

# Vendor Performance Data Analytics Using Explanatory AI

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**Abstract:** *Effective inventory and sales management are critical for optimizing profitability and operational efficiency in both retail and wholesale sectors. This study analyzes vendor performance to identify underperforming brands, evaluate the impact of bulk purchasing on unit cost reduction, and assess overall inventory turnover efficiency. Using exploratory data analysis and hypothesis testing techniques, the research examines profitability variations between high-performing and low-performing vendors based on key performance indicators such as revenue contribution, profit margin, and stock movement. The findings reveal a significant dependency on a limited group of vendors, which may increase operational risk and reduce supply chain flexibility. Additionally, a clear distinction is observed between high-volume vendors and high-margin vendors, indicating differing profitability models that require strategic alignment. The study further highlights inefficiencies in slow-moving inventory and pricing structures that affect overall financial performance. Based on these insights, actionable recommendations are proposed, including vendor diversification, optimized pricing strategies, and improved inventory control mechanisms. The proposed approach supports data-driven decision-making and enhances long-term sustainability, profitability, and resilience within supply chain operations.*

**Keywords:** Inventory management, Profit margin optimization, Retail analytics, Supply chain risk, Vendor performance

## I. INTRODUCTION

Companies must ensure they are not incurring losses due to inefficient pricing, poor inventory turnover, or vendor dependency. The goal of this analysis is to identify underperforming brands, determine top vendors contributing to sales and profit, and analyze the impact of bulk purchasing on unit costs. Furthermore, this study assesses inventory turnover to reduce holding costs and investigates profitability variances across different vendor performance tiers.

## II. METHODOLOGY

The analysis utilized a dataset of 10,692 records encompassing vendor metrics, purchase costs, and sales performance. To enhance the reliability of insights, the data was filtered to remove inconsistent points as follows:  
Transactions where Gross Profit  $\leq 0$  or Profit Margin  $\leq 0$  were excluded.  
Instances where Total Sales Quantity = 0 were eliminated to focus on active inventory.



## I. Exploratory data analysis (EDA)

### Summary Statistics

	count	mean	std	min	25%	50%	75%	max
VendorNumber	10692.0	1.085065e+04	18753.519148	2.00	3951.000000	7153.000000	9562.000000	2.013190e+05
Brand	10692.0	1.803923e+04	12662.187074	68.00	6793.600000	18761.600000	25614.250000	9.063100e+04
PurchasePrice	10692.0	2.438530e+01	109.269375	0.36	6.840000	10.485000	19.482000	5.681800e+03
ActualPrice	10692.0	3.564367e+01	148.246016	0.49	10.950000	15.990000	28.990000	7.499900e+03
Volume	10692.0	8.473805e+02	664.309212	60.00	750.000000	750.000000	750.000000	2.000000e+04
TotalPurchaseQuantity	10692.0	3.140860e+03	11095.086769	1.00	36.000000	262.000000	1975.750000	3.379600e+05
TotalPurchaseDollars	10692.0	3.010669e+04	123067.799627	0.71	451.457000	3655.465000	20738.245000	3.871252e+06
TotalSalesQuantity	10692.0	3.077468e+03	10952.881391	0.00	33.000000	261.000000	1928.250000	3.348390e+05
TotalSalesDollars	10692.0	4.223907e+04	167865.285984	0.00	729.220000	5298.045000	28396.919000	5.101920e+06
TotalSalesPrice	10692.0	1.879378e+04	44952.773386	0.00	289.710000	2857.800000	16058.662000	6.728193e+05
TotalExciseTax	10692.0	1.742236e+03	10975.582240	0.00	4.800000	46.570000	418.650000	3.682426e+05
FreightCost	10692.0	6.143276e+04	60938.488032	0.09	14069.879000	50293.620000	79628.890000	2.570327e+06
GrossProfit	10692.0	1.215238e+04	46224.327904	-5202.78	52.920000	1399.640000	8660.200000	1.290668e+06
ProfitMargin	10692.0	-inf	NaN	-inf	13.324816	30.405457	39.986135	9.971666e+01
StockTurnover	10692.0	1.706793e+00	6.020460	0.00	0.687229	0.691629	1.039342	2.746000e+02
SalesToPurchaseRatio	10692.0	2.804395e+00	8.489067	0.00	1.153729	1.436894	1.665449	3.528286e+02

Figure 1. Summary statistics

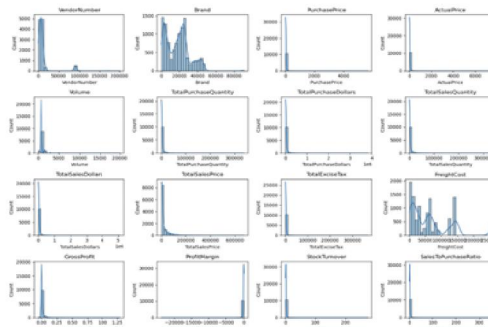


Figure 2. Summary statistics

Summary statistics revealed significant outliers and variances in key metrics:

- **Pricing:** Maximum purchase prices (\$5,681.81) and actual prices (\$7,499.99) are significantly higher than the means (\$24.39 and \$35.64), indicating premium product offerings.
- **Logistics:** Freight costs varied drastically from \$0.09 to \$257,032.07, suggesting logistics inefficiencies or erratic bulk shipping costs.
- **Profitability:** Gross profit showed a minimum of -\$52,002.78, indicating potential losses from selling below cost or heavy discounting

## II. Correlation Analysis

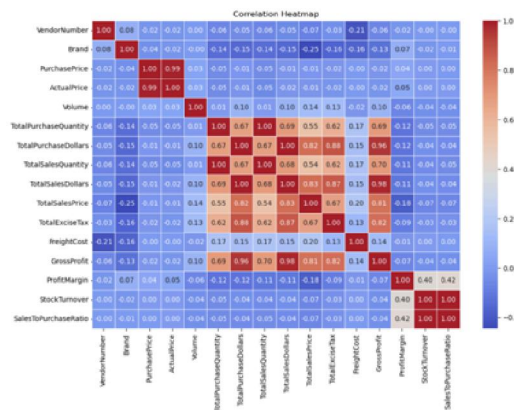


Figure 3. Correlation heatmap



The correlation heatmap highlighted several critical operational relationships:

- **Inventory Efficiency:** A strong correlation (0.999) between Total Purchase Quantity and Total Sales Quantity confirms efficient turnover for the majority of products.
- **Profitability Drivers:** A negative correlation (-0.179) between Profit Margin and Total Sales Price suggests that increasing sales prices may lead to reduced margins due to competitive pressures.
- **Turnover vs. Profit:** Weak negative correlations between Stock Turnover and profitability metrics indicate that faster stock turnover does not necessarily equate to higher profitability.

### III. RESULTS AND DISCUSSION

The following findings highlight the critical intersections between vendor dependency, pricing strategies, and inventory efficiency:

Identification of High-Margin, Low-Volume Brands: Analysis identified 198 brands that maintain high profit margins but suffer from low sales volume, such as "Crown Royal Apple" with an 89.81% margin. These specific brands are primary candidates for targeted promotions or price optimizations to stimulate demand without eroding unit profitability.

Brands with Low Sales but High Profit Margins:

	Description	TotalSalesDollars	ProfitMargin
6199	Santa Rita Organic Svgn Bl	9.99	66.466466
2369	Debauchery Pnt Nr	11.58	65.975820
2070	Concannon Glen Ellen Wh Zin	15.95	83.448276
2188	Crown Royal Apple	27.86	89.806174
6237	Sauza Sprkkg Wild Berry Marg	27.96	82.153076
...	...	...	...
5074	Nanbu Bijin Southern Beauty	535.68	76.747312
2271	Dad's Hat Rye Whiskey	538.89	81.851584
57	A Bichot Clos Marechaudes	539.94	67.740860
6245	Sbragia Home Ranch Merlot	549.75	66.444748
3326	Goulee Cos d'Estournal 10	558.87	69.434752

198 rows x 3 columns

Figure 4. brands with low sales but high profit margins

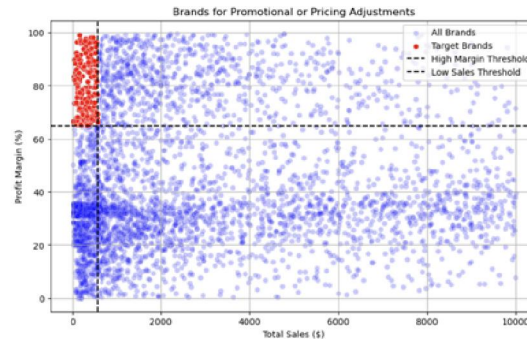


Figure 5. Brands for promotional or pricing adjustments

Significant Vendor Concentration Risk: The top 10 vendors account for 65.69% of all purchase expenditures, leaving only 34.31% to the remaining vendor base. This heavy reliance on a few suppliers, led by Diageo North America Inc (16.3%), creates substantial vulnerability to supply chain disruptions and necessitates a diversification strategy.



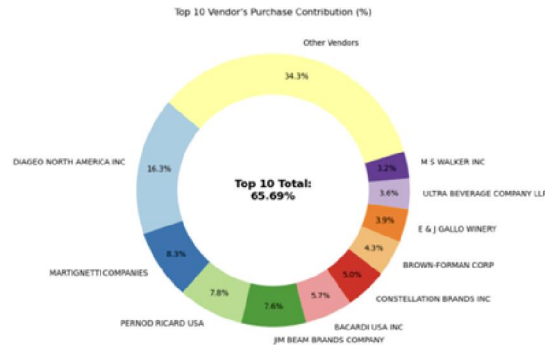


Figure 6. top 10 vendor's purchase contribution(%)

Economies of Scale via Bulk Purchasing: Data confirms that order size drastically influences unit costs, with large orders achieving a 72% cost reduction compared to small orders. Specifically, large-scale purchasing brings the unit cost down to \$10.78, whereas small orders average \$39.06, providing a clear competitive advantage for high-volume procurement.

OrderSize	UnitPurchasePrice
Small	39.057543
Medium	15.486414
Large	10.777625

Figure 7. Impact of Bulk Purchasing on Cost Savings

Underutilized Capital in Slow-Moving Inventory: Approximately \$2.71M in capital is currently tied up in unsold inventory. Large vendors like Diageo North America Inc and Jim Beam Brands Company hold the highest values of unsold stock at \$722.21K and \$554.67K respectively, indicating a need for more aggressive inventory liquidation or revised purchasing cycles.

VendorName	StockTurnover	VendorName	UnsoldInventoryValue
ALISA CARR BEVERAGES	0.615385	DIAGEO NORTH AMERICA INC	722.21K
HIGHLAND WINE MERCHANTS LLC	0.708333	JIM BEAM BRANDS COMPANY	554.67K
PARK STREET IMPORTS LLC	0.751306	PERNOD RICARD USA	470.63K
Circa Wines	0.755676	WILLIAM GRANT & SONS INC	401.96K
Dunn Wine Brokers	0.766022	E & J GALLO WINERY	228.28K
CENTEUR IMPORTS LLC	0.773953	SAZERAC CO INC	198.44K
SMOKY QUARTZ DISTILLERY LLC	0.783835	BROWN-FORMAN CORP	177.73K
TAMWORTH DISTILLING	0.797078	CONSTELLATION BRANDS INC	133.62K
THE IMPORTED GRAPE LLC	0.807569	MOET HENNESSY USA INC	126.48K
WALPOLE MTNVIEW WINERY	0.820548	REMY COINTREAU USA INC	118.60K

Figure 8. Identifying Vendors with Low Inventory Turnover

Divergent Profitability Models: Statistical testing revealed that high-performing (top-selling) vendors and low-performing vendors operate under fundamentally different business models. While top vendors focus on volume with a mean profit margin of 31.17%, low-performing vendors maintain a significantly higher mean margin of 41.55%, suggesting they prioritize niche, high-value sales over market reach.



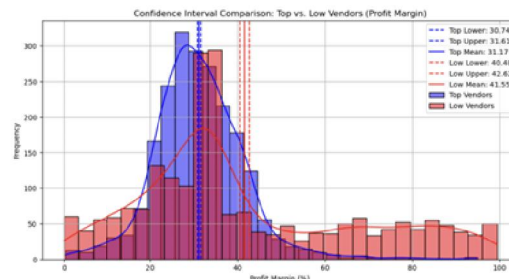


FIGURE 9. Confidence Interval Comparison: Top VS Low Vendors(Profit Margin)

Inefficiencies in Logistics and Pricing: High standard deviations in freight costs (ranging from \$0.09 to \$257,032.07) and gross profit (with losses reaching -\$52,002.78) highlight operational gaps. These outliers suggest that certain products are being sold at a loss due to excessive shipping expenses or over-discounting, requiring immediate structural adjustments.

#### IV. CONCLUSION AND FUTURE WORK

Hypothesis testing confirmed that top-performing and low-performing vendors operate under distinctly different profitability models. Top vendors have a mean profit margin of 31.17%, while low-performing vendors maintain a higher mean of 41.55% but struggle with sales volume.

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