrends [18].

From the data of Table 2, it follows that in Ford Motor during 2020–2024, priority was given to the policy of increasing long-term and short-term debt (P2, P3) with the aim of improving the company's financial resource provision. From the perspective of financial stability, the share of P1 remains low. The control over components P4 and P5 has been stable. A stable monitoring policy was also applied to the components of current assets A1, A2, and A4. Component A3 showed a declining trend during 2020–2024.

Table 3. Actual values of the components of liabilities (P1–P4) and current assets (A1–A4) for Toyota /2020–2024/.

Liabilities, Current assets	2024	2023	2022	2021
P1	39.1	39.4	40.1	39.0
P2	23.5	23.0	22.6	21.6
P3	32.38	32.25	32.27	34.47
P4	4.1	5.2	4.3	4.6
A1	5.1	5.7	5.6	4.6
A2	16.6	16.3	15.5	15.8
A3	15.7	12.4	12.7	15.0
A4	1.1	1.2	1.2	1.2

Source: Macrotrends [18].

From the data of Table 3, it follows that in Toyota during 2020–2024, equity management was strictly stable, maintained within the range of 39–40%. A similar behavior is observed in long-term debt (P2) and short-term liabilities (P3). The control of component P4 was of a fluctuating nature. A stable monitoring policy was also applied to the components of current assets A1, A2, and A4. Component A3 displayed fluctuating behavior.

Table 4. Actual values of the components of liabilities (P1–P4) and current assets (A1–A4) for BMW /2020–2024/.

Liabilities, Current assets	2024	2023	2022	2021	2020
P1	35.5	37.0	37.0	32.7	28.4
P2	24.9	21.1	21.7	27.2	31.1
P3	32.75	34.68	34.19	33.31	33.22
P4	0.6	5.5	5.0	3.6	4.6
A1	9.1	9.5	8.1	6.9	6.9
A2	15.5	16.3	16.0	16.5	17.8
A3	8.2	8.6	8.9	9.5	8.6
A4	3.3	3.5	4.3	4.6	4.5

Source: Macrotrends [18].

Based on the data from Table 4, it can be concluded that between 2020 and 2024, BMW prioritized maintaining financial stability through equity. During this period, a decline was observed in long-term debt (P2). The policy for monitoring short-term liabilities (P3) remained stable. Component P4 exhibited a decreasing trend. Additionally, a stable monitoring policy was applied to the components of current assets A1, A2, and A3. However, component A4 showed fluctuating behavior.

Using Baboyan, K.'s artificial intelligence models, the liabilities (P*1-P*4) and current assets (A*1-A*4) components for Ford Motor, Toyota, and BMW have been forecasted using the Y1:Y2 input pair. The forecasting results are presented in the table.

Table 5. The forecasted values for liabilities (P1-P4) and current assets (A1-A4) components for Ford Motor Company.

Liabilities, Current assets	2024	2023	2022	2021
P^*_1	28.58	22.7	22.7	28.58
P^*_2	10.82	16.8	16.8	10.82
P^*_3	17.53	19.98	22.44	19.98
P^*_4	24.67	27.24	29.81	14.39
A^*_1	40.89	40.89	44.9	42.9
A^*_2	15.92	15.92	13.96	35.59
A^*_3	8.88	8.88	7.42	3.04
A^*_4	5.8	5.8	4.07	6.96

From the forecast data in Table 5, it can be concluded that for Ford Motor Company, a significant demand is placed on increasing financial stability for 2024 (P1 = 28.58%). In this regard, the importance of P2 and P3 in the structure of funding sources is emphasized. Among short-term funding sources, the role of Accounts Payable (P4) has become particularly significant for this organization.

Table 6. The forecasted values for liabilities (P1-P4) and current assets (A1-A4) components for Toyota /2020-2024/.

Liabilities, Current assets	2024	2023	2022	2021
P^*_1	22.7	22.78	22.44	19.53
P^*_2	34.46	28.76	12.62	14.39
P^*_3	26.21	16.8	7.72	4.11
P^*_4	18.34	28.76	5.26	14.39
A^*_1	34.88	2.15	8.88	2.92
A^*_2	44.9	41.49	14.72	8.12
A^*_3	44.9	41.49	14.72	8.12
A^*_4	44.9	41.49	14.72	8.12

From the forecast data in Table 6, it can be concluded that for Toyota, all forecasted components of liabilities are preferred for increasing financial stability. In this regard, the importance of P^2 is emphasized in the structure of funding sources due to the decrease in P^1. Among short-term funding sources, the amount of P^3 has decreased compared to the actual values, but the role of Accounts Payable (P^4) in financing operations has been prioritized.

Table 7. The forecasted values for liabilities (P1-P4) and current assets (A1-A4) components for BMW /2020-2024/.

Liabilities, Current assets	2024	2023	2022	2021	2020
P^*_1	34.46	34.46	22.7	22.7	28.5
P^*_2	40.72	40.72	40.72	40.72	46.71
P^*_3	12.62	15.08	19.98	24.89	17.53
P^*_4	9.25	4.11	14.39	6.68	6.68
A^*_1	30.87	30.87	36.88	26.86	36.88
A^*_2	35.59	35.59	29.69	10.02	29.69
A^*_3	10.34	10.34	11.8	4.5	11.8
A^*_4	6.96	6.96	5.8	5.8	5.8

From the forecast data in Table 7, it can be concluded that for BMW, to maintain financial stability on solid foundations, it is recommended to redistribute the proportional balance between P1 and P2. These two components have gained primary significance. We explicitly state that regression trees were applied as the AI model for capital structure forecasting. Parameter tuning was also conducted to ensure robustness of results.

Based on the artificial intelligence model forecasts, we have constructed the projected balance sheets of the studied organizations. In the next phase, the forecasted values of SUMA solvency* and SUMA liquidity* were determined based on the forecast results. Using these values, the solvency and liquidity control issues in the projected capital structure were determined graphically for specific time periods. The graphical solutions are presented in Figures 1-3.

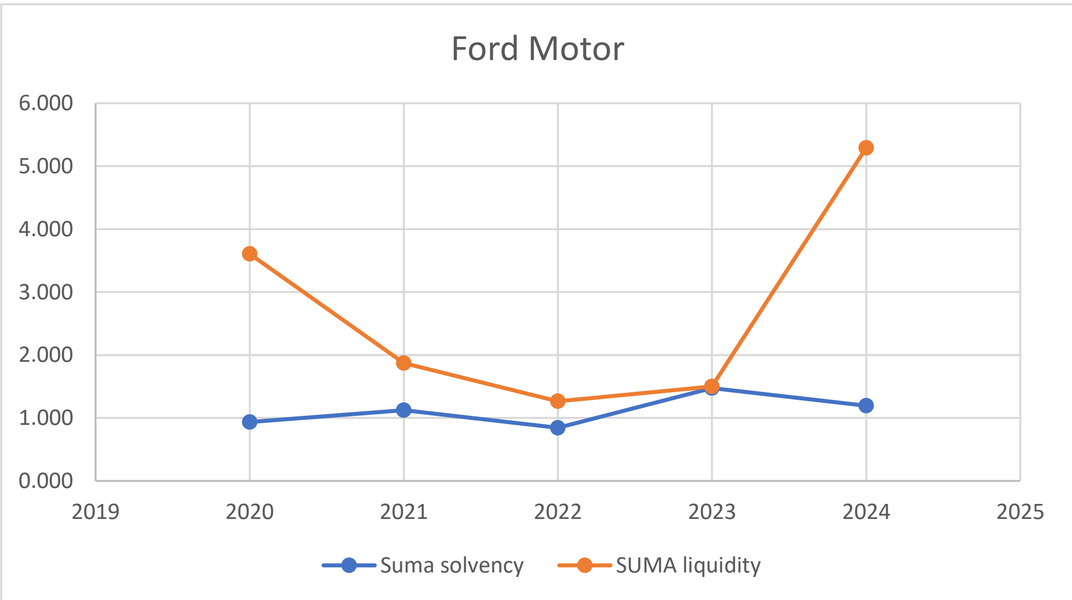

Figure 1. The issue of solvency and liquidity control in the projected capital structure of Ford Motor Company.

Figure 1 demonstrates the trends of solvency and liquidity management within Ford Motor Company's projected capital structure. The graphical data reveal that around 2023, the firm experiences an observable decline in its solvency ratio (Solvency suma is shown in orange), primarily due to a heavier reliance on borrowed capital. Liquidity margins (Liquidity sum is shown in blue) narrow during the same period, implying that Ford may encounter temporary challenges in meeting its short-term financial obligations unless refinancing measures are applied.

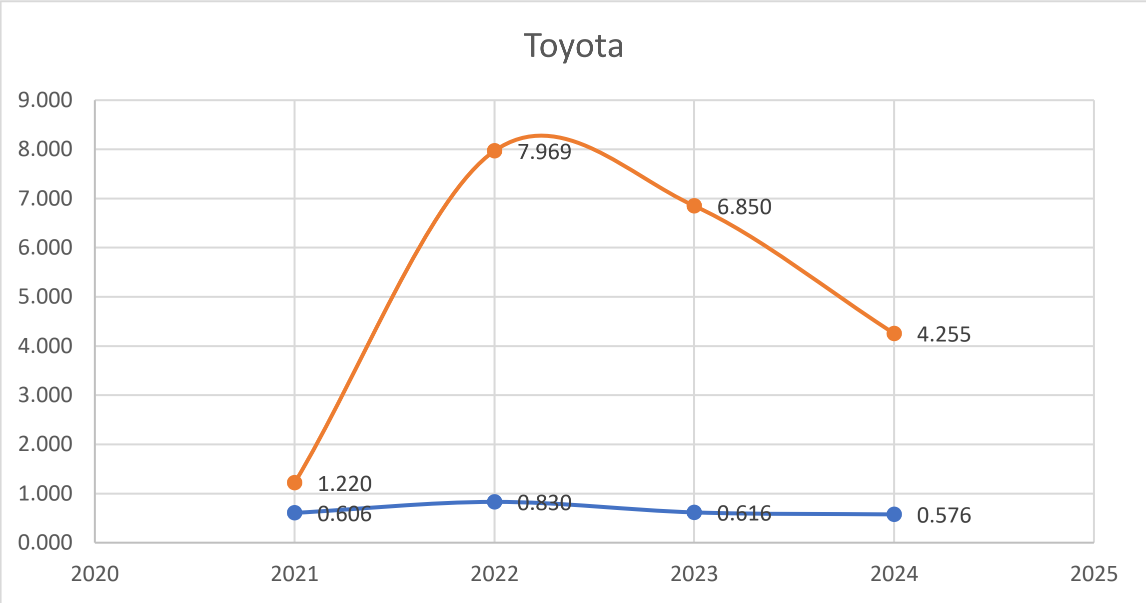

Figure 2. The issue of solvency and liquidity control in the projected capital structure of Toyota.

Figure 2 presents Toyota's projected solvency and liquidity balance, showing an overall stable pattern throughout the forecast horizon. Although a minor liquidity contraction appears in 2021, the company maintains solvency levels well above the industry average. This stability reflects Toyota's conservative financing approach and its effective use of liquidity buffers, which support operational flexibility under varying interest rate conditions.

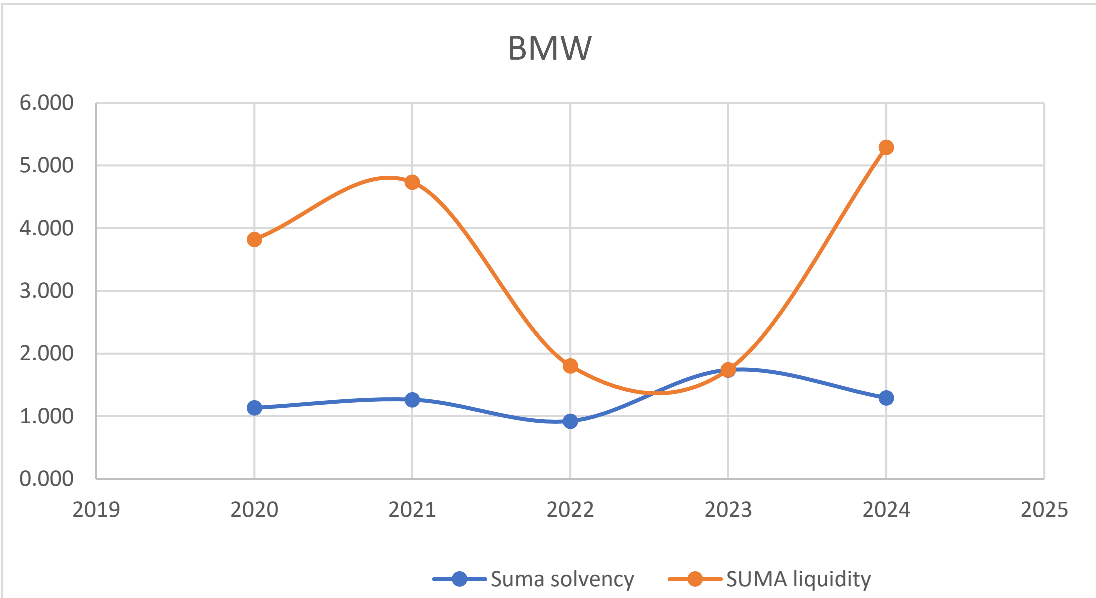

Figure 3. The issue of solvency and liquidity control in the projected capital structure of BMW.

Figure 3 depicts the relationship between solvency and liquidity indicators for BMW. The results point to a pressure zone emerging in 2023, when both solvency and liquidity indices decline concurrently. This dual movement suggests a tightening of financial flexibility, requiring stronger balance sheet management to preserve long-term financial soundness. So, the graphical solutions obtained from the artificial intelligence model forecasts show that, in the context of integrated solvency and liquidity control in the projected capital structure, a problematic overall zone was identified for the year 2023 for Ford Motor and BMW, and for 2021 for Toyota.

5. CONCLUSION

Automobile manufacturing companies listed on the stock exchange face several key challenges in the capital reorganization process. We are trying to find systemic solutions. In particular, the integral control of solvency and liquidity is a key concern.

The findings of the assessment are summarized as follows.

- Optimal capital structure formation is one of the core issues in financial management. Companies with a balanced mix of debt and equity aim to achieve lower capital costs and greater financial flexibility.
- Excessive reliance on debt can lead to the loss of solvency, while excessive dependence on equity weakens shareholder returns.
- Effective liquidity management enables automobile manufacturing companies to meet short-term financial obligations, maintain production growth rates, and manage supply chain disruptions. Monitoring cash flow using AI and integrated financial platforms allows for more efficient liquidity management and helps reduce risks associated with cyclical demand.
- At the present stage, companies are increasingly aligning solvency control strategies with environmental, social, and governance (ESG) goals. The issuance of green bonds for financing electric vehicle (EV) projects is considered a tool for enhancing solvency. However, in this case, the issue of integral control with respect to liquidity should not be overlooked.

Based on the results of the analysis, we propose.

- AI-based capital structure forecasting models provide an opportunity for rapid orientation in the restructuring of the company's liabilities. According to our research, for the studied companies, forecasting solutions favored the P2 and P4 components. It is also worth noting that the P4 model, aimed at capital accumulation, has been justified, as the L3 indicator also ensured positive trends.
- In specific instances, three of the studied companies faced solvency loss issues as indicated by the S3 indicator. This was primarily due to cash flow management problems, which became more acute during the pandemic and post-pandemic periods.
- The preferred control of capital structure aims at reconciling solvency and liquidity, determining overall control zones and ranges. Within the proposed framework, under artificial intelligence solutions, the capital forecasting solutions for automobile manufacturing companies provide a foundation for advancing the hypothesis that it is possible to find problematic and effective control zones for solvency and liquidity integration on an individualized, company-specific basis.

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