



Predicting procurement Value-at-Risk (VAR) based on financial & geopolitical risk associated with suppliers

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Abstract The consumer electronics supply chain industry faces challenges in evaluating and predicting procurement Value-at-Risk (VAR) due to the complex interplay of financial and geopolitical risks associated with suppliers. This paper addresses the shortcomings of the current ad-hoc assessment process by proposing a structured methodology for risk analysis and prediction. Leveraging financial analysis techniques such as Altman Z-Score and Ohlson O-Score methodologies, coupled with geopolitical risk measures based on supplier locations, the project aims to develop a robust risk assessment framework.

The paper emphasizes the need for a repeatable process that alerts procurement teams to financial distress or geopolitical triggers, enabling proactive risk mitigation actions. Furthermore, integration with Tableau is proposed to visualize risk metrics effectively. Leveraging SQL for data management, the project seeks to automate the aggregation and distribution of supplier risk metrics, facilitating informed decision-making by stakeholders.

By implementing this methodology, the paper endeavors to enhance supplier risk management practices, minimize the impact of supplier failures, and ensure continuity of the procurement process. Through actionable insights derived from comprehensive risk assessment, procurement teams can strategically manage supplier relationships and mitigate potential disruptions in the supply chain.

Keywords Supply chain risk management, Procurement, Value-at-Risk (VAR), Financial risk analysis, Geopolitical risk assessment, Altman Z-Score, Ohlson O-Score, Supplier categorization, Tableau integration, SQL data management.

1. Introduction

The intricate web of global supply chains has long been subject to a myriad of uncertainties and challenges, ranging from volatile market conditions to geopolitical upheavals. In recent times, the interconnectedness of economies and the rise of geopolitical tensions have further exacerbated these challenges, rendering traditional supply chain management approaches insufficient in mitigating risks effectively. Amidst this backdrop, organizations are compelled to adopt innovative strategies to safeguard their supply chains and ensure business continuity.

One of the critical aspects in this endeavor is the assessment and management of procurement risks, which encompasses a wide array of factors including financial instability of key suppliers, geopolitical risks, regulatory changes, and environmental disruptions. Among these, the financial health of suppliers stands out as a pivotal determinant of supply chain resilience. The failure of a key supplier due to financial distress can ripple through the entire supply chain, leading to production delays, increased costs, and ultimately, reputational damage.



In parallel, geopolitical tensions and macroeconomic uncertainties pose significant threats to global trade and supply chain operations. Events such as trade disputes, geopolitical conflicts, and regulatory changes can disrupt supply chains, impeding the flow of goods and services across borders. Moreover, the emergence of new geopolitical risks, such as cyber threats and geopolitical shifts, further complicates the landscape, necessitating a holistic approach to risk assessment and management.

In response to these challenges, organizations are increasingly turning to predictive analytics methodologies to enhance their ability to anticipate and mitigate procurement risks. By leveraging advanced analytics techniques, organizations can gain deeper insights into supplier dynamics, identify potential vulnerabilities, and proactively implement risk mitigation strategies.

This paper proposes a comprehensive framework for assessing procurement Value-at-Risk (VAR) by integrating both financial and geopolitical risk factors into the evaluation process. Drawing on established financial models such as the Altman Z-Score and Ohlson O-Score, as well as geopolitical risk measures, the framework aims to provide organizations with a robust methodology for evaluating supplier risk exposure and implementing proactive risk mitigation measures.

In the following sections, we will delve into the methodology underlying the proposed framework, detailing the process of data collection, analysis, and risk assessment. We will also discuss the implications of the findings for supply chain resilience and business continuity, as well as potential avenues for future research and development.

Overall, the integration of predictive analytics methodologies offers organizations a proactive approach to managing procurement risks, enabling them to navigate the complexities of the modern supply chain landscape with greater agility and resilience. By embracing innovation and leveraging data-driven insights, organizations can enhance their competitive advantage and ensure sustained growth in an increasingly volatile and uncertain environment.

2. Literature Review

Supply chain risk management is crucial in addressing the complexities of global supply chains. Traditionally, risk management focused on operational risks, but there's now a recognized need for a holistic approach considering financial and geopolitical factors.

Predictive analytics enhances supply chain risk management by leveraging historical data and advanced modeling techniques. Financial distress prediction models like the Altman Z-Score and Ohlson O-Score assess the financial health of suppliers, predicting bankruptcy likelihood. Integrating geopolitical risk measures into supplier assessment is vital. Geopolitical risks, such as political instability and trade disputes, can disrupt supply chains.

Effective integration of financial and geopolitical risk assessment enhances supply chain resilience. Organizations adopting proactive risk management and leveraging predictive analytics technologies gain a competitive edge in dynamic business landscapes.

3. Methodology

This section outlines the methodology for evaluating supplier Value-at-Risk (VAR), encompassing both financial health analysis and geopolitical risk assessment. Key components include:

Financial Analysis: Utilizing the Altman Z-Score and Ohlson O-Score models to assess supplier financial stability based on key financial ratios.

The Altman Z-Score model, developed by Edward Altman in 1968, incorporates five key financial ratios derived from the supplier's financial statements: Working Capital/Total Assets, Retained Earnings/Total Assets, Earnings Before Interest and Taxes (EBIT)/Total Assets, Market Value of Equity/Total Liabilities, Sales/Total Assets

The Altman Z-Score model comprises five key components, each providing essential insights into different aspects of a company's financial health:

A. $X_1 = \text{Working Capital} \div \text{Total Assets}$:



This ratio evaluates the company's short-term liquidity by comparing its working capital to total assets. Working capital represents the difference between current assets and current liabilities, indicating the company's ability to meet its short-term financial obligations. A higher ratio suggests better short-term liquidity, implying the company has sufficient current assets to cover its current liabilities.

B. $X_2 = \text{Retained Earnings} \div \text{Total Assets}$:

The retained earnings to total assets ratio assesses the company's reliance on debt financing versus earnings for funding its operations. Retained earnings represent the accumulated profits that have not been distributed to shareholders as dividends. A higher ratio indicates that the company can finance its operations using its retained earnings rather than relying heavily on debt financing, which is generally considered favorable for financial stability.

C. $X_3 = \text{EBIT} \div \text{Total Assets}$:

This ratio measures the company's ability to generate operating profits using its assets. EBIT (Earnings Before Interest and Taxes) reflects the company's operating income before deducting interest expenses and taxes. A higher ratio signifies greater profitability and asset-utilization efficiency, indicating that the company effectively utilizes its assets to generate operating profits.

D. $X_4 = \text{Market Capitalization} \div \text{Total Liabilities}$:

The market capitalization to total liabilities ratio evaluates the potential downside in the market value of equity relative to the risk of insolvency. Market capitalization represents the total market value of a company's outstanding shares, while total liabilities encompass all of the company's debts and obligations. A low market capitalization relative to total liabilities suggests weak market sentiment regarding the company's financial outlook, potentially indicating a higher risk of insolvency.

E. $X_5 = \text{Sales} \div \text{Total Assets}$:

This ratio measures the efficiency of the company in generating sales revenue relative to its asset base. A higher percentage indicates more efficient revenue generation per unit of assets, implying higher profitability and reduced reliance on reinvestments to sustain sales growth.

By analyzing these five components collectively, the Altman Z-Score model provides a comprehensive assessment of a company's financial health and predicts the likelihood of financial distress or bankruptcy. Each ratio offers unique insights into different aspects of the company's financial performance, enabling stakeholders to make informed decisions regarding risk management and financial stability.

1. Altman Z-Score Calculation Methodology: Interpreting the Altman Z-Score involves understanding its implications for a company's financial health and likelihood of facing financial distress or bankruptcy. While the Z-Score provides an absolute numeric value ranging between 0 and 4, it lacks a direct indication of the probability or severity of financial troubles. Therefore, it's essential to contextualize the Z-Score and consider it in conjunction with other financial analysis tools.

Equation for Altman's Z-Score Model (1968):

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1X_5$$

$$X_1 = \text{Working Capital} / \text{Total Assets}$$

$$X_2 = \text{Retained Earnings} / \text{Total Assets}$$

$$X_3 = \text{Earnings Before Interest \& Tax (EBIT)} / \text{Total Assets}$$

$$X_4 = \text{Market Capitalisation} / \text{Total Liabilities}$$

$$X_5 = \text{Sales} / \text{Total Assets}$$

For instance, a Z-Score below 1.81 suggests a high probability of financial distress, indicating that the company may face challenges meeting its financial obligations. A score between 1.81 and 2.99 falls within a gray area, requiring further scrutiny and analysis to assess the company's financial stability accurately. A Z-Score above 2.99 generally indicates a low risk of financial distress, implying that the company is financially healthy and stable.



For public manufacturing companies, the following rules serve as general benchmarks:

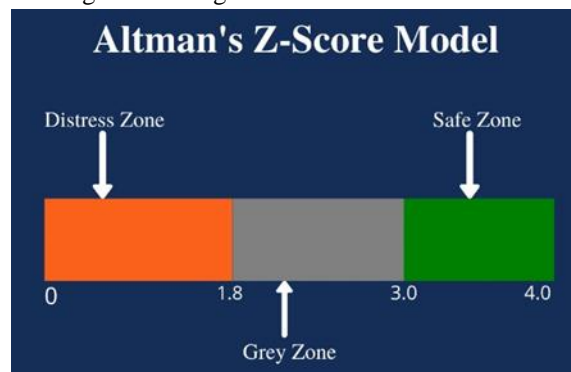
Z-Score	Interpretation
> 2.99	Safe Zone – Low Likelihood of Bankruptcy
1.81 to 2.99	Grey Zone – Moderate Risk of Bankruptcy
< 1.81	Distress Zone – High Likelihood of Bankruptcy

However, it's crucial to note that the interpretation of the Z-Score should not be viewed in isolation. Other factors, such as industry norms, market conditions, and qualitative assessments of the company's operations and management, should also be considered when evaluating financial health and risk.

For private non-manufacturing companies, the benchmarks are as follows:

Z-Score	Interpretation
> 2.60	Safe Zone – Low Likelihood of Bankruptcy
1.10 to 2.6	Grey Zone – Moderate Risk of Bankruptcy
< 1.10	Distress Zone – High Likelihood of Bankruptcy

To complement the Z-Score's absolute value and provide a more nuanced understanding of financial distress likelihood, incorporating additional tools like the Ohlson O-Score is recommended. The Ohlson O-Score offers a probability estimation of financial failure, enhancing the interpretability and accuracy of financial risk assessment. By combining the insights from both the Altman Z-Score and Ohlson O-Score, stakeholders can gain a more comprehensive understanding of a company's financial health and make informed decisions regarding risk management and mitigation strategies.



An inherent limitation of relying solely on the Altman Z-Score is its provision of an absolute numerical value, ranging from 0 to 4, without offering insight into the likelihood of financial distress. For instance, it does not clarify whether a supplier with a Z-Score of 1.2 is more or less at risk compared to another supplier with a Z-Score of 1.4. To address this limitation, we suggest incorporating the Ohlson O-Score, which offers a probability percentage, thus complementing the Altman Z-Score and providing a more comprehensive assessment of financial risk.

2. Ohlson O-Score: The Ohlson O-Score is derived through a sophisticated calculation method involving a nine-factor linear combination of coefficient-weighted business ratios. These ratios are typically sourced from the standard periodic financial disclosure statements provided by publicly traded corporations. The Ohlson O-Score aims to evaluate the probability of a company's failure by considering various financial metrics and indicators.

In the calculation formula, certain financial variables are utilized: Total Assets (TA), Gross National Product Price Index Level (GNP), Total Liabilities (TL), Working Capital (WC), Current Liabilities (CL), Current Assets (CA), Net Income (NI), Funds from Operations (FFO)

The probability of distress (in %) can then be calculated based on the formula below (where O-Score=T from above)



$$p(\text{failure}) = \frac{e^{O-\text{score}}}{1 + e^{O-\text{score}}}$$

Additionally, the formula incorporates binary variables: X, which equals 1 if Total Liabilities are greater than Total Assets, and 0 otherwise, Y, which equals 1 if there has been a net loss for the last two years, and 0 otherwise.

3. Geo Political Risk Measures: In addition to financial assessments, geopolitical risk factors associated with supplier locations are crucial considerations in the evaluation process. These geopolitical risk measures include:

a) Political Instability: This metric assesses the likelihood of government instability due to economic distress and susceptibility to unrest within the country.

b) Logistics Performance Index: This index gauges the efficiency and ease of product movement both into and within the country, reflecting on logistical infrastructure and capabilities. The Logistics Performance Index (LPI), sourced from World Bank data, is a composite measure derived from six key dimensions: Efficiency of clearance processes, Quality of trade and transport-related infrastructure, Ease of arranging competitively priced shipments, Competence and quality of logistics services, Ability to track and trace consignments, and Timeliness of shipments. These dimensions collectively assess aspects such as the speed, simplicity, and predictability of clearance processes, the condition and reliability of infrastructure, the ease of securing competitively priced shipments, the competency of logistics service providers, the capability to monitor and trace shipments, and the punctuality of shipments reaching their destinations.

c) Ease of Doing Business Index: This index evaluates the regulatory environment's conduciveness to business operations within the country, providing insights into bureaucratic hurdles and regulatory complexities.

d) Corruption Perception Index: This index measures the perceived levels of corruption within the public sector of the country, indicating potential risks associated with bribery, kickbacks, and other corrupt practices. The Corruption Perceptions Index ranks countries according to their perceived levels of public-sector corruption. The 2011 index draws on different assessments and business opinion surveys carried out by independent and reputable institutions. The surveys and assessments used to compile the index include questions relating to the bribery of public officials, kickbacks in public procurement, embezzlement of public funds, and questions that probe the strength and effectiveness of public-sector anti-corruption efforts.

e) Climate Risk Index: This metric assesses the exposure and vulnerability of the country to extreme climate-related events, providing insights into potential disruptions to supply chains due to natural disasters. The Climate Risk Index indicates a level of exposure and vulnerability to extreme events which countries should see as a warning signal to prepare for more frequent or more severe events in the future. The limitations to the data availability, including the socio-economic data, means that the analysis does not encompass some very small countries such as certain small island states, since in particular in a longer-term comparison, sufficiently sound data is not always available. Furthermore the data only reflects the direct impacts (direct losses and fatalities) of extreme weather events, while heat waves for example often lead to much stronger indirect impacts (e.g. through droughts and food scarcity) which is often the case in African countries. Also, it does not include the total number of affected people (in addition to the fatal casualties), since the comparability of such data is very limited.

By incorporating these geopolitical risk measures into the assessment process, organizations can gain a comprehensive understanding of the risks associated with supplier locations and make informed decisions to mitigate potential disruptions and vulnerabilities in the supply chain.

4. Conclusion

In this paper, we have outlined a comprehensive methodology for evaluating and predicting procurement Value-at-Risk (VAR) based on financial and geopolitical risk associated with suppliers. The current procurement risk assessment process in the consumer electronics supply chain industry is often ad-hoc, incomplete, and not automated. To address this issue, we have proposed a systematic approach to analyze, predict, and alert



procurement teams and leadership about potential risks associated with key component suppliers and Original Design Manufacturers (ODMs).

Our methodology incorporates both financial health indicators, such as the Altman Z-Score and Ohlson O-Score, as well as geopolitical risk measures based on supplier locations. By evaluating financial ratios derived from supplier financial statements and geopolitical risk indices, we aim to provide a holistic view of supplier risk, enabling proactive contingent and mitigation actions to be developed and implemented.

Furthermore, we have outlined strategic and executional components of the project, emphasizing the importance of collaboration with key stakeholders, data collection, analysis, and integration into existing risk assessment frameworks such as Tableau dashboards. Additionally, the project aims to create a repeatable and automated supplier assessment process that can be scaled to evaluate a larger population of suppliers.

Overall, this project has the potential to significantly enhance procurement risk management within the consumer electronics supply chain industry. By identifying high-risk suppliers, analyzing their financial and geopolitical risk factors, and providing actionable recommendations, companies can minimize the impact of supplier failures and ensure continuity of operations. Moreover, the integration of additional risk summary metrics and automation through SQL and Tableau Server will further streamline the risk assessment process, enabling timely decision-making and proactive risk mitigation strategies.

Through the implementation of this methodology, we anticipate a reduction in supply chain disruptions, improved supplier relationship management, and ultimately, a more resilient and sustainable procurement ecosystem.

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