Scaling Up Performance:
The Impact of Economies of Scale in the Sportswear Industry

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The sportswear industry has experienced substantial development as a result of the increasing demand for products that are both performance-oriented and lifestyle-oriented. This study examines the influence of economies of scale on the development and profitability of this dynamic sector. Despite the fact that industry leaders exhibit robust production efficiencies that are indicative of economies of scale, they face difficulties in managing the escalating operating and SG&A expenses. The study emphasizes the importance of stringent cost control measures and continuous innovation in order to maintain a competitive advantage and profitability in the sportswear industry amidst the changing market conditions.

Keywords: sportswear industry, economies of scale, translog cost function, production function, cost elasticity

INTRODUCTION

The sportswear industry has become a vital component of the global fashion and athletic markets, with consumers increasingly turning to these products for performance and lifestyle purposes. Offering a diverse range of products from footwear and apparel to accessories, it caters to everyone from professional athletes to casual fitness enthusiasts. With rising health consciousness and the popularity of the athleisure trend, which blends athletic and leisure wear, the market has experienced robust growth. Projected to command a significant portion of the apparel and footwear market, the sportswear sector is expected to reach USD 422 billion by 2024, with a steady annual growth rate of 7% through 2027, driven by technological innovations and growing demand for versatile sportswear (Becker et al, 2024).

The sportswear market is intensely competitive, dominated by global giants like Nike and Adidas, which continually expand through strategic global outreach and enhanced direct-to-consumer channels. These major brands push for market leadership with innovative product offerings, and targeted marketing strategies. Meanwhile, smaller niche firms such as Shimano and Acushnet Holdings hone in on specific product categories, targeting niche markets effectively. Through exceptional product innovation, premium brands like Lululemon stand out in the high-end athleisure segment. Particularly, Lululemon is rapidly expanding its global presence and diversifying its product range, achieving faster growth than many of its competitors.

The competition in the sportswear market compels companies to distinguish themselves through product innovation and improving cost efficiencies. For example, Nike's recent strategy to cut approximately 1,600 jobs, simplify its product assortment, increase automation and technology use, streamline its organization, and leverage its scale to enhance efficiency demonstrates a proactive approach to optimizing operations and reducing costs (Safaya, 2024). Similarly, Columbia Sportswear's decision to lay off 3% to 5% of its workforce reflect ongoing efforts to manage costs effectively and maintain competitiveness in a dynamic industry (Pettigrew, 2024).

To maintain their competitive edge and profitability, sportswear companies increasingly focus on achieving cost efficiencies through economies of scale. Economies of scale allow companies to reduce costs as production scales up, spreading costs over many goods. Given the complex landscape of the sportswear industry, it is crucial to examine economies of scale to understand how they contribute to cost reductions and operational efficiencies. Furthermore, the aggressive expansions by major players and varied growth trajectories across different business segments in the sportswear industry raise important questions about the strategic implications of expansion and potential risks of scalability, especially if increasing scale shifts from generating cost benefits to causing inefficiencies, known as diseconomies of scale.

This study aims to investigate the role of economies of scale in the sportswear industry and its impact on growth and profitability. Specifically, it explores how economies of scale contribute to cost reductions and operational efficiencies within the sector. Additionally, the study conducts a comparative analysis of economies of scale across various sportswear companies, identifying best practices, and pinpointing opportunities for improvement.

The significance of this study lies in several factors. First, understanding the factors that drive growth in the sportswear industry is crucial due to its significant economic impact and highly competitive nature. Despite the industry's importance, there is a lack of focused research on economies of scale within this sector. This study aims to fill that gap by providing comprehensive insights into how scaling operations can affect cost structures and efficiencies.

Secondly, the timing of this study is critical. The sportswear industry has undergone significant transformation in recent years, driven by digital shifts and global supply chain adjustments, especially after the pandemic and the subsequent recovery phase. The shift towards e-commerce has been vital as companies enhance their online platforms to adapt to changing consumer behaviors. Integrating advanced analytics and artificial intelligence has improved demand forecasting and inventory management, enabling more agile responses to market demands. Disruptions in global supply chains have prompted companies to diversify their manufacturing and distribution networks to mitigate risks. These changes necessitate significant initial investments but will likely yield substantial long-term benefits through economies of scale. Additionally, post-pandemic conditions, including inflation and geopolitical issues, have pressured sportswear companies to prioritize cost efficiencies. These dynamics create a unique context for examining economies of scale, providing insights that might not be apparent in other periods and enriching the broader body of knowledge on the topic.

Lastly, this study provides practical implications for various industry stakeholders. By examining the impact of economies of scale in the sportswear industry and conducting a comparative analysis across different companies, the findings will help established and new market entrants comprehend the benefits and challenges of scaling operations. This analysis offers strategic guidance for improving operational efficiency and achieving a competitive edge. Additionally, it provides valuable insights for potential investors looking to make informed decisions.

PREVIOUS STUDIES

Economies of scale are a foundational concept in industrial economics, offering insight into the potential cost advantages linked with escalating production levels. First described by Adam Smith (1776), who noted efficiencies from labor specialization and work division in larger operations, the concept of economies of scale explains why larger firms can produce goods or services at a lower per-unit cost than smaller firms. Alfred Marshall (1890) further developed the theory by differentiating between internal

economies of scale, which are cost savings within a firm, and external economies of scale, which are cost savings across an industry or sector. George Stigler (1958) provided empirical evidence and further theoretical refinement, focusing on the sources of economies of scale and their implications for the market. Cost savings from economies of scale arise from several factors: spreading fixed costs such as administration, equipment, and R&D across a more significant number of units; enhancing labor specialization; optimizing processes for more efficient use of labor and materials; negotiating better prices for raw materials through bulk purchasing; leveraging advanced technology; and managing marketing and distribution expenses more efficiently. Subsequent research has expanded these concepts, examining economies of scale in complex multi-product production environments (Kim, 1987; Panzar & Willig, 1977), exploring their role in creating barriers to entry (Baumol, 1982), and investigating how urbanization and industrial concentration foster external economies of scale (Henderson et al., 1995).

Numerous studies have explored the phenomenon of economies of scale across various industries. Martin and Voltes-Dorta (2008) discovered that larger airports exhibit increasing returns to scale, benefiting from technological advancements, outsourcing, regulatory reform, and privatization. In the cosmetics industry, Benner and Malhotra (2023) observed that companies experienced economies of scale with varying degrees of cost savings as their size increased. Studies in the healthcare industry indicate that larger hospitals and systems achieve greater cost efficiencies, reflecting economies of scale (Gaynor & Vogt, 2003; Carey, 2003).

The study by Shi and Smyth (2012) on economies of scale in the Australian tourism industry from 1997 to 2007 found increasing returns to scale in the transport sector, retail trade, and recreational services, while the accommodation sector showed constant returns to scale. Chen et al. (2023) found the presence of economies of scale in the housing estate market attributed to the shared management and maintenance costs of facilities in buildings. A study by Morikawa (2011) in the personal service industry in Japan from 2002 to 2005, including movie theaters, golf courses, tennis courts, bowling alleys, fitness clubs, wedding halls, and aesthetic salons, showed significant economies of scale in almost all the service industries.

In the textile and apparel industry, a study examining the U.S. sectors from 1953 to 2001 highlighted the role of economies of scale and technological innovation in reducing costs and boosting productivity (Datta & Christoffersen, 2005). Additionally, Bennur and Malhotra's (2020) research into the textile, apparel, and accessories industry from 2015 to 2019 emphasized the significant impact of company size on cost efficiencies, with larger firms showing reduced costs of goods sold and operating expenses, demonstrating the presence of economies of scale.

While these studies confirm the presence of economies of scale across various industries, researchers have also identified that cost functions can become non-linear, revealing diseconomies of scale when firms expand beyond an optimal size (Canback et al., 2006; Chen et al., 2023; McAfee & McMillan, 1995). Factors contributing to diseconomies of scale include managerial challenges from overexpansion, bureaucratic inefficiencies, increased coordination costs, reduced employee motivation, decreased flexibility, and diminished competitive pressure. As organizations grow overly large, complexities and inefficiencies can increase costs, negating the benefits of scale. In line with this notion, Mitchell and Onvural (1996) found that large banks are generally cost-efficient, with little or no gains from further scaling or combining outputs across banks. This suggests that further expansion does not necessarily lead to additional cost savings beyond a certain size.

The translog cost function is a widely used tool for analyzing economies of scale, offering insights into complex cost-output relationships, and capturing economies and diseconomies of scale across various industries. Studies employing this model have utilized diverse cost variables and output variables tailored to specific sectors: Kim's (1987) study on water utilities used labor, capital, and energy as costs with amount of water as output; Daglish et al. (2015) examined banks with labor, capital, and borrowing as costs, and total assets as output; Martin and Voltes-Dorta (2008) analyzed airports using labor, capital, materials, and time as costs with Work Load Units and Air Traffic Movements as outputs; Shi and Smyth (2012) focused on the tourism sector with labor, capital, materials, and energy as costs and total revenue as output; and Benner and Malhotra's studies on textile and apparel (2020) and cosmetics (2023) used Cost of Goods Sold

(COGS), Operating Expenses, and Selling, General, and Administrative (SG&A)Expenses as costs, and analyzed total assets and revenue as outputs.

Using COGS, Operating Expenses, and SG&A Expenses as costs provides a detailed view of a company's operational spending, accessible from standardized financial statements, which allows for easy comparisons across companies or industries. On the output side, total assets reflect the scale of resources, while revenue indicates market demand, both essential for evaluating business strategy effectiveness and economies of scale.

MODEL

In order to analyze scale economies, we utilize a translog cost function, a commonly used approach in financial economics to assess economies of scale. This model enables us to incorporate a U-shaped average cost function and permits variations in economies of scale based on a company's size. Equation 1 shows the translog cost function:

$$\text{LN } Cost_{it} = \beta_0 + \beta_1 \text{ LN } Output_{it} + \frac{1}{2}\beta_2(\text{LN } Output_{it})^2 + \beta_3 Control_{it} + e_{it} \quad (1)$$

The translog model requires two primary data inputs: cost and output. Previous studies have debated the most suitable measures of each variable, particularly for output. Thus, we adopt multiple cost measures, including the cost of goods sold, other operating costs, and selling, general, and administrative expenses. For output, we utilize both total company assets and total revenue. When we measure output by total assets, we use total revenue as a control variable in the model. Similarly, when we measure output by total revenue, we use total assets as a control variable in the model.

We utilized the translog cost function to estimate the data for all 14 companies over four years. When data observations vary over time and across individuals, it is crucial to consider how to model the disparities. Panel data analysis enables the identification and measurement of effects that may not be evident in purely cross-sectional or time-series data. Using the full panel, we can mitigate potential multicollinearity problems since explanatory variables are less likely to exhibit high time-series and cross-sectional correlation. However, panel data analysis also presents potential econometric issues. Unobserved heterogeneity across years can result in misleading empirical estimates if left unaddressed (Baltagi 2008). We employed the least squares dummy variable fixed effects model to control for unobserved heterogeneity in our sample of textiles, apparel, and accessories companies.

Cost Elasticity

The cost elasticity of production is a frequently utilized metric for evaluating operating efficiency and economies of scale. If costs increase slower than output, a company or industry demonstrates economies of scale. To determine cost elasticity, we take the first derivative of the translog cost function (Equation 1) concerning assets. This computation yields Equation 2.

$$\frac{\partial(\text{LN } Cost)}{\partial(\text{LN } Output)} = \beta_1 + \beta_2(\text{LN } Output) \quad (2)$$

If an estimate of cost elasticity is significantly less than one, a company's expenses increase less than proportionately with changes in output, indicating the presence of economies of scale. Conversely, if elasticity is greater than one, we can infer the presence of diseconomies of scale. We estimate cost elasticity for the full panel of data and individual years within the sample, averaging elasticities across companies to obtain a group-level measure.

DATA

This study utilized a sample of fourteen (14) companies over four years from 2020 to 2023. The summary statistics of the variables used in this study are presented in Table 1, indicating notable changes in the financial metrics of the sample companies over the four years. Specifically, the cost of goods sold increased by 31% in 2023 relative to 2020, while other operating expenses and selling, general, and administrative expenses increased by 29% and 30%, respectively, in 2023 relative to 2020. Additionally, the companies' total assets increased by 12% in 2023 relative to 2020, and the total revenue increased by 34% in 2023 relative to 2020.

TABLE 1
SUMMARY STATISTICS OF VARIABLES USED IN THIS STUDY

Year		2020	2021	2022	2023	Panel Data
Cost of Goods Sold	Mean	4332	5009	5328	5673	5085
	Standard Deviation	5622	6402	6595	7447	6387
Operating Expenses	Mean	2974	3229	3502	3845	3388
	Standard Deviation	3839	3634	4141	4460	3933
Selling, General, and Administrative Expenses	Mean	2960	3229	3513	3847	3387
	Standard Deviation	3822	3652	4156	4469	3940
Total Assets	Mean	8181	9113	9142	9193	8907
	Standard Deviation	9036	10179	10362	9588	9543
Total Revenue	Mean	7983	9616	10030	10664	9573
	Standard Deviation	10066	11675	12110	13098	11506

Note: All figures in Table 1 are in millions of dollars

Table 1 demonstrates that the increase in total revenue over the sample period kept pace with the increase in the cost of goods sold but did not outpace the increases in other operating and selling expenses, general expenses, and administrative expenses. This suggests that while the companies were able to increase their revenue, they also faced rising expenses across multiple categories, which may have limited their overall profitability.

EMPIRICAL RESULTS

To evaluate economies of scale, we started by estimating translog cost functions (Equation 1) using a panel data set covering 2020 to 2023. We then used the coefficients obtained from Equation 1 and combined them with the output levels of each company in Equation 2 to estimate the cost elasticity of each company. We used several measures of costs, including total operating costs, cost of goods sold, and selling, general, and administrative expenses, about output. Output is also measured in two ways—total assets of the company as a measure of output and total revenue. Table 2 presents the estimated translog cost function and the average cost elasticity of the sample companies when total assets are used as the output measure.

Table 2 presents the findings from a regression analysis employing a translog cost function, with total assets as the measure of output. The independent variables consist of the natural logarithms (LN) of various

cost components: Cost of Goods Sold (Column 1), Operating Costs (Column 2), and Selling, General, and Administrative Expenses (Column 3).

The robustness of the models is indicated by the high R-squared values (0.90 for cost of goods sold, 0.83 for operating costs, and 0.83 for SG&A expenses), signifying a substantial portion of the variability in these cost elements is explained. This suggests that the selected independent variables—total assets and total revenue—are reliable predictors of cost behavior within firms.

TABLE 2
COST ELASTICITY, OUTPUT MEASURED BY TOTAL ASSETS

Translog cost function estimates: output measured by total assets.

	Dependent Variable:		
	LN (Cost of Goods Sold)	**LN (Operating Costs)**	**LN (Selling, General, and Administrative Expenses)**
Parameter	(1)	(2)	(3)
LN (Assets)	5.77	2.34	2.12
	(5.78***)	(1.99**)	(1.75*)
½ LN (Assets)^2	-0.64	-0.23	-0.20
	(-5.11***)	(-1.56)	(-1.31)
Total Revenue	0.000	0.00	0.000
	(6.91***)	(3.87***)	(3.52***)
R-Squared	0.90	0.83	0.83
No. Observations	56	56	56
Panel B:			
Cost Elasticity (Total Assets)	0.21	0.35	0.39
	(-9.90***)	(-22.89***)	(-24.71***)

***statistically significant at 1% significance level; **statistically significant at 5% significance level; *statistically significant at 10% significance level.

Across all three models (Columns 1-3), the coefficients of the natural logarithm of assets (LN(Assets)) are positive and statistically significant. This indicates that as a firm's total assets increase, there is a corresponding rise in the costs of goods sold, operating costs, and selling, general, and administrative (SG&A) expenses. Specifically, the coefficients are 5.77 for cost of goods sold, 2.34 for operating costs, and 2.12 for SG&A expenses. This implies that a 1% increase in total assets leads to approximately a 5.77%, 2.34%, and 2.12% increase in the respective costs, holding other factors constant.

The magnitude of these coefficients suggests that the cost of goods sold is most responsive to changes in total assets, likely due to the direct relationship between production capacity and asset expansion. Operating costs and SG&A expenses also increase with assets, albeit to a lesser degree, potentially reflecting the incremental costs associated with larger operational scales and administrative complexity.

Including the squared term (½ LN(Assets)^2) sheds light on the non-linear nature of the cost-asset relationship. Negative coefficients for this term across all cost components (-0.64 for cost of goods sold, -0.23 for operating costs, and -0.20 for SG&A expenses) indicate diminishing returns to scale. As firms expand their asset base, the incremental increase in costs diminishes. This suggests economies of scale, where larger firms benefit from more efficient production processes, bulk purchasing, and spreading fixed costs over a larger asset base.

The statistical significance of the squared term in the cost of goods sold model, but not in the operating costs and SG&A expenses models, underscores the stronger presence of diminishing returns in production-

related costs compared to other operational areas. This aligns with traditional economic theory, which suggests that manufacturing processes often exhibit more pronounced scale economies.

Total revenue emerges as a significant positive predictor of costs in all three models, with coefficients of 0.000 for cost of goods sold, 0.00 for operating costs, and 0.000 for SG&A expenses. Despite seemingly small coefficients, their statistical significance ($p < 0.01$) highlights the association between revenue growth and cost increases. This relationship likely reflects the scaling of operations and market activities in response to higher revenue, necessitating increased expenditure on goods, operations, and administrative functions to support revenue-generating activities.

Table 3 presents an analysis of cost elasticity within sportswear companies using a translog cost function, with total revenue as the measure of output. The models exhibit high R-squared values (0.92 for cost of goods sold and operating costs, 0.99 for SG&A expenses), indicating a significant portion of the variance in costs is explained. The coefficients of the natural logarithm of total revenue (LN (Total Revenue)) in all three models are statistically significant, providing insights into how costs respond to changes in revenue. For LN (Cost of Goods Sold) (Column 1), the coefficient is -2.53, indicating that a 1% increase in total revenue results in a 2.53% decrease in the cost of goods sold. This negative relationship suggests strong economies of scale in production, where higher revenue leads to more efficient production processes and lower per-unit costs.

TABLE 3
COST ELASTICITY, OUTPUT MEASURED BY TOTAL REVENUE

Translog cost function estimates: output measured by total revenue.

	Dependent Variable:		
	LN (Cost of Goods Sold)	**LN (Operating Costs)**	**LN (Selling, General, and Administrative Expenses)**
Parameter	(1)	(2)	(3)
LN (Total Revenue)	-2.53	-2,84	2.51
	(-2.66***)	(-2.95***)	(5.82***)
½ LN (Total Revenue)^2	0.43	0.47	-0.19
	(3.53***)	(3.84***)	(-3.46***)
Total Assets	-0.000	-0.000	0.39
	(-2.60***)	(-2.98***)	(3.45***)
R-Squared	0.92	0.92	0.99
No. Observations	56	56	56
Cost Elasticity (Total Revenue)	1.20	1.24	0.86
	(3.58***)	(3.88***)	(-5.60***)

***Statistically significant at 1% significance level.

For LN (Operating Costs) (Column 2), the coefficient is -2.84, indicating that a 1% increase in total revenue results in a 2.84% decrease in operating costs. This suggests significant operational efficiencies as companies expand their revenue, potentially attributable to improved resource utilization and optimized operational practices.

For LN (Selling, General, and Administrative Expenses) (SG&A) (Column 3), the coefficient is 2.51, indicating that a 1% increase in total revenue leads to a 2.51% increase in SG&A expenses. This positive correlation may reflect escalated spending on marketing, administration, and other overheads necessary to support revenue growth.

The negative coefficients for cost of goods sold and operating costs support the existence of economies of scale, wherein increased revenue enables firms to distribute fixed costs over a larger output, thus reducing average costs. However, the positive coefficient for SG&A expenses suggests that these costs may escalate with revenue growth, likely due to the need for expanded administrative functions and marketing efforts to sustain higher revenue.

The squared terms (½ LN (Total Revenue)^2) offer insight into the non-linear nature of the cost-revenue relationship. For cost of goods sold and operating costs, the positive coefficients (0.43 and 0.47, respectively) suggest that initial economies of scale diminish as revenue increases. This implies that while there are cost savings at lower revenue levels, these savings become less pronounced at higher revenue levels. For SG&A expenses, the negative coefficient (-0.19) indicates increasing returns to scale at higher revenue levels, wherein additional revenue leads to proportionally lower increases in SG&A expenses. This may indicate improved efficiency in administrative and marketing activities as firms expand.

Total assets also significantly influence costs. For cost of goods sold and operating costs, the negative coefficients (-0.000 for both) suggest that larger asset bases contribute to cost reductions, aligning with the notion that greater assets enable more efficient production and operational processes. Conversely, for SG&A expenses, the positive coefficient (0.39) suggests that larger asset bases might result in higher administrative and overhead costs, likely due to the complexity of managing more extensive operations.

For cost of goods sold and operating costs, the elasticity values (1.20 and 1.24, respectively) are positive and significant, indicating that total revenue increases are associated with these costs. For SG&A expenses, the elasticity is 0.86, suggesting that SG&A costs increase at a decreasing rate with total revenue growth. The pronounced economies of scale in production and operations suggest significant benefits from increasing revenue. Efforts to boost sales and expand market share can lead to lower average costs and improved profitability.

The diminishing returns to scale at higher revenue levels suggest that companies need to continuously innovate and enhance efficiencies to maintain cost advantages as they grow. The escalation of SG&A expenses with revenue growth underscores the importance of effective management and scaling of administrative functions.

Table 4 offers a comprehensive examination of cost efficiencies relative to total assets for sportswear companies from 2020 to 2023. This analysis concentrates on three key cost areas: cost of goods sold, other operating expenses, and selling, general, and administrative (SG&A) expenses. The table presents the mean cost elasticity for each year, alongside corresponding t-statistics, elucidating significant trends and alterations in cost efficiency.

The mean cost elasticity of the cost of goods sold (COGS) relative to total assets reveals a declining trend from 0.30 in 2020 to 0.17 in 2023, with a panel data mean of 0.21. The consistently negative t-statistics (all significant at the 1% level) indicate the statistical significance of these elasticity values.

This declining trend indicates increasing cost efficiency over time, suggesting that the proportional increase in COGS decreases as total assets grow. This reflects economies of scale, where sportswear companies are becoming more efficient in their production processes, likely benefiting from improved production technologies, better supply chain management, and higher bargaining power with suppliers.

The cost elasticity of other operating expenses also shows a decreasing trend, although the changes are more modest compared to COGS. The mean elasticity declines from 0.38 in 2020 to 0.33 in 2023, with a panel data mean of 0.35. The consistently negative t-statistics (all significant at the 1% level) indicate the statistical significance of these values. The slight decrease in elasticity values over time suggests incremental improvements in operational efficiencies. Sportswear companies might achieve this through better resource utilization, process optimizations, and leveraging technology for operational management.

The cost elasticity of SG&A expenses relative to total assets remains relatively stable, with a slight decrease from 0.38 in 2020 to 0.37 in 2023, and a panel data mean of 0.39. The consistently negative t-statistics (all significant at the 1% level) indicate the statistical significance of these values. The relative stability in SG&A cost elasticity suggests that while sportswear companies are scaling, the proportional increase in SG&A expenses remains consistent. This could indicate that administrative and selling expenses

scale linearly with assets, reflecting the necessary expansion in marketing, sales, and administrative activities to support larger operations.

TABLE 4
TRENDS IN COST EFFICIENCIES WITH RESPECT TO TOTAL ASSETS FOR SPORTSWEAR COMPANIES FOR THE PERIOD 2020 TO 2023

	2020	**2021**	**2022**	**2023**	**Panel Data**
Cost Elasticity of cost of goods sold relative to Total Assets					
Mean	0.30	0.20	0.19	0.17	0.21
t-statistics	-3.83***	-5.06***	-5.22***	-5.42***	-9.89***
Cost Elasticity of other operating expenses relative to Total Assets					
Mean	0.38	0.34	0.34	0.33	0.35
t-statistics	-9.50***	-11.58***	-11.87***	-12.15***	-22.89***
Cost Elasticity of Selling, General, and Administrative Expenses relative to Total Assets					
Mean	0.38	0.38	0.38	0.37	0.39
t-statistics	-9.50***	-12.50***	-12.80***	-13.09***	-24.71***

***statistically significant at 1% significance level, **statistically significant at 5% significance level. *statistically significant at 10% significance level

The observed trends in cost elasticity relative to total assets provide strong evidence of economies of scale within the sportswear industry, particularly in COGS and operating expenses. The declining elasticity in COGS is especially notable, highlighting significant production efficiencies. However, the relatively stable elasticity in SG&A expenses suggests that while efficiencies are being gained in production and operations, administrative and marketing costs may need continuous monitoring and optimization to avoid eroding these gains.

Table 5 examines trends in cost efficiencies relative to total revenue for sportswear companies from 2020 to 2023. The analysis focuses on three primary cost components: cost of goods sold (COGS), other operating expenses, and selling, general, and administrative (SG&A) expenses. This discussion interprets the results, highlighting significant trends and their implications for economies of scale within the sportswear industry.

TABLE 5
TRENDS IN COST EFFICIENCIES WITH RESPECT TO TOTAL REVENUE FOR SPORTWEAR COMPANIES FOR THE PERIOD 2020 TO 2023

	2020	**2021**	**2022**	**2023**	**Panel Data**
Cost Elasticity of cost of goods sold relative to Total Revenue					
Mean	0.91	0.86	0.85	0.83	0.86
t-statistics	-1.73**	-2.70***	-3.19***	-3.58***	-5.60***
Cost Elasticity of other operating expenses relative to Total Revenue					
Mean	1.10	1.20	1.23	1.26	1.20
t-statistics	0.82	1.73**	2,15**	2.50***	3.58***
Cost Elasticity of Selling, General, and Administrative Expenses relative to Total Revenue					
Mean	1.13	1.24	1,27	1.31	1.24
t-statistics	0.96	1.87**	2.30**	2.67***	3.88***

***statistically significant at 1% level; **statistically significant at 5% level.

The mean cost elasticity of cost of goods sold (COGS) relative to total revenue displays a declining trend throughout the observed period, suggesting an enhancement in cost efficiencies over time. Supported

by negative t-statistics, with significance levels at both 5% and 1%, these elasticity values exhibit statistical significance. The descent from 0.91 in 2020 to 0.83 in 2023 indicates that as total revenue expands, the proportional increase in COGS diminishes, illustrating economies of scale. This progression implies an improvement in the efficiency of production processes among sportswear companies, likely attributable to technological advancements, optimization of supply chains, and enhanced production methodologies.

Conversely, the mean cost elasticity of other operating expenses relative to total revenue demonstrates a slight increasing trend, suggesting a less favorable yet still significant relationship. Supported by positive t-statistics, these elasticity values retain statistical significance with select values attaining significance at both 5% and 1% levels. The uptick from 1.10 in 2020 to 1.26 in 2023 signifies that other operating expenses are growing marginally faster than total revenue. This uptrend could be attributed to escalated costs associated with scaling operations, such as logistics, utilities, and maintenance, which may not experience commensurate benefits from economies of scale as production costs do.

Similarly, the mean cost elasticity of selling, general, and administrative (SG&A) expenses relative to total revenue gradually increases over the period. Supported by positive t-statistics, with numerous values significant at both 5% and 1% levels, these elasticity values affirm their statistical significance. The elevation from 1.13 in 2020 to 1.31 in 2023 indicates that SG&A expenses are escalating faster than total revenue. This trend suggests that as sportswear companies expand, they incur heightened administrative and marketing costs, which may not scale as efficiently as production costs.

Table 6 furnishes a comparative analysis of economies of scale across various sportswear companies by scrutinizing the average cost elasticity of total operating costs, selling, general, and administrative (SG&A) expenses, and cost of goods sold (COGS) concerning total assets. This analysis elucidates how these costs scale with company size, measured by total assets, providing insights into each company's cost efficiencies and scalability.

TABLE 6
ECONOMIES OF SCALE WITH RESPECT TO SIZE AS TOTAL ASSETS BY EACH COMPANY

	Average Cost Elasticity of Total Operating Costs	Average Cost Elasticity of Selling, General, and Administrative Expenses	Average Cost Elasticity of Cost of Goods Sold
NIKE, Inc.	-0.08	0.02	-0.96
adidas AG	0.03	0.11	-0.67
ANTA Sports Products Limited	0.22	0.28	-0.14
JD Sports Fashion	0.24	0.30	-0.07
DICK'S Sporting Goods, Inc.	0.25	0.30	-0.05
Amer Sports, Inc.	0.27	0.32	-0.01
Shimano	0.34	0.38	0.18
Lululemon Athletica Inc.	0.37	0.40	0.27
Under Armour, Inc.	0.39	0.42	0.32
ASICS	0.48	0.51	0.60
Columbia Sportswear	0.50	0.52	0.64
Topsports International Holdings Limited	0.54	0.56	0.76
Acushnet Holdings	0.58	0.59	0.88
On Holding AG	0.72	0.71	1.26

TABLE 7
ECONOMIES OF SCALE WITH RESPECT TO SIZE AS TOTAL ASSETS BY EACH COMPANY

	Average Cost Elasticity of Total Operating Costs	Average Cost Elasticity of Selling, General, and Administrative Expenses	Average Cost Elasticity of Cost of Goods Sold
NIKE, Inc.	-0.08	0.02	-0.96
Adidas AG	0.03	0.11	-0.67
ANTA Sports Products Limited	0.22	0.28	-0.14
JD Sports Fashion	0.24	0.30	-0.07
DICK'S Sporting Goods, Inc.	0.25	0.30	-0.05
Amer Sports, Inc.	0.27	0.32	-0.01
Lululemon Athletica Inc.	0.37	0.40	0.27
Shimano	0.34	0.38	0.18
Under Armour, Inc.	0.39	0.42	0.32
ASICS	0.48	0.51	0.60
Columbia Sportswear	0.50	0.52	0.64
Acushnet Holdings	0.58	0.59	0.88
Topsports International Holdings Limited	0.54	0.56	0.76
On Holding AG	0.72	0.71	1.26

Note: The order of companies in the table is arranged based on total assets, from largest to smallest, as of 2023

While certain companies exhibit robust efficiencies, others encounter significant challenges in cost management as they expand. Giants like NIKE, Inc. and Adidas AG demonstrate pronounced economies of scale, particularly in production, evident in their notably negative COGS elasticities. Conversely, firms like ANTA Sports Products Limited and JD Sports Fashion display moderate efficiencies in operating costs and SG&A expenses but struggle to achieve substantial production efficiencies.

On the other hand, companies such as Shimano, Lululemon Athletica Inc., and Under Armour, Inc. reveal increasing costs across all categories, hinting at potential difficulties in scaling efficiently. Similarly, ASICS, Columbia Sportswear, Topsports International Holdings Limited, and Acushnet Holdings face rising costs in all areas, indicating limited economies of scale.

Notably, On Holding AG stands out with high positive elasticities in all cost categories, suggesting considerable challenges in cost management as they expand, potentially impeding their competitive stance.

Table 7 furnishes an analysis of economies of scale concerning total revenue for various sportswear companies, exploring the average cost elasticity of total operating costs, selling, general, and administrative (SG&A) expenses, and cost of goods sold (COGS). The provided cost elasticity values offer insights into how costs evolve concerning changes in total revenue, thereby shedding light on the scalability and efficiency of these companies.

TABLE 8
ECONOMIES OF SCALE CONCERNING TOTAL REVENUE FOR EACH COMPANY

	Average Cost Elasticity of Total Operating Costs	Average Cost Elasticity of Selling, General, and Administrative Expenses	Average Cost Elasticity of Cost of Goods Sold
On Holding AG	0.45	0.42	1.19
Acushnet Holdings Corp.	0.76	0.75	1.06
Columbia Sportswear	0.93	0.94	0.98
Amer Sports, Inc.	0.95	0.97	0.97
ASICS	0.99	1.01	0.95
Shimano	1.05	1.07	0.93
Topsports International Holdings Limited	1.10	1.12	0.91
Under Armour, Inc.	1.17	1.20	0.88
Lululemon Athletica	1.27	1.31	0.83
ANTA Sports Products Limited	1.30	1.34	0.82
JD Sports Fashion	1.48	1.55	0.74
DICK'S Sporting Goods, Inc.	1.50	1.56	0.73
adidas AG	1.80	1.89	0.60
NIKE, Inc.	2.07	2.19	0.48

TABLE 9
ECONOMIES OF SCALE WITH RESPECT TO TOTAL REVENUE FOR EACH COMPANY

	Average Cost Elasticity of Total Operating Costs	Average Cost Elasticity of Selling, General, and Administrative Expenses	Average Cost Elasticity of Cost of Goods Sold
NIKE, Inc.	2.07	2.19	0.48
Adidas AG	1.80	1.89	0.60
JD Sports Fashion	1.48	1.55	0.74
DICK'S Sporting Goods, Inc.	1.50	1.56	0.73
Lululemon Athletica	1.27	1.31	0.83
ANTA Sports Products Limited	1.30	1.34	0.82
Under Armour, Inc.	1.17	1.20	0.88
Amer Sports, Inc.	0.95	0.97	0.97
ASICS	0.99	1.01	0.95
Topsports International Holdings Limited	1.10	1.12	0.91
Columbia Sportswear	0.93	0.94	0.98

	Average Cost Elasticity of Total Operating Costs	Average Cost Elasticity of Selling, General, and Administrative Expenses	Average Cost Elasticity of Cost of Goods Sold
Shimano	1.05	1.07	0.93
Acushnet Holdings Corp.	0.76	0.75	1.06
On Holding AG	0.45	0.42	1.19

Note: The order of companies in the table is arranged based on total revenue, from largest to smallest, as of 2023

Regarding total operating costs, On Holding AG and Acushnet Holdings Corp. lead with the lowest average cost elasticities, signifying moderate cost escalations compared to revenue growth, indicative of efficient scaling. Columbia Sportswear and Amer Sports, Inc. closely approach the neutral point with elasticities near 1, demonstrating proportional cost increments alongside revenue. ASICS and Shimano maintain elasticities around 1, suggesting parallel growth rates between operating costs and revenue. Conversely, Topsports International Holdings Limited, Under Armour, Inc., and Lululemon Athletica display higher elasticities, implying less efficient scaling. The highest elasticities are found in ANTA Sports Products Limited, JD Sports Fashion, DICK'S Sporting Goods, Inc., Adidas AG, and NIKE, Inc., indicating substantial operating cost increases as revenue expands, potentially posing challenges in achieving operational efficiencies.

Regarding SG&A expenses, On Holding AG and Acushnet Holdings Corp. showcase the lowest cost elasticities, demonstrating better control over administrative and selling costs as revenue climbs. Columbia Sportswear and Amer Sports, Inc. exhibit elasticities close to 1, suggesting proportional increases in SG&A expenses with revenue. ASICS and Shimano maintain similar growth rates between SG&A expenses and revenue. In contrast, Topsports International Holdings Limited, Under Armour, Inc., and Lululemon Athletica reveal higher elasticities, indicating larger SG&A cost hikes relative to revenue growth. The highest SG&A expense elasticities are observed in ANTA Sports Products Limited, JD Sports Fashion, DICK'S Sporting Goods, Inc., adidas AG, and NIKE, Inc., pointing towards significant challenges in managing SG&A costs effectively as they scale.

For COGS, On Holding AG and Acushnet Holdings Corp. exhibit the highest cost elasticities, suggesting that their production costs increase more rapidly than revenue, reflecting diseconomies of scale. Conversely, Columbia Sportswear, Amer Sports, Inc., and ASICS show elasticities close to 1, indicating proportional increases in COGS with revenue. Shimano, Topsports International Holdings Limited, and Under Armour, Inc. demonstrate slightly lower elasticities, indicating some production efficiency. Lululemon Athletica and ANTA Sports Products Limited exhibit better efficiency with lower elasticities. JD Sports Fashion, DICK'S Sporting Goods, Inc., Adidas AG, and NIKE, Inc. display the lowest COGS elasticities, suggesting significant economies of scale in their production processes.

Companies like NIKE, Inc. and Adidas AG demonstrate strong production efficiencies, as reflected in their low COGS elasticities. This indicates substantial economies of scale in their production processes. Higher elasticities in total operating costs and SG&A expenses for companies like NIKE, Inc., Adidas AG, and others suggest challenges in managing these costs as they scale. These companies may need to focus on operational efficiencies and cost control measures. Firms such as Columbia Sportswear, Amer Sports, Inc., and ASICS show balanced cost elasticities, indicating proportional cost increases with revenue, reflecting a mixed performance in scaling efficiencies.

SUMMARY AND CONCLUSIONS

The sportswear industry has undergone significant growth and evolution in recent years, driven by escalating consumer demand for performance-driven and lifestyle-oriented products. Various factors including technological advancements, a burgeoning health-conscious population, and the widespread

popularity of athleisure fashion have fueled this surge. As the industry continues to evolve, companies are increasingly emphasizing the attainment of cost efficiencies through the realization of economies of scale.

This study scrutinized the impact of economies of scale on growth and profitability within the sportswear industry. Through the analysis of financial data and cost components across a spectrum of companies, several pivotal findings emerged:

Companies such as NIKE, Inc. and Adidas AG exhibit robust production efficiencies, indicative of significant economies of scale within their production processes. However, higher elasticities in total operating costs and selling, general, and administrative (SG&A) expenses for entities like NIKE, Inc., Adidas AG, and others suggests impending challenges in managing these costs as they scale. Therefore, implementing operational efficiencies and stringent cost control measures emerge as imperative strategies to counter these challenges.

Conversely, firms like Columbia Sportswear, Amer Sports, Inc., and ASICS demonstrate balanced cost elasticities, reflective of a mixed performance in scaling efficiencies. It becomes evident that continuous innovation and enhancement of operational efficiencies are indispensable for sustaining cost advantages as these companies expand.

This study furnishes invaluable insights into how economies of scale influence the sportswear industry. Armed with this understanding, companies can devise targeted strategies to bolster efficiency, augment profitability, and preserve competitiveness within this dynamic market milieu. Continuous vigilance and adaptation of cost management practices will prove indispensable for adeptly navigating the intricacies of scaling in the sportswear sector.

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