Executive Report: Vendor Performance & Inventory Optimization

1. Executive Summary & Problem Statement

Context

Retail and wholesale beverage operations operate under tight margins, high inventory volumes, and multi-vendor procurement structures. Profitability is directly influenced by pricing strategy, purchase volumes, vendor mix, and inventory turnover efficiency.

Despite strong revenue performance, structural inefficiencies may be eroding margins and locking working capital.

Core Issues Identified

Vendor Concentration

A significant portion of total procurement is concentrated among a small number of vendors. This increases supply risk and reduces negotiation leverage.

Pricing vs Margin Uncertainty

It is unclear whether higher sales volumes correlate with stronger margins. The relationship between sales price, profit margin, and vendor performance requires validation.

Inventory Inefficiency

Slow-moving inventory results in capital lock-in, increased holding costs, and reduced liquidity.

Bulk Purchasing Effectiveness

The cost advantage of bulk purchasing has not been quantified relative to inventory risk and turnover performance.

Strategic Objective

To optimize profitability by:

- Reducing vendor dependency risk
- Improving pricing and margin structure
- Enhancing inventory turnover efficiency
- Quantifying the financial impact of bulk purchasing
- Releasing capital locked in unsold inventory

2. Data Infrastructure & Methodology

Approximately **2GB of raw transactional data** (purchases, sales, pricing, vendor invoices, inventory) was ingested into **SQLite** using Python.

- Automated ingestion scripts ensured schema consistency.
- Logging was implemented for monitoring and traceability.

Data Modelling

SQL **Common Table Expressions (CTEs)** were used to optimize joins across transactional tables.

A consolidated table, **vendor_sales_summary**, was created to integrate:

- Purchase data
- Sales data
- Freight allocation
- Vendor pricing

This served as the analytical base for all subsequent analysis.

Data Preparation

- Standardized categorical fields (e.g., vendor names).
- Corrected data types and handled missing values.
- Validated transactional integrity.

Feature Engineering

New performance metrics were derived to enable profitability and efficiency analysis:

- **Gross Profit** = Total Sales – Total Purchase
- **Profit Margin (%)** = Gross Profit / Total Sales
- **Stock Turnover** = Total Sales Quantity / Total Purchase Quantity
- **Unsold Inventory Value** = (Purchased Qty – Sold Qty) × Purchase Price
- **Purchase Contribution (%)** = Vendor Purchase / Total Purchases

These engineered features formed the foundation for EDA, statistical testing, and Power BI visualization.

# 3. Exploratory Data Analysis (EDA) & Correlation Insights

Summary Statistics

	count	mean	std	min	25%	50%	75%	max
VendorNumber	10692.0	1.065065e+04	18753.519148	2.00	3951.000000	7153.000000	9552.000000	2.013590e+05
Brand	10692.0	1.803923e+04	12662.187074	58.00	5793.500000	18761.500000	25514.250000	9.063100e+04
PurchasePrice	10692.0	2.438530e+01	109.269375	0.36	6.840000	10.455000	19.482500	5.681810e+03
ActualPrice	10692.0	3.564367e+01	148.246016	0.49	10.990000	15.990000	28.990000	7.499990e+03
Volume	10692.0	8.473605e+02	664.309212	50.00	750.000000	750.000000	750.000000	2.000000e+04
TotalPurchaseQuantity	10692.0	3.140887e+03	11095.086769	1.00	36.000000	262.000000	1975.750000	3.376600e+05
TotalPurchaseDollars	10692.0	3.010669e+04	123067.799627	0.71	453.457500	3655.465000	20738.245000	3.811252e+06
TotalSalesQuantity	10692.0	3.077482e+03	10952.851391	0.00	33.000000	261.000000	1929.250000	3.349390e+05
TotalSalesPrice	10692.0	1.879378e+04	44952.773386	0.00	289.710000	2857.800000	16059.562500	6.728193e+05
TotalSalesDollars	10692.0	4.223907e+04	167655.265984	0.00	729.220000	5298.045000	28396.915000	5.101920e+06
TotalExciseTax	10692.0	1.774226e+03	10975.582240	0.00	4.800000	46.570000	418.650000	3.682428e+05
FreightCost	10692.0	6.143376e+04	60938.458032	0.09	14069.870000	50293.620000	79528.990000	2.570321e+05
GrossProfit	10692.0	1.213238e+04	46224.337964	-52002.78	52.920000	1399.640000	8660.200000	1.290668e+06
ProfitMargin	10692.0	-inf	NaN	-inf	13.324515	30.405457	39.956135	9.971666e+01
StockTurnover	10692.0	1.706793e+00	6.020460	0.00	0.807229	0.981529	1.039342	2.745000e+02
SalesToPurchaseRatio	10692.0	2.504390e+00	8.459067	0.00	1.153729	1.436894	1.665449	3.529286e+02
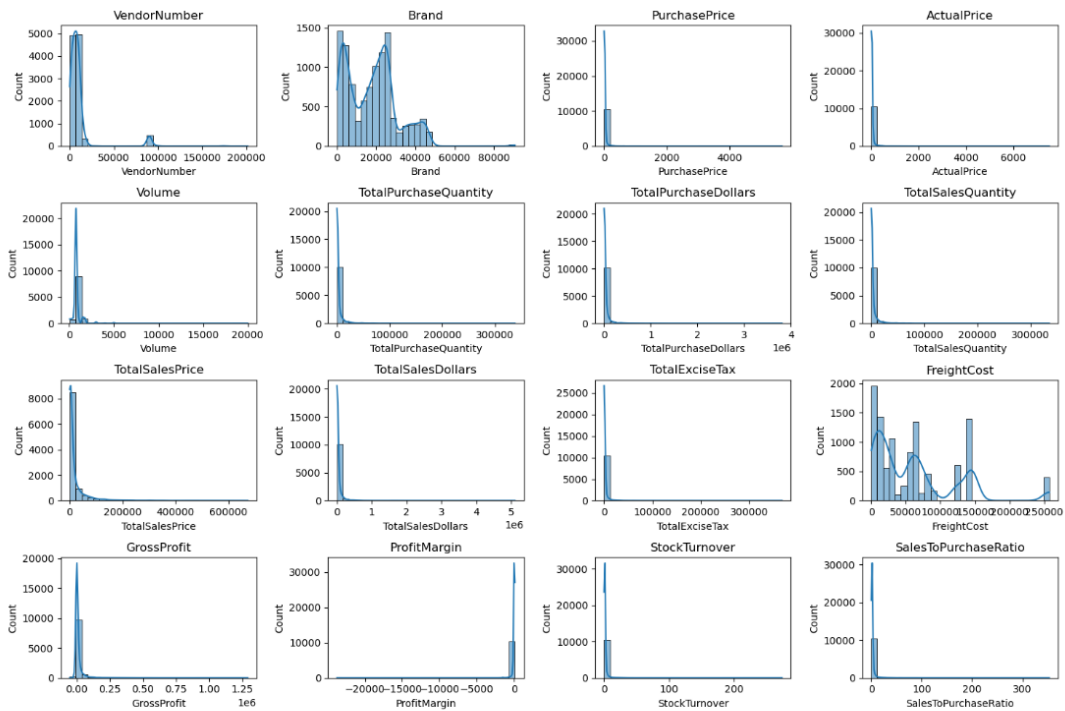
We can see that the data is skewed along a wide range in many plots (such as Purchase, sales data); this means that there are a lot of outliers

Outlier analysis revealed extreme values in purchase prices and freight costs, indicating premium products and logistical variability.
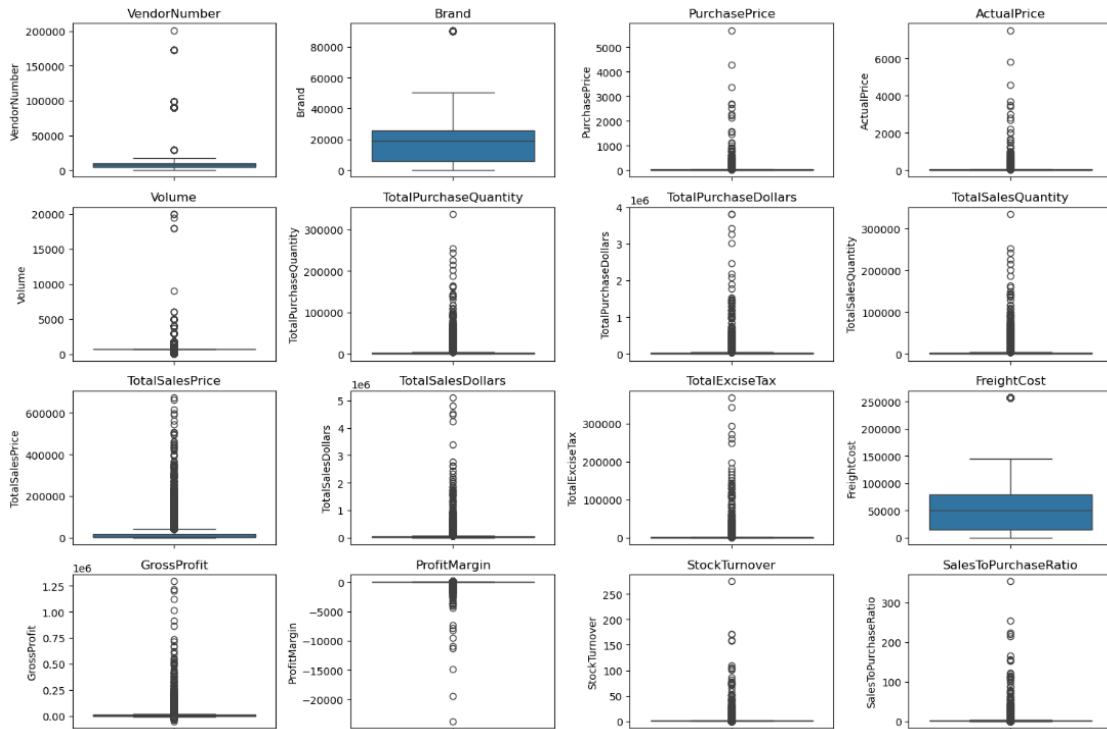
Negative & Zero Value Diagnostics

Initial summary statistics revealed structural anomalies requiring investigation:

- Gross Profit: Minimum of –52,002.78, indicating transactions where selling price fell materially below purchase cost. This suggests either heavy discounting, pricing errors, or cost misalignment.
- Margin: Minimum of –∞, occurring where revenue equals zero or is lower than cost. These cases distort ratio-based metrics and indicate non-performing or mispriced inventory.
- Total Sales Quantity & Sales Dollars: Presence of zero values. Products were purchased but never sold, creating capital lock-in and signaling potential obsolescence.

These observations confirmed the need for controlled filtering prior to inferential analysis.

Outlier Analysis (High Dispersion Indicators)

Standard deviation analysis revealed significant dispersion across pricing and logistics variables:

Purchase Price
- Mean: 24.39
- Max: 5,681.81

Actual Price
- Mean: 35.64
- Max: 7,499.99

The magnitude difference between mean and maximum values indicates a long-tailed distribution with premium-tier products materially skewing the dataset.

Freight Cost
- Range: 0.09 to 257,032.07

This extreme variability suggests:
- o Bulk shipment allocations
- o Vendor-level logistics concentration
- o Inconsistent freight distribution across purchase orders

Stock Turnover
- Range: 0 to 274.5

A turnover >1 indicates sales fulfillment from older inventory.
A turnover of 0 indicates capital fully immobilized in unsold stock.

This dispersion reflects uneven inventory efficiency across vendors.

3.2 Data Filtering for Analytical Integrity

To ensure reliability of margin and profitability analysis, the following records were removed:

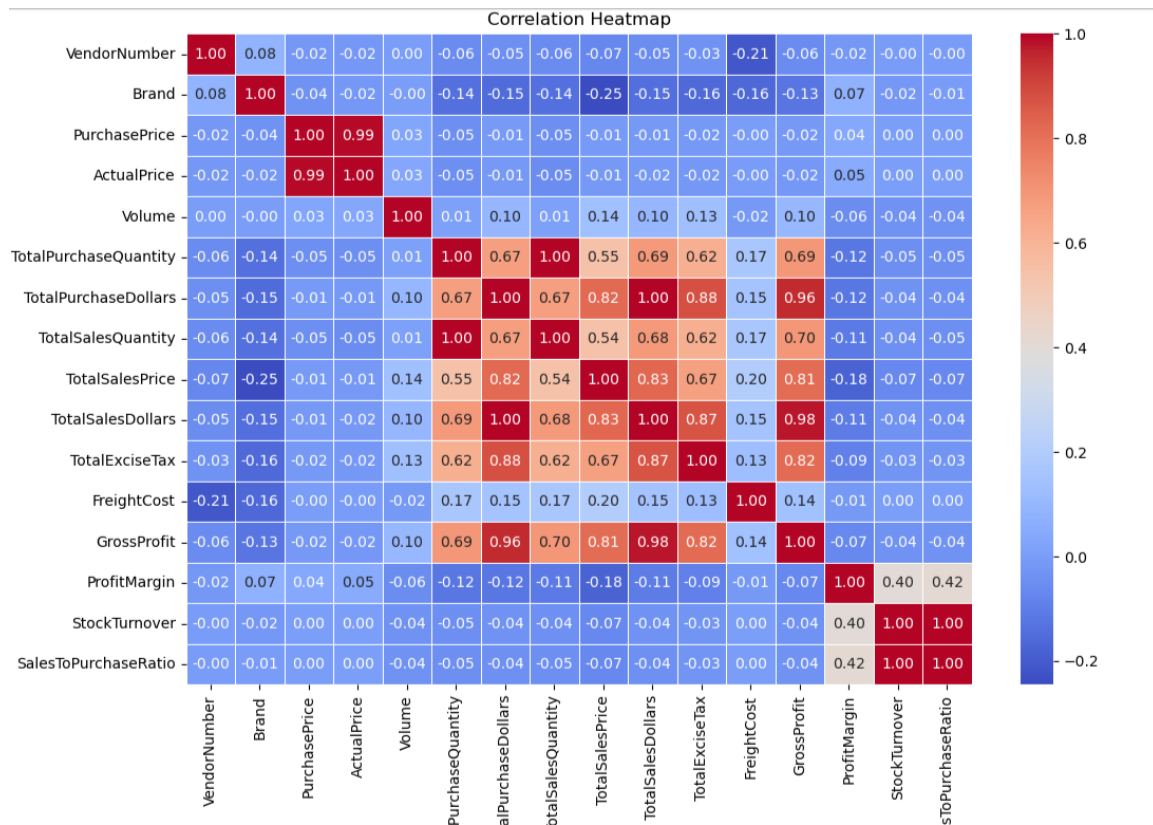Gross Profit ≤ 0
Profit Margin ≤ 0
Total Sales Quantity = 0

This filtering ensured:
- o Elimination of structurally loss-making distortions
- o Removal of infinite or undefined ratio values
- o Focus on economically viable transactions

The resulting dataset reflects operationally meaningful performance behavior.

3.3 Correlation Insights

A correlation matrix was constructed to evaluate linear relationships among pricing, cost, and performance variables.

Correlation Heatmap

Key findings:

Purchase Price vs Total Sales Revenue: Near-zero correlation

→ Unit cost variation does not materially influence revenue generation.

Purchase Price vs Gross Profit: Weak relationship

→ High cost does not guarantee high profitability.

Sales Price vs Profit Margin: Negative correlation

→ Increasing selling price does not proportionally increase margins.

This suggests cost pressures, discounting strategies, or vendor mix effects.

Purchase Quantity vs Sales Quantity: Strong positive correlation (~0.999)

→ Procurement aligns closely with demand volume.

Stock Turnover vs Profit Margin: Weak association

→ High movement does not necessarily imply high margin performance.

3.4 Analytical Interpretation

Revenue performance in this portfolio is primarily volume-driven rather than price-driven.

Margin dispersion is structurally influenced by:
- Vendor mix
- Procurement cost tiers
- Bulk pricing agreements
- Product positioning

These findings justified deeper investigation into:
- Vendor concentration
- Bulk purchasing leverage
- High-margin low-volume brands
- Capital exposure from unsold inventory

Correlation Heatmap Findings:
- Weak correlation between price variations and sales revenue.
- Negative correlation between sales price and profit margin.
- Strong alignment between purchase quantity and sales quantity.
- Inventory turnover does not automatically guarantee profitability.

4. Key Research Findings
Brands for Promotional or Pricing Adjustments
- Identified 198 'Target Brands' (bottom 15% of sales but top 85% of profit margins).
- These brands require promotional or strategic pricing adjustments.

------ 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 Sprklg 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'Estournel 10	558.87	69.434752

198 rows × 3 columns

Brands for Promotional or Pricing Readjustment
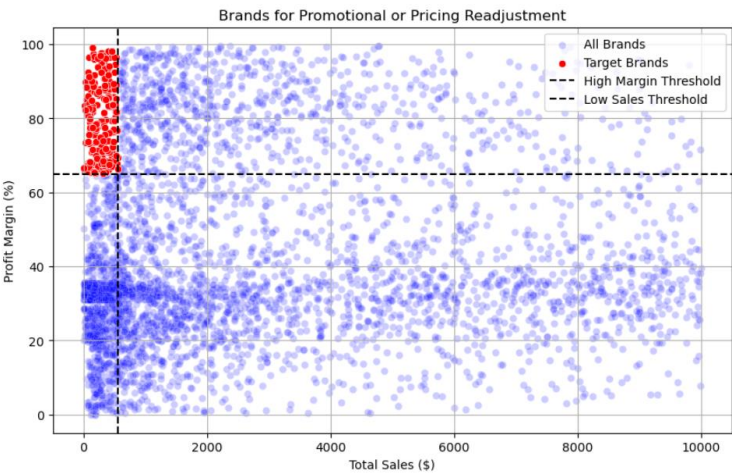
Top Vendors by Sales & Purchase Contribution

- Top 10 vendors contribute ~66% of total purchase volume.
- Indicates high supply chain concentration risk.

Top 10 Vendor's Purchase Contribution (%)

Other Vendors

34.3%

DIAGEO NORTH AMERICA INC   16.3%

Top 10 Total: 65.690000%

M S WALKER INC   3.2%

ULTRA BEVERAGE COMPANY LLP   3.6%

E & J GALLO WINERY   3.9%

BROWN-FORMAN CORP   4.3%

MARTIGNETTI COMPANIES   8.3%

CONSTELLATION BRANDS INC   5.0%

BACARDI USA INC   5.7%

PERNOD RICARD USA   7.8%

JIM BEAM BRANDS COMPANY   7.6%
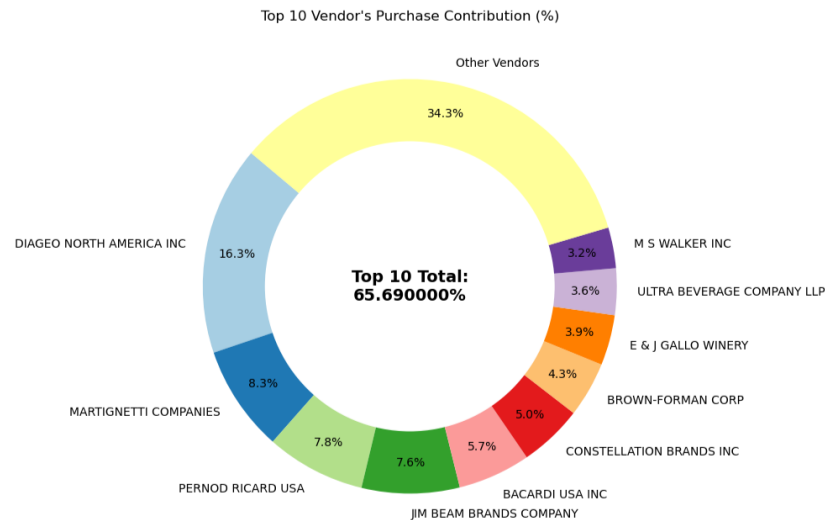
Impact of Bulk Purchasing on Cost Savings

- 72% reduction in unit cost when moving from small to large order sizes.
- Significant cost efficiency and margin improvement opportunity.

OrderSize	UnitPurchasePrice
Small	39.068186
Medium	15.486414
Large	10.777625

Identifying Vendors with Low Inventory Turnover

• $2.7 million currently locked in unsold inventory.
• Impacts liquidity and working capital efficiency.

	VendorName	UnsoldInventoryValue
25	DIAGEO NORTH AMERICA INC	722.21K
46	JIM BEAM BRANDS COMPANY	554.67K
68	PERNOD RICARD USA	470.63K
116	WILLIAM GRANT & SONS INC	401.96K
30	E & J GALLO WINERY	228.28K
79	SAZERAC CO INC	198.44K
11	BROWN-FORMAN CORP	177.73K
20	CONSTELLATION BRANDS INC	133.62K
61	MOET HENNESSY USA INC	126.48K
77	REMY COINTREAU USA INC	118.60K

Profit Margin Comparison: High vs. Low-Performing Vendors
Top Vendors' Profit Margin (95% CI): (30.74%, 31.61%), Mean: 31.17%
Low Vendors' Profit Margin (95% CI): (40.48%, 42.62%), Mean: 41.55%

Low-performing vendors operate at significantly higher margin levels despite generating lower sales volumes. This indicates a structural margin–volume imbalance within the vendor portfolio. High-performing vendors drive revenue scale but at thinner margins, whereas low-performing vendors maintain premium pricing but lack sales traction.

Actionable Insights
Top-performing vendors: Improve margin efficiency through cost optimization, selective pricing adjustments, and bundled offerings to enhance profitability without sacrificing volume.
Low-performing vendors: Strengthen demand generation through targeted marketing, improved distribution reach, and calibrated pricing strategies to convert margin strength into revenue growth.

Confidence Interval Comparison: Top vs Low Vendors (Profit Margin)
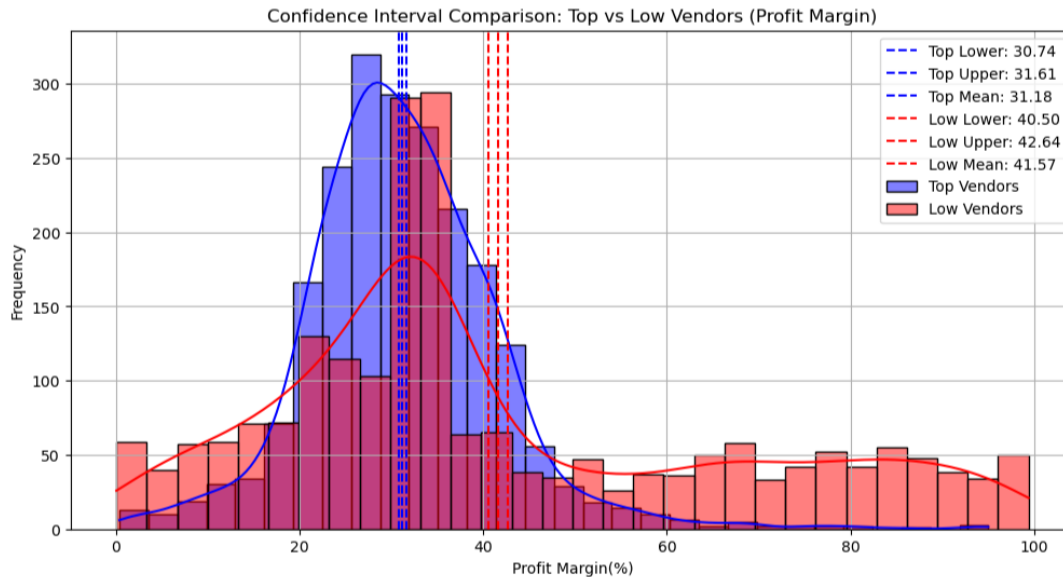
Statistical Validation of Profit Margin Differences: Hypothesis Testing

H_0 (Null Hypothesis): There is no statistically significant difference in mean profit margins between top- and low-performing vendors.

H_1 (Alternative Hypothesis): A statistically significant difference exists in mean profit margins between the two vendor groups.

Result: The null hypothesis is rejected. The margin differential between the two groups is statistically significant, indicating structurally distinct profitability behavior.

Interpretation

The two vendor segments operate under different economic models:
- High-volume vendors prioritize scale, operating at thinner margins.
- Low-volume vendors sustain higher margins, likely through premium pricing or niche positioning.

Strategic Implication

Margin expansion for top-selling vendors should focus on cost efficiency and procurement optimization.

Low-performing vendors should leverage their margin strength through targeted growth strategies to improve revenue contribution without diluting profitability.

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T-Statistics: -17.6695, P-Value: 0.0000
Reject H₀: There is a significant difference in Profit Margins between top and low performing vendors.
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6. Final Strategic Recommendations

Recalibrate Pricing for High-Margin, Low-Sales Brands

Re-evaluate pricing and promotional positioning of low-volume, high-margin brands to stimulate demand without materially compressing margins. Controlled pricing experiments and bundled offerings can improve volume conversion while preserving profitability.

Reduce Vendor Concentration Risk

Diversify procurement across a broader vendor base to reduce over-reliance on a limited group of suppliers. This will enhance negotiation leverage, improve resilience, and mitigate supply chain disruption risk.

Institutionalize Bulk Purchasing Strategy

Leverage demonstrated bulk-order cost advantages to structurally reduce unit costs. Align procurement planning with demand forecasts to capture margin gains without creating excess inventory exposure.

Optimize Slow-Moving Inventory

Adjust purchase quantities for low-turnover products, implement targeted clearance strategies, and rationalize warehouse allocation. This will accelerate inventory velocity and release locked working capital.

Strengthen Demand Generation for Low-Performing Vendors

Enhance marketing visibility, improve channel distribution, and refine pricing strategy for underperforming vendors with strong margin profiles. The objective is to convert margin strength into sustainable revenue growth.

By executing these actions, the organization can strengthen profitability, reduce operational risk, improve capital efficiency, and establish a more balanced margin–volume structure across its vendor portfolio.

Appendix: Power BI Dashboard

Vendor Performance Dashboard

441.41M	307.34M	134.07M	38.7	2.71M
Total Sales ($)	Total Purchase ($)	Gross Profit ($)	Profit Margin (%)	Unsold Capital ($)

Purchase Contribution %

- M S WALKER INC 3.2
- E & J GALLO WINERY 3.9
- BROWN-FORMAN C... 4.3
- CONSTELLATION B... 5.0
- BACARDI USA INC 5.7
- JIM BEAM BRANDS COMPANY 7.6
- PERNOD RICARD USA 7.8
- MARTIGNETTI COMPA... 8.3
- DIAGEO NORTH AMERICA INC 16.3

65.7 Top 10 Vendors Total Contribution %

Top Vendors By Sales

Vendor	Sales
DIAGEO NORT...	68M
MARTIGNETTI ...	39M
PERNOD RICA...	32M
JIM BEAM BRA...	31M
BACARDI USA ...	25M
CONSTELLATI...	24M
E & J GALLO ...	18M
BROWN-FOR...	18M
ULTRA BEVERA...	17M
M S WALKER I...	15M

Top Brands By Sales

Brand	Sales
Jack Daniels No 7...	8.0M
Tito's Handmade ...	7.4M
Grey Goose Vodka	7.2M
Capt Morgan Spi...	6.4M
Absolut 80 Proof	6.2M
Jameson Irish Wh...	5.7M
Ketel One Vodka	5.1M
Baileys Irish Cream	4.2M
Kahlua	3.6M
Tanqueray	3.5M

Low Performing Vendors

Vendor	Value
Dunn Wine Brok...	0.766
Circa Wines	0.756
PARK STREET IM...	0.751
HIGHLAND WIN...	0.708
ALISA CARR BEV...	0.615

Low Performing Brands

Legend: ◆ No ◆ Yes

(Scatter plot: Avg Profit Margin vs Total Sales)