

Developing a Financial Sustainability Index (FSI) for Export-Oriented manufacturing firms: A Panel-Based Early Warning Framework

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Abstracts

This study explores how profitability, export efficiency, and cost functionality correlated with the financial sustainability index (FSI) for Indian manufacturing companies and the development of the early warning system. The study was conducted on 50 Indian manufacturing companies those participate in the export business, whose data has been collected for the nine quarters from 2023 till 2025. A composite FSI was developed by integrating three selected financial indicators: profitability, cost efficiency, and export efficiency (intensity). Three econometrics approaches used for the analysis are named pooled correlation, within-firm (fixed-effect), and between-firm (mean-level) to capture both intra-firm and inter-firm (long-term and short-term) correlation between the financial indicators and FSI. The findings indicate that export efficiency is the most reliable indicator of financial sustainability (FSI), with an almost perfect positive correlation value ($r = 0.9992$) with FSI. Although cost efficiency shows a negative correlation ($r = -0.5664$), profitability shows a moderately positive correlation ($r = 0.3020$), suggesting that export-oriented businesses retain higher costs in order to remain competitive. This study offers novel viewpoints on the dynamic relationship between export performance, cost efficiency, and financial sustainability in developing economies by using a panel-based FSI approach that captures both firm-specific and time-based fluctuations.

Keywords: FSI (Financial Sustainability Index), Profitability, Export Performance, Cost efficiency, Early warning System

1. Introduction

This research is focusing on the financial sustainability of the manufacturing sectors in India and the role of exports in attaining the long-term financial objective (financial sustainability) of the companies and using the financial parameters for the effective early warning system for predicting financial sustainability risk. Several companies are focusing on the development and implementation of the Financial Early Warning Systems (FEWS), as they become essential instruments made to identify and forecast possible financial distress in businesses, allowing for prompt actions designed to mitigate negative consequences. The need for strong FEWS frameworks is highlighted by the growing complexity and volatility of growing international markets, as well as by the quick development of technology and unanticipated economic repercussions. These systems use both qualitative and quantitative data to determine weaknesses, giving stakeholders vital information to deal with upcoming threats in advance. However, it is critical to evaluate the different financial parameters and their correlation with the financial warning system to conclude the model, which helps in the prediction of the distress in the financial structure of the companies. The world has experienced numerous economic downturns and economic shifts in recent decades. Trade wars, conflicts, environmental changes, growing manufacturing hubs, and other factors have highlighted significant supply chain shifts. With the political climate steady, many businesses that rely on exports and outsourcing are searching for new possibilities and improved conditions. Companies are searching for a new, stable nation to relocate their operations to in consideration of the recent tariff battle between China and the United States and the rising cost of labor. A growing number of businesses are under financial difficulty as a result of the unexpected shift in the supply chain, which is also upsetting the export market. In such circumstances, financial risk management becomes even more significant, and the development of early warning systems for financial stress aids in risk mitigation and damage control for both investors and businesses.

The countries with the leading economies are reorienting their economic operations in the current trend towards globalization and focusing on these specific business sectors, stipulating that manufacturing companies are crucial to the exponential growth of every nation and the advancement of technology. Exporting goods has become a vital means for manufacturing companies to increase their worldwide market share and quickly reach economies of scale as a result of the growing interconnection between nations. The best illustration of contemporary times is the rise of the Chinese economy; similarly, India has been concentrating on manufacturing for a decade now, as seen by a notable expansion in their economic scale, and in 2025 they ranked fourth in the world in terms of economy size after surpassing Japan recently (NITI Aayog, India). In order to market their goods and offer the most competitive prices on the global market, China and India set up extremely sophisticated supply chains all around the world. Manufacturing firms that focus on exports are the sectors most impacted by the COVID-19 epidemic. Surplus exports are crucial for any economy's growth since they have a big impact on the nation's GDP and the income of its citizens. Furthermore, exports play a big role in the long-term growth of any business as a result of globalization. The competitiveness of the products' prices and accessibility is the most crucial element for success in the global market. But the question arises whether the export helps in the financial sustainability of the companies, more specifically the manufacturing sectors. According to a WTO (World Trade Organization) report, a sharp decline has been reported in the export of services and goods, with 30 percent and 23 percent, respectively, during the second quarter of 2020. A decline in exports has been reported differently to different industries, like fuels and mining products, which declined by 23.9 percent due to a decline in demand, while exports of automotive products declined by 16.4 percent during the year 2020. However, the export of medical goods has shown their highest export growth in several decades. Post-Covid-19 effects have been observed in several sectors, and several companies and industries have taken it as a lesson and diversified their sources and shifted their focus towards knowledge-based economics rather than solely focusing on the export-oriented manufacturing sector. Moreover, the business has the expectation that exports and FDIs will bring positive and continuous growth in the economy and help in the recovery from the loss incurred during the pandemic. In this research paper, we will focus on the data collected post-COVID-19 to check the financial turmoil in the firms and the performance in relation to the financial stability. Covid-19 has an impact on every aspect of human life, including health, social and personal life, working culture, expenditure behavior, and so forth (Liu et al. 2022). Business and export got impacted the most, and it triggered the sharp decline in the export market. During the Covid-19 period, different markets were understanding the importance of local manufacturing and adopting the policies of protectionism by implementing the trade restriction, as the global supply chain got disrupted and logistics services were not operational for a long time. With the lock down by different countries, closing the borders to contain the infection, and the unexpected financial burden to the companies along with the government collapse, the supply chain is completely disrupted. Along with every financial and non-financial activity, there has been some degree of risk associated. It can also be shown in all economic activities, from day-to-day life to corporate financial activities. Therefore, to ensure the financial sustainability of firms, it is very important to have the early warning distress alarm system, which will help the managers and management to take precautionary measures. Risk management has been understood very narrowly by several managers and practitioners; it is not only about the insurance of identified risk (Alexander, C. 2005) but also about identifying the risk to take the corrective action to ensure the long-term financial sustainability of the firms. According to the Basel Committee (2001), risk management includes identification, assessment, monitoring & reporting, and controlling of the risks. It is not possible to avoid all the risks, but risk can be delayed, mitigated, or transferred with the proper management (Moles, 1998). However, most of the research on risk management has been conducted on the financial market, but it is also significantly important for the manufacturing sector.

1.1 Research Gaps

Financial risk is an inherent component of every business, evident at each stage of the firm's processes and development. However, firms can detect at early stages and can take the preventive measures to mitigate the risk. The main aim of this research paper is to use the export performance of the company along with the financial performance to develop the early warning system for the firms that provide the alarming situation to firms for taking the corrective measures for the long-term financial sustainability. This research will help those firms that are more export-oriented rather than domestic market-oriented. With the change of the sophisticated nature of hierarchical structure and the significance of risk management in the decision-making process of export and import, the relevance of warning systems became more significant for the manufacturing firms. This research will focus on the manufacturing of developing countries' manufacturing firms.

1.2 Research Objective:

This research paper mainly focusing on the financial sustainability of the corporates and role of the exports and its contribution in the financial growth and sustainability. Determining the background and objective, this research paper primarily examines the following questions:

1. Which financial metrics (indicators) are the most effective early indicators of the firm's financial sustainability?
2. Considered it practicable to use export efficiency as a signal for predicting a firm's financial sustainability?
3. Can the businesses use the integrating model of export efficiency, cost efficiency, and profitability as an early warning system?

The scope this article is not limited to the financial risk management of the manufacturing companies, moreover, understanding the impact of the export and its fluctuation on the financial sustainability of the firms.

2. Conceptual and Theoretical Framework

2.1 Financial Risk Management Theories:

Risk management is a proactive activity that is made possible by early warning indicator (EWI) systems, which are intended to alert management and investors to possible financial trouble before crises arise. These tools are designed to spot anomalous activity and divergences from prevalent financial practices. In the changing landscape of geopolitics, disruptive supply chains, and business environment development, early warning indicators for the financial risk management of the manufacturing companies are increasingly relevant. The aim can be achieved by using the data analysis techniques. By integrating financial parameters and export statistics (value and volume of exported products and services) with the big data analytics, companies can detect the early warning and predict and mitigate the impact of the financial risk more effectively. In the previous research, several researchers used several models, metrics, and analysis methods for the development of early warning systems.

In this research the integrated framework was used for developing the early warning system, especially when the export as well as the financial data were both applied in this research paper for the evaluation and building of the early warning model to indicate the financial distress based on the financial and export performance of the companies. According to the risk management theory, the foundation of risk management is identifying, assessing, mitigating, and monitoring financial risk (Ramos, J. 2000; Ariful et al. 2006), which involves the systematic process to deal with the undesirable situation in the financial operation. Moreover, the resource-based view focuses on the internal resources and capabilities, like the export capability of firms, to determine competitive advantages and sustainable performance (Wernerfelt, B. 1984). However, the export capability does not indicate only the export of the products' value or volume but also includes the information about foreign markets, risks associated with the markets, documentation requirements for the exports and customs, attracting foreign customers, and export capabilities (Catanzaro & Teyssier, 2021).

H1: The financial sustainability index (FSI) is positively and statistically significantly impacted by profitability.

H2: The financial sustainability index (FSI) is positively and statistically significantly impacted by employee costs.

2.2 Export performance and Financial Risk:

The scientific literature study frequently demonstrates a substantial relationship between a firm's financial performance and its export engagement. In order to establish the relationship between financial risk and export, a number of researchers carried out studies and came to the conclusion that financial constraints have a negative impact on export performance because exports have multiple obligations and time differences between capital investment and return due to a variety of factors, including transportation time, geopolitical conditions, banking systems, domestic and international regulations, and so on (Broll, U. 1997). A major strait that passes through the Middle East is in imminent danger due to the current geopolitical situation, which also poses a threat to several major sea routes, including the Red Sea. This could ultimately disrupt international trade and put financial strain on nations and businesses that depend on exports. In times of geopolitical crises, countries are using these routes as leverage and bargaining chips. However, governmental legislation, insurance firms, and stakeholder trust are crucial in reducing these detrimental impact elements and mitigating the risk associated with the exports (Heiland & Yalcin, 2021). Moreover, studies have been attempted in order to comprehend more about the flow of international trade and how it affects the financial arrangements of businesses that rely on exports for commercial finance.

In addition to having a direct impact on the financial performance of the companies, exporting to foreign markets aids in encouraging foreign direct investment and the process of expansion, which boosts the financial growth of the firms. Firms that are engaged in the export market have more options for the access of financial resources than those that are engaged only in the domestic market (Matsoai & Kalebe et al., 2024). Furthermore, exports increase the sophistication and resilience of financial strategies for risk mitigation by diversifying the customer base and lowering reliance on the domestic market. The current geopolitical situation, such as the United States of America's new governmental policies in 2025, which imposed an assortment of import tariffs on nearly all major countries, particularly China, can have a negative impact on the financial health of businesses. However, because of their established respective positions, sophisticated supply chains, and diversified markets, businesses are able to withstand economic shocks and become risk-resilient. Previous studies have also reported broadly comparable results, confirming that exports significantly increased the companies' sales and profitability (Dhliwayo, S. 2016; Kumar & Churakoca, 2025). From the literature, it can be concluded that there are several research papers that developed the early warning system for the financial risk assessment by using the financial indicators of all types of industries, including the manufacturing sector; however, there are very few researchers who used the export parameters for the development of the early warning system for the manufacturing firms that are focusing not only on the domestic but also on the export or international market. For countries that are manufacturing hubs, like India and China, obtaining their significant percentage of the national income from the export market, it is necessary to study the export performance of the manufacturing firms to understand the financial performance and potential risk associated. The hypothesis for the mentioned research is listed here:

H3: Export efficiency can be used in predicting financial sustainability early as a reduction in export efficiency precedes a subsequent decline in the FSI; it exhibits a positive and substantial significance.

2.3 Early Warning Indicator Methodologies:

The traditional analysis method of the risk measurement associated with finance is less effective in the current changing financial environment. Thus, researchers need a more optimal and efficient method to analyze the financial risk and develop an early warning system. Sun, H. (2021), used financial indicators from the financial crisis and non-crisis organizations to develop a warning model for the Chinese manufacturing

enterprises. The approach, which has been validated using statistical methods, assists companies in identifying operational deficiencies and promptly implementing the required changes to enhance their long-term viability and financial sustainability.

In the recent research conducted by Long, Y. (2022), the hierarchical analysis method (AHP) and fuzzy evaluation method were used to develop a financial risk early warning model. The built financial risk warning model was then examined using the company’s recent financial data. The automotive industry has been studied in this research paper due to several uncertainties in the fast-growing industry.

Subsequently, for developing a financial risk evaluation system, Zhang & Wang (2023) and Wan, L. (2023), used the data mining method. Researchers used the financial parameters like profitability, cash flow, operations, debt, and other parameters for framing the metrics. Moreover, the analysis provided a reliable early warning system with a reliability of 80%, which helps in the improvement of the risk management. Similar research also has been conducted by Hu, Y. (2024), which focuses on the development of the sustainable financial risk assessment system by using big data analysis.

With the increasing distress in the financial sector in the manufacturing companies, several researchers are trying to develop the warning system; similarly, Zhang, X. P. (2025), Data Mining Technologies (DMT), tracks financial circumstances and displays the need for an indicator system for financial monitoring since it can predict potential financial shocks through extensive data analysis. By integrating decision tree models, the system enhances the identification of manufacturing firms/organizations that are vulnerable, enhancing risk mitigation and financial sustainability by enabling timely and informed decision-making.

H4: An effectively functioning early warning system for forecasting financial sustainability utilizes a model which integrates export efficiency, profitability, and cost efficiency.

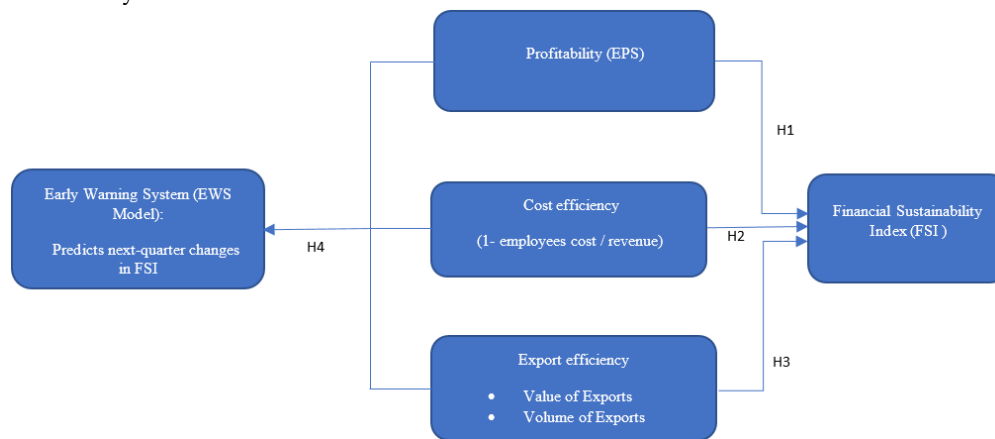


Figure 1: Theoretical Framework

3. Materials and Methodology

3.1 Data Collection:

To analyze data that has been acquired from India for the Indian chemicals and allied sectors to fulfill the objectives of this research. For the data analysis, secondary data has been collected from the reliable and credible sources of the secondary data. Export data has been compiled quarterly from 2023 to 2025 with the assistance of Eximpedia for all the considered firms. Data for the year 2025 is available solely for the first quarter. Additionally, the financial metrics have been obtained from the annual financial reports via the websites Moneycontrol.com and Yahoo.com, which publish the financial performance of the firms. The data collection targeted the export value of the products as well as the volume of the exported products for each quarter. The systematic search has been conducted for the selection of the companies, as all selected companies are listed in the top exporters of the chemicals and their allied respective sectors. Among the list of the most prominent manufacturers and exporters of chemicals in conjunction with sectors, we decided on each organization to conduct this research. As the research's objective is to investigate manufacturing firms that significantly contribute to their economies through export sales and prepare the early warning system to indicate the financial stress to mitigate the financial risk.

3.2 Data Description:

In the first, we collected the secondary data for the more than 60 companies but removed the companies with the missing data and finalized 50 companies for the final analysis with the complete data from 2023 till the first quarter of 2025. In the conclusion, panel data for the total nine quarters has been collected for the 50 companies for the Indian manufacturer from the manufacturing sectors. The study involves the use of quarterly panel data at the firm level for 50 organizations across 9 time periods (450 observations). In the collected data the variables are here:

- Net Sales – revenue indicator of the companies
- Employee Cost – cost efficiency indicator of the companies
- Net Profit—Profit after tax (or net income) for firm *i* in period *t*
- Export Value and Export Volume – used to compute export efficiency of the companies
- FSI (Financial Sustainability Index)—a composite index constructed to indicate the financial sustainability of the companies

3.3 Methodology

In this research, we utilize a quantitative panel data approach combined with financial early warning system (EWS) metrics to examine the determinants and predictors of financial sustainability among Indian manufacturing companies over time. Panel data models are employed to capture both cross-sectional (firm-specific data) and time-series (quarterly) variations in financial and export outcomes, enabling more accurate estimation of dynamic relationships between the financial sustainability index and financial variables (Baltagi & Baltagi, 2008). All the analysis was conducted with the help of Google Colab (Python).

In this investigation, we constructed the financial sustainability index based on the three fundamental dimensions of the corporate financial performance and export performance indicated as profitability, export efficiency/intensity, and cost efficiency. Profitability can be defined as the firm’s ability to generate profit relative to its operational income. His ratio is also defined as the net profit margin or return on sales. It measures the core income-generating capacity of the firms for the measurement of the financial sustainability of the firms (Epstein & Rubinfeld, 2001; Ameer & Othman, 2012; Jordão & Almeida, 2017; Kumar & Churakova, 2025).

$$Profitability_{i,t} = \frac{Net\ Profit_{i,t}}{Net\ Sales_{i,t}} \text{----- (i)}$$

Whereas:

- Net Profits i,t : Profit after tax (or net income) for firm i in period t
- Net Sales i,t : Net sales or income from the operations (in USD)

Another major pillar influencing the financial sustainability index is export efficiency, as it is the ability to generate export revenues from operations of firms. It used to measure the efficiency of firms' capacity of their trade and marketing efforts for the international trades and earnings (Kasahara & Lapham, 2013; Defever & Riaño, 2022). It also indicates the revenue diversification strategies and operational resilience of firms, which helps them to manage the financial risk during the financial shocks.

$$Export\ Efficiency\ or\ Export\ Intensity_{i,t} = \frac{Export\ Value_{i,t}}{Net\ Sales_{i,t}} \dots\dots\dots (ii)$$

Whereas;

- Export Value i,t : total export revenue of firm i in period t
- Net Sales i,t : Net sales or income from the operations (in USD)

Another major pillar used for the calculation of the FSI is cost efficiency. Cost efficiency evaluates the extent to which a company optimizes its employee-related costs in relation to its profits. It shows how effectively a business is capable of turning labor expenditures into income. Greater efficiency is shown by an increase in value, which suggests that the company invests less on employees per unit of sales, several researchers used the formula for the calculation for the cost efficiency and in this research, we are using the modified formula used by Berger & Mester, (1997) and 2. Syverson, (2011)

$$Cost\ Efficiency_{i,t} = 1 - \frac{Employees\ Cost_{i,t}}{Net\ Sales_{i,t}} \dots\dots\dots (iii)$$

Whereas;

- Employees Cost i,t : It is total amount of pay and benefits provided for employees over the time t and firms i
- Net Sales i,t : Net sales or income from the operations (in USD)

These three essential elements of firm performance—profitability, export efficiency, and cost efficiency—are integrated to create a composite index which measures the total financial sustainability of firms. Each component represents an exclusive element of financial health: cost efficiency captures corporate cost control capabilities, export efficiency assesses external competitiveness in the market, and profitability quantifies internal financial performance. For this research, collected data for the firm i in quarter for 2023 till 2025 indicated as t , the Financial Sustainability Index (FSI) is calculated as follows (Wagenhals et al., 2014; malik et al., 2024):

$$FSI_{i,t} = \frac{1}{n} \sum_{k=1}^n X_{k(i,t)}$$

Whereas;

- $FSI_{i,t}$ = Financial Sustainability Index for firm i in year t
- $X_{k(i,t)}$ = normalized value of the k -th financial indicator (e.g., profitability, efficiency, liquidity, leverage, etc.)
- n = total number of indicators included in the index

In this study, however, we evaluated the FSI and the association between the variables and the FSI utilizing the three fundamental indices of profitability, cost efficiency, and export efficiency.

$$FSI\ (Financial\ Sustainability\ Index)_{i,t} = \frac{1}{3} (Profitability_{i,t} + Export\ Efficiency_{i,t} + Cost\ Efficiency_{i,t})$$

$$FSI_{i,t} = \frac{1}{3} \left(\left(1 - \frac{Employees\ Cost_{i,t}}{Net\ Sales_{i,t}} \right) + \frac{Export\ Value_{i,t}}{Net\ Sales_{i,t}} + \frac{Net\ Profit_{i,t}}{Net\ Sales_{i,t}} \right) \dots\dots\dots (iv)$$

Since the FSI is constructed from several different financial indicators, one measurement with a standardized score is required in order to measure and quantify the results. Direct comparison is challenging since financial indicators (such as profitability, cost efficiency, and export efficiency) are assessed in several dimensions and variables. All indicators are normalized through a single scale between 0 and 1 in order to resolve ambiguity. The index offers a consistent assessment of financial sustainability, enabling insightful comparisons between companies over time. However, it is not necessary for all the companies to fall within the range, while in the real economic market, it is possible to have the value be more than 1 and sometimes in the negative also.

All the businesses included in this study will be ranked according to their FSI values. Three sustainability categories are used to classify firms according to their mean FSI values. Firms are classified as highly sustainable if their FSI value is greater than 0.8 ($FSI \geq 0.8$), moderately sustainable if it is between 0.5 and 0.8 ($0.5 \leq FSI < 0.8$), and low sustainable if it is less than 0.5 ($FSI < 0.5$).

3.3.1 Correlation Analysis:

Correlation analysis was used to determine the nature and degree of the relationship between the Financial Sustainability Index (FSI) and the three main study determinants—profitability, cost effectiveness, and export efficiency. For a thorough examination of the Financial Sustainability Index as an analytical concept and an indicator of quantitative significance, the panel dataset was examined using three different types of correlation studies: pooled correlation, within-firm (fixed-effect) correlation, and between-firm correlation. By combining panel-based correlations with firm-level assessments, the research not only identifies significant sustainability indicators but also acknowledges temporal dynamics and structural differences among organizations. Classification enables investors and management to comprehend the risk and performance of the companies.

3.3.1.1 Pooled Correlation:

Pearson correlation has been selected as the main analytical instrument for the correlation analysis between the financial variables used throughout the study and the indicators integrated for the FSI's development. Given that it accurately illustrates the linear relationships that exist between the FSI and its numerous components, the Pearson correlation is more appropriate for the analysis (Pearson, 1896; Baltagi, 2008). The Pearson correlation coefficient can be used to identify a linear relationship between two continuous variables:

$$r_{xy} = \frac{Cov(X, Y)}{\sigma_X \sigma_Y}$$

Whereas, where $Cov(X, Y)$ denotes covariance and σ_X, σ_Y are the standard deviations of the respective variables.

3.3.1.2 Within-Firm (Fixed-Effect) correlation

The within-firm (fixed-effect) correlation method was employed to control for firm-specific heterogeneity, as the panel data consist of cross-sectional (between firms) and time-series (within firms) dimension (Wooldridge, 2010).

For each firm, the mean of each variable was subtracted to isolate time-based variations:

$$\tilde{X}_{i,t} = X_{i,t} - \bar{X}_i \text{ and } \tilde{Y}_{i,t} = Y_{i,t} - \bar{Y}_i$$

The correlation was then computed between these demeaned values:

$$\begin{aligned} r_{within\ firms} &= corr(\tilde{FSI}_{i,t}, \tilde{Profitability}_{i,t}) \\ r_{within\ firms} &= corr(\tilde{FSI}_{i,t}, \tilde{Export\ Efficiency}_{i,t}) \\ r_{within\ firms} &= corr(\tilde{FSI}_{i,t}, \tilde{Cost\ Efficiency}_{i,t}) \end{aligned}$$

In this approach, we measure the changes within the firms over the time in the indicators, that influences the change in the financial sustainability, while eliminating firm-specific constraints.

3.3.1.3 Between-Firm (Fixed-effect) correlation

The between-firm correlation was computed using firm-level averages for each variable over all quarters. This approach examines cross-sectional differences among firms and identifies whether firms that are generally more profitable, cost-efficient, or export-oriented also tend to have higher average FSI values (Allison, 2009; Hsiao, 2022).

$$\begin{aligned} r_{within\ firms} &= corr(FSI_i, \overline{Profitability}_i) \\ r_{within\ firms} &= corr(FSI_i, \overline{Export\ Efficiency}_i) \\ r_{within\ firms} &= corr(FSI_i, \overline{Cost\ Efficiency}_i) \end{aligned}$$

By comparing within-firm and between-firm correlations, the analysis distinguishes between short-term dynamic effects and long-term structural differences in sustainability performance.

4. Results and Discussion

In this study, dual detailed Pearson correlation metrics has been conducted to study dynamic (short-term) and structural (long-term) correlation between the underlying financial indicators and financial sustainability index (FSI).

Table 1: Result of WITHIN-FIRM (Fixed-Effect) Pearson Correlation

Financial Indicators	FSI	Profitability	Cost Efficiency	Export Efficiency	Employees Cost	Export Value	Net Sales	Net Profit
FSI	1.0000	0.1208	-0.2318	0.9950	-0.1626	0.2199	-0.1280	0.0192
Profitability	0.1208	1.0000	0.0025	0.0516	0.0314	0.0058	0.0466	0.4786
Cost Efficiency	-0.2318	0.0025	1.0000	-0.3029	-0.8184	0.0284	0.0679	0.0221
Export Efficiency	0.9950	0.0516	-0.3029	1.0000	-0.1017	0.2143	-0.1344	-0.0149
Employees Cost	-0.1626	-0.1626 0.0314	-0.8184	-0.1017	1.0000	0.0403	0.1970	0.0403
Export Value	0.2199	0.0058	0.0284	0.2143	0.0403	1.0000	0.1988	0.0942
Net Sales	-0.1280	0.0466	0.0679	-0.1344	0.1970	0.1988	1.0000	0.2834
Net Profit	0.0192	0.4786	0.0221	-0.0149	0.0403	0.0942	0.2834	1.0000

Table 1 displays the results of the within-firm (fixed-effect) Pearson correlation, which shows a moderately favorable connection between profitability and FSI with a correlation value ($r = 0.1208$), indicating that a short-term increase in profitability will have a slight positive impact on the firms' financial sustainability. In contrast, export efficiency has a very strong correlation with FSI, indicating that variations in the firms' financial sustainability will be primarily driven by quarterly changes in export intensity or export performance. However, cost efficiency demonstrated a weak negative correlation with the FSI, with a correlation value ($r = -0.2318$). This suggests that a rising trend in cost efficiency will have a negative impact on the FSI of firms. This could be because most businesses are export-oriented and require higher labor and logistics costs in order to accommodate their export necessities. Additionally, comparable outcomes with regard to employee costs have been obtained. Nonetheless, a small negative association was additionally observed with net sales, summarizing the findings that an increase in net sales merely would not lead to an improvement in the businesses' financial sustainability, supporting an assortment of recommendations. Financial sustainability is a complicated idea that can be affected by various kinds of internal and external factors. Export efficiency is the primary indicator influencing financial sustainability; other variables only have modest correlations. This illustrates that the primary factor influencing variations in company sustainability over time is dynamic, quarter-to-quarter export performance.

Table 2: Result of BETWEEN-FIRM (Mean-Level) Pearson Correlation

Financial Indicators	FSI	Profitability	Cost Efficiency	Export Efficiency	Employees Cost	Export Value	Net Sales	Net Profit
FSI	1.0000	0.4029	-0.6208	0.9995	-0.0130	0.0600	-0.1055	-0.0739
Profitability	0.4029	1.0000	-0.5923	0.4012	0.2300	0.1940	0.0937	0.3230
Cost Efficiency	-0.6208	-0.5923	1.0000	-0.6408	-0.3470	-0.0701	0.0442	-0.0219
Export Efficiency	0.9995	0.4012	-0.6408	1.0000	-0.0020	0.0580	-0.1072	-0.0779
Employees Cost	-0.0130	0.2300	-0.3470	-0.0020	1.0000	0.7102	0.7232	0.7302
Export Value	0.0600	0.1940	-0.0701	0.0580	0.7102	1.0000	0.9164	0.9209
Net Sales	-0.1055	0.0937	0.0442	-0.1072	0.7232	0.9164	1.0000	0.9215
Net Profit	-0.0739	0.3230	-0.0219	-0.0779	0.7302	0.9209	0.9215	1.0000

The results of the BETWEEN-FIRM (Mean-Level) Pearson Correlation are displayed in Table 2. According to the results, profitability has a moderately positive association with the correlation value ($r = 0.4029$), indicating that companies with consistently greater profit margins are much more likely to have long-term FSI values. It is a structural predictor of financial sustainability, as demonstrated by profitability. Additionally, export efficiency demonstrated a very high correlation with correlation value ($r = 0.9995$), indicating a nearly perfect relationship and confirming that export efficiency is the primary factor influencing long-term financial sustainability across companies. The companies with the highest average FSI values are those that consistently have more exports than sales. However, a contradictory result was observed for cost efficiency with a negative value ($r = -0.6208$), which indicates a strong negative correlation. The results indicate that companies with lower cost ratios are typically displaying lower FSI values, which can be explained by the operational costs of export-oriented businesses. Because exporting usually requires greater expenditures on logistics and operations than domestic sales. However, the correlation value ($r = -0.0130$) for employee costs across businesses was nearly zero, indicating that the average financial sustainability is not considerably impacted by variations in employee cost structures among companies. Nonetheless, there is a modest negative association between net sales and net profit ($r = -0.1055$ and $r = -0.0739$, respectively), suggesting that companies with higher sales amounts are not always able to sustain themselves financially. In the same way, the absolute profit level has little influence on how financially sustainable a company actually. The sustainability structure is dominated by export efficiency, with profitability having a moderately supporting function. The high negative correlation between cost efficiency and export-driven sustainability suggests a trade-off. Long-term FSI is not significantly impacted by firm size or overall profit levels.

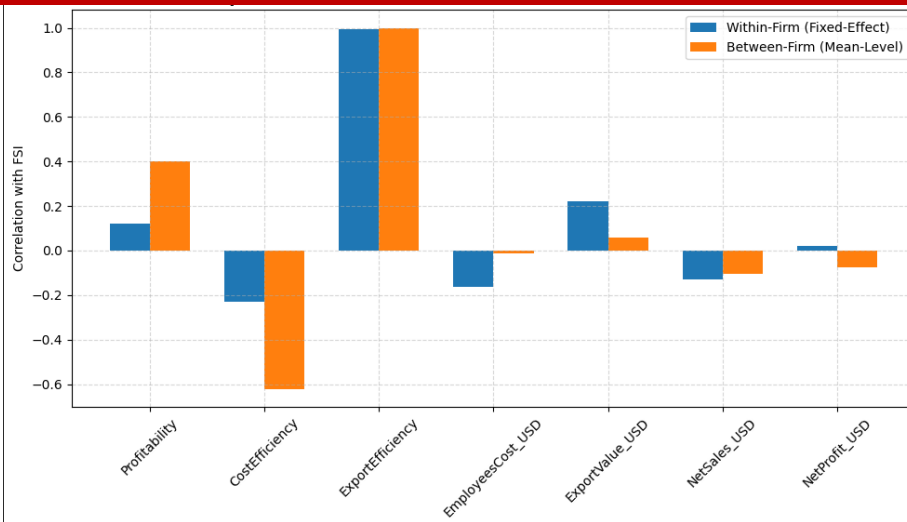


Figure 2: Comparison of Within-Firm vs. Between-firm correlation with FSI
 Note: USD current used for the financial variables used for the analysis

Table 3: Comparative study of correlation of investigated variables with FSI

Variables	Within-Firm (Fixed-Effect)	Between-Firm (Mean-Level)
Profitability	0.1208	0.4029
Cost Efficiency	-0.2318	-0.6208
Export Efficiency	0.9950	0.9995
Employees Cost	-0.1626	-0.0130
Export value	0.2199	0.0600
Net sales	-0.1280	-0.1055
Net Profit	0.0192	-0.0739

The comparative analysis of the within-firm (fixed-effect) and between-firm (mean-level) correlations between the Financial Sustainability Index (FSI) and specific financial indicators, including profitability, cost efficiency, and export efficiency, as well as the financial parameters (employee cost, net profit, net sales, and export value), is shown in Figure 2 and Table 3. The findings showed that, both within and across enterprises, export efficiency had the strongest positive association with FSI ($r = 0.9950$ and $r = 0.9995$, respectively), demonstrating its critical role in improving financial sustainability. However, Profitability exhibited a moderate positive correlation at the between-firm level ($r = 0.4029$), suggesting that firms with consistently higher profit margins maintain superior sustainability outcomes.

However, there is a negative correlation between cost efficiency and FSI ($r = -0.2318$ within firms; $r = -0.6208$ between firms), suggesting that export-intensive companies have greater employee and operational expenses, which lower cost-efficiency ratios. Businesses that focus on exports are always labor-intensive and have higher logistical costs, which raises operating costs. The study's other financial variables, such as employee cost, net sales, and net profit, show limited or absent correlations, indicating that efficiency ratios—rather than company size or absolute financial values actually drive financial sustainability. Overall, our results highlight that among the manufacturing and export-oriented businesses under investigation, export competitiveness and profitability stability rather than cost minimization are the main factors influencing financial sustainability.

Table 4: Result of Pearson Correlation Matrix

Financial Indicators	FSI	Profitability	Cost Efficiency	Export Efficiency	Employees Cost	Export Value	Net Sales	Net Profit
FSI	1.000	0.3020	-0.5664	0.9992	-0.0357	0.0752	-0.1047	-0.0619
Profitability	0.3020	1.0000	-0.3844	0.2879	0.1483	0.1321	0.0705	0.3533
Cost Efficiency	-0.5664	-0.3844	1.0000	-0.5922	-0.4584	-0.0549	0.0428	-0.0137
Export Efficiency	0.9992	0.2879	-0.5922	1.0000	-0.0174	0.0728	-0.1065	-0.0693
Employees Cost	-0.0357	0.1483	-0.4584	-0.0174	1.0000	0.5528	0.6014	0.5498
Export Value	0.0752	0.1321	-0.0549	0.0728	0.5528	1.0000	0.8599	0.7913
Net Sales	-0.1047	0.0705	0.0428	-0.1065	0.6014	0.8599	1.0000	0.8393
Net Profit	-0.0619	0.3533	-0.0137	-0.0693	0.5498	0.7913	0.8393	1.0000

In the table 4, result of Pearson Correlation Matrix has been published, which shows the matrices among the financial sustainability index and its related financial indicators along with the financial parameters. The results concluded that FSI is significantly correlated with export efficiency with the correlation value ($r = 0.9992$) which is approximately indicating perfect correlation, this suggests that companies that have stronger export performance have a higher probability of financial sustainability. Nonetheless, a moderately positive correlation between profitability and FSI with the correlation value ($r = 0.3020$) indicates that companies with higher profit margins are comparatively more financially sustainable. Additionally, there is a negative correlation ($r = -0.5664$) between cost efficiency and FSI, indicating that export-intensive companies frequently have higher production, logistical, operational, and labor expenditures, which leads to less efficient cost-efficiency ratios.

Additionally, a modest correlation was found between the financial indicators utilized to analyze the company's financial sustainability and the FSI. However, if we construct conclusions about the relationship between the indicators used for financial sustainability, we can observe variations in the relationship. For example, highly profitable firms might not be the most cost-efficient ($r = -0.3844$), which indicates a negative correlation between profitability and cost-efficiency; however, profitability and export efficiency showed a weakly positive correlation with the correlation value ($r = 0.2879$); net sales and export value show weak correlations with FSI, indicating that efficiency ratios are more important for financial sustainability than company size.

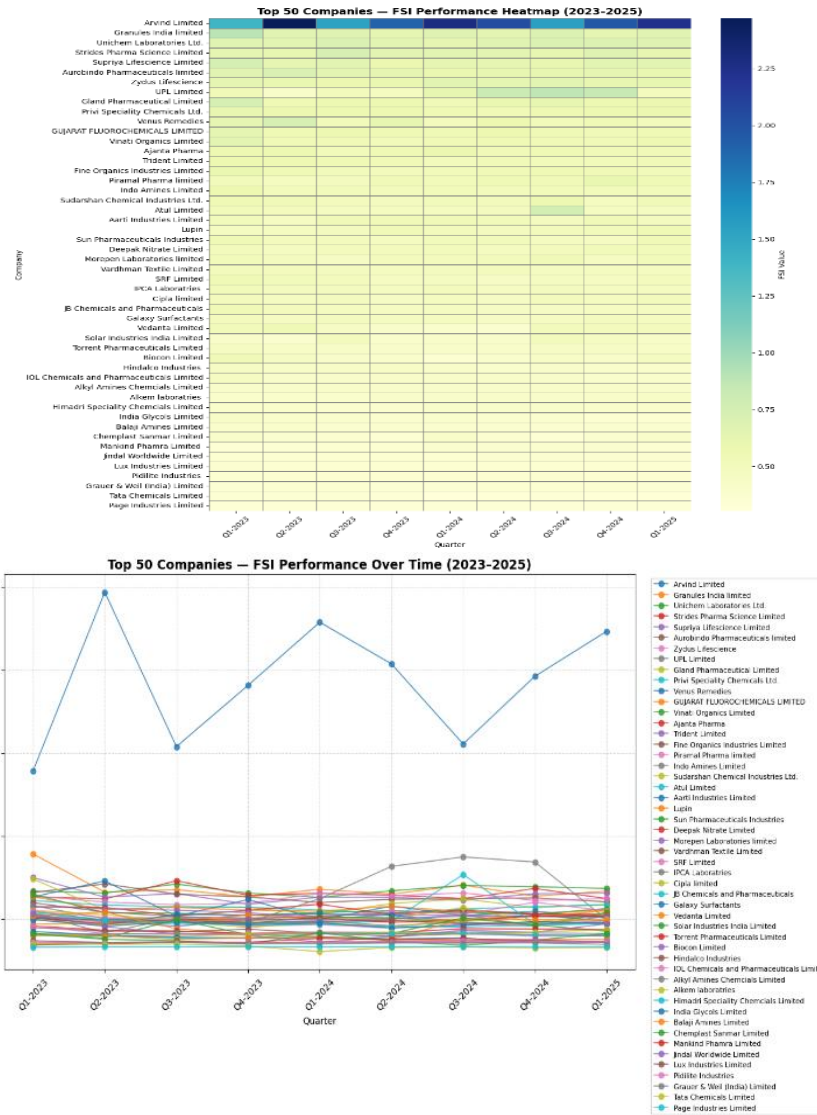


Figure 3: Scale and Heatmap of FSI performance of evaluated companies from 2023-2025

The order of rank of the companies that were selected for the study according to the FSI value is presented in Figure 3. However, compared to other industries, Arvind Industries demonstrated an exceptional result in the financial sustainability score. However, this is possible in real-world economics when the export value exceeds net sales, indicating the firms' dependence on exports. The investigation's findings showed a strong correlation between export efficiency and the FSI scores.

From the result obtained we checked the hypothesis and can be concluded as mentioned in the Table 5.

Table 5: Hypothesis Testing and Validation

Hypothesis	Statement	Result	Interpretation
H1	The financial sustainability index (FSI) is positively and statistically significantly impacted by profitability	Partially Accepted	Moderate positive correlation, indicates profitability has impact on the long-term financial sustainability
H2	The financial sustainability index (FSI) is positively and statistically significantly impacted by employee costs	Rejected	Weak negative correlation, indicates employee cost do not significantly influence financial sustainability
H3	Export efficiency can be used in predicting financial sustainability early as a reduction in export efficiency precedes a subsequent decline in the FSI; it exhibits a positive and substantial significance	Accepted	Extremely strong Correlation, export efficiency can be considered as the primary deterrent of the financial sustainability for the manufacturing companies participating in export
H4	An effectively functioning early warning system for forecasting financial sustainability utilizes a model which integrates export efficiency, profitability, and cost efficiency	Accepted	The viability of utilizing these indicators in simultaneously as early-warning metrics for sustainability risk has been established by the combined correlation and FSI formulation.

5. Conclusion

This study investigated the relationship between financial performance, cost efficiency, and export performance in relation to the Financial Sustainability Index (FSI) of Indian manufacturing companies between 2023 and 2025. Using quarterly panel data from 50 selected firms, three most suitable correlation methods, such as pooled, within-firm (fixed-effect), and within-firm (mean-level), were employed to investigate the structural (long-term) and dynamic (short-term) associations between FSI and its financial determinants.

From the result, we can conclude that export efficiency is considered the primary determinant of the financial sustainability for the manufacturing companies participating in the export activities. Moreover, the profitability also shows the positive correlation at the structural level but is moderately significant. Firms with continuous profitability can achieve financial sustainability over time. However, cost efficiency

has a significantly adverse correlation (negative) with FSI, indicating that export-focused businesses have greater logistics and operating expenses, which lower cost efficiency while maintaining financial sustainability. In the conclusion, we can establish with the obtained result that export efficiency is the most significant determinant of the financial sustainability for the manufacturing companies participating in the export activities. The obtained result can be used as the strong foundation for the deployment of the financial early warning system for the manufacturing companies, which can help the investors and managers to understand the associated sustainability risk of the investment and operation of companies. For the policymaker, the result provided the guideline to support and focus on the export competitiveness, rather than focusing on cutting the employees' cost, including the operational and other related costs. The policy makers and management should support the export activities and invest in the core activities such as logistics, marketing for export, financing, and so forth, as the export performance significantly influences the financial sustainability in the long term. As a result, we also presented the list of the financial sustainability ranking of the investigated companies, which indicates the financial health of the companies based on the export competitiveness and profitability stability over time. The listed ranking can set the practical benchmark for identifying the companies with the most robust financial stability and industry-wide financial sustainability performance over time. From the investor's perspective, investors can understand the robustness of the business model, effective strategic planning, export competitiveness, profit retention capacity, and long-term financial stability of firms based on the FSI score and ranking.

6. Gaps and future Research

The current research was carried out in a short amount of time with a small number of firms. For the long-term financial sustainability study, the quarterly data from 2023 to 2025 is insufficient. Future research can be carried out over longer time periods, such as five or ten years, with a larger number of businesses engaged in the manufacturing industry in different regions of the global economy. The manufacturing sector was the exclusive focus of the data samples that were collected, which limits the results' generalizability because the outcomes could differ for other businesses operating in other industries, such as finance, IT, services, and so on. In order to determine if the relationship between FSI and financial indicators is consistent throughout the various business sectors or varies, further research may be carried out to establish the relationship in the cross-sectoral comparison. Finally, only correlation and descriptive analysis were utilized in this study to examine the relationship between the variables; the causality of the relationship was not examined. Future studies may additionally employ causal econometrics models, such as panel regression, vector error correction models, dynamic panel models, and so on. Future studies may be able to show a causative relationship between financial variables and the FSI, extending beyond the correlation.

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