

# Business Problem

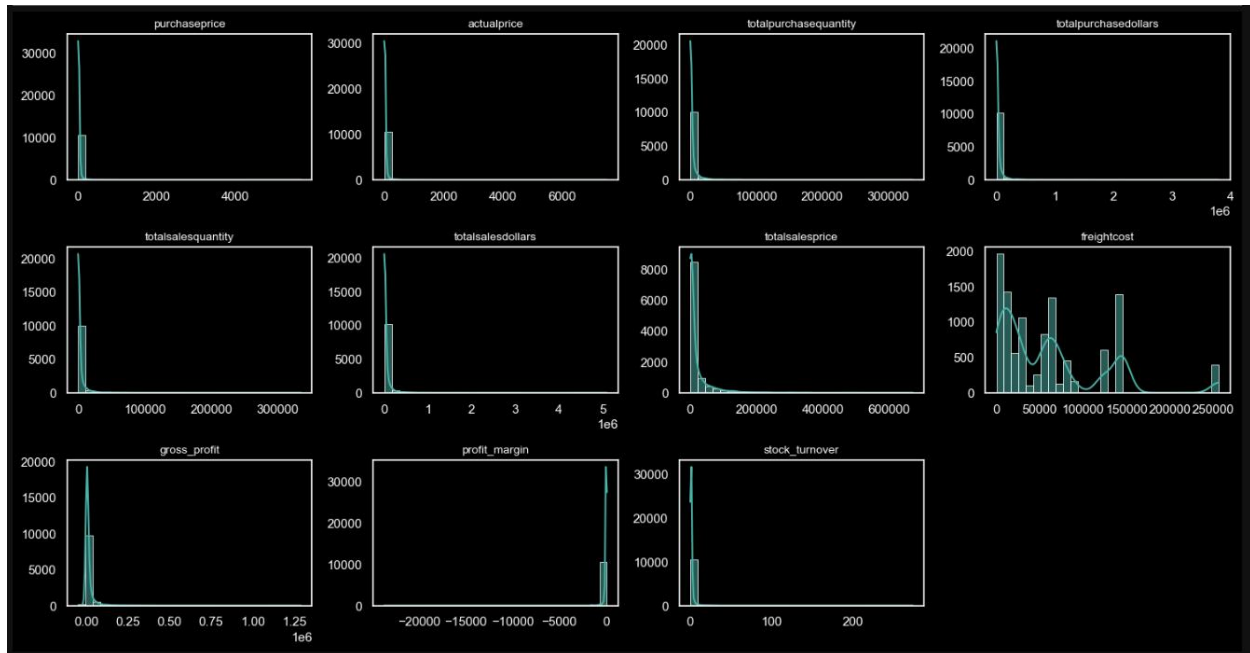
Effective inventory and sales management are critical for optimizing profitability in the retail and wholesale industry. Companies need to ensure that they are not incurring losses due to inefficient pricing, poor inventory turnover, or vendor dependency. The goal of this analysis is to:

- Identify underperforming brands that require promotional or pricing adjustments.
- Determine top vendors contributing to sales and gross profit.
- Analyze the impact of bulk purchasing on unit costs.
- Assess inventory turnover to reduce holding costs and improve efficiency.
- Investigate the profitability variance between high-performing and low-performing vendors.

## Exploratory Data Analysis Insights

### Summary Statistics

	count	mean	std	min	25%	50%	75%	max
vendornumber	10692.0	10650.649458	18753.519148	2.000000	3951.000000	7153.000000	9552.000000	2.013590e+05
brand	10692.0	18039.228769	12662.187074	58.000000	5793.500000	18761.500000	25514.250000	9.063100e+04
purchaseprice	10692.0	24.385303	109.269375	0.360000	6.840000	10.455000	19.482500	5.681810e+03
actualprice	10692.0	35.643671	148.246016	0.490000	10.990000	15.990000	28.990000	7.499990e+03
volume	10692.0	847.360550	664.309212	50.000000	750.000000	750.000000	750.000000	2.000000e+04
totalpurchasequantity	10692.0	3140.886831	11095.086769	1.000000	36.000000	262.000000	1975.750000	3.376600e+05
totalpurchasedollars	10692.0	30106.693372	123067.799627	0.710000	453.457500	3655.465000	20738.245000	3.811252e+06
totalsalesquantity	10692.0	3077.482136	10952.851391	0.000000	33.000000	261.000000	1929.250000	3.349390e+05
totalsalesdollars	10692.0	42239.074419	167655.265984	0.000000	729.220000	5298.045000	28396.915000	5.101920e+06
totalsalesprice	10692.0	18793.783627	44952.773386	0.000000	289.710000	2857.800000	16059.562500	6.728193e+05
totalexcisetax	10692.0	1774.226259	10975.582240	0.000000	4.800000	46.570000	418.650000	3.682428e+05
freightcost	10692.0	61433.763214	60938.458032	0.090000	14069.870000	50293.620000	79528.990000	2.570321e+05
gross_profit	10692.0	12132.381048	46224.337964	-52002.780000	52.920000	1399.640000	8660.200000	1.290668e+06
profit_margin	10692.0	-15.620770	443.555329	-23730.638953	13.324515	30.405457	39.956135	9.971666e+01
stock_turnover	10692.0	1.706793	6.020460	0.000000	0.807229	0.981529	1.039342	2.745000e+02
sales_to_purchase_ratio	10692.0	2.504390	8.459067	0.000000	1.153729	1.436894	1.665449	3.529286e+02



## Summary Statistics Insights

### 📊 Value Distribution & Outliers

- Most numeric features (sales, purchase, profit) are **right-skewed**, with a high concentration of values near the lower end.
- **Boxplots revealed extreme outliers** in almost all key columns except freightcost, which appears tightly distributed.
- profit\_margin includes **real and deep losses**, likely caused by heavy discounts or unsold inventory.

### ⚠️ Negative or Zero Values

- gross\_profit has values as low as **-52002.78**, indicating **loss-making transactions** — possibly due to high costs or clearance sales.
- profit\_margin has extreme negatives, even approaching **-infinity** in some rows, suggesting sales below cost or zero revenue.
- totalsalesquantity and totalsalesdollars have **0 as minimum**, meaning certain vendors made no sales — could be inactive, new, or seasonal vendors.

### 📦 Freight Cost Behavior

- freightcost stands out for **its stable distribution**.
- Histogram shows **distinct spikes**, likely due to system-defined slabs (e.g., ₹25K, ₹50K).
- This should be considered while analyzing vendor profitability — high freight can reduce margin.

## Pricing Observations

- purchaseprice and actualprice show a large difference between **max and mean**, indicating some **premium or irregularly priced items**.
- Most prices are low, but a few extremely high-priced items pull the mean up.

## Stock Turnover

- Very wide range: from **0 to 274.5**
- High turnover means the item sells faster than it's purchased — possible stock depletion or fulfillment from older stock.

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## Data Filtering Strategy for Vendor Performance Analysis

Before diving deeper into KPIs and visualizations, we apply a targeted filter to clean and focus our dataset.

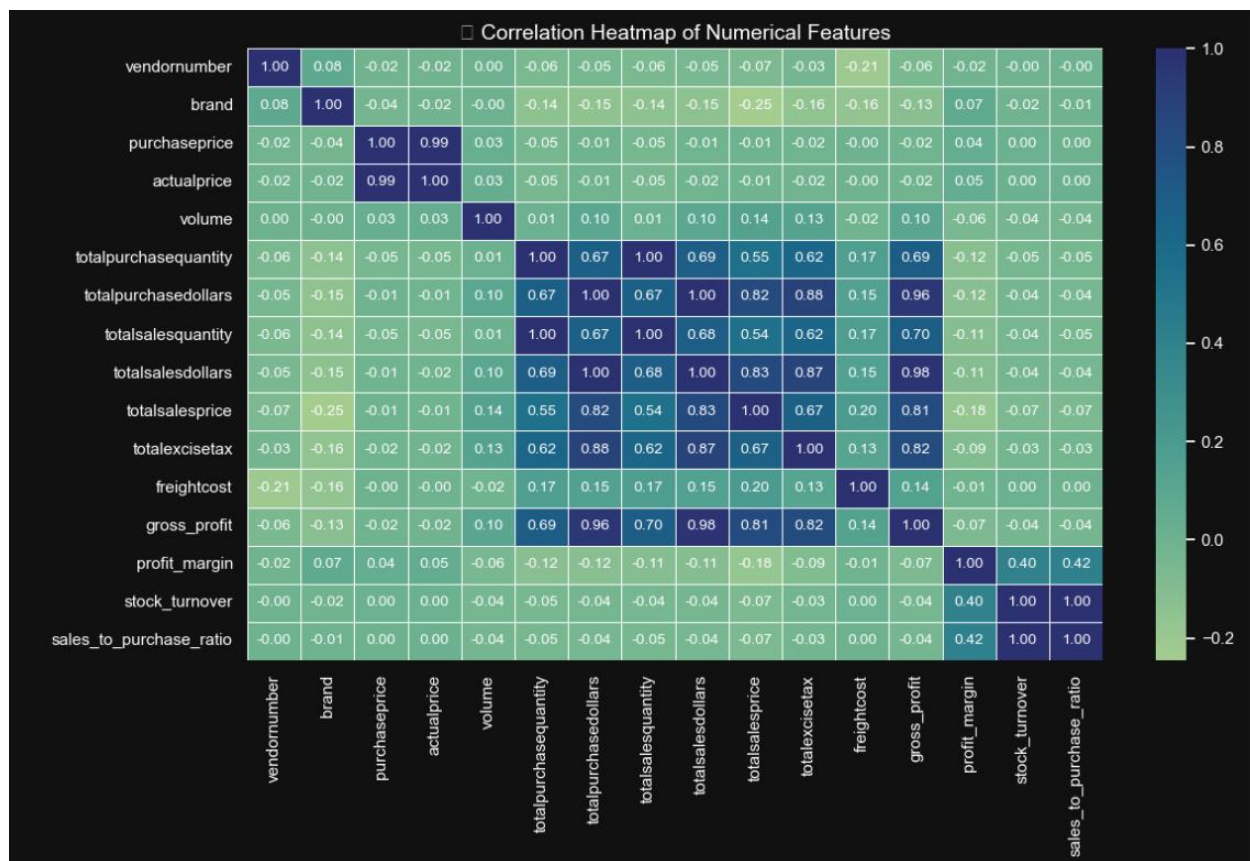
### Why This Filtering?

- We aim to analyze vendors **who are actively generating sales and contributing to profit**.
- Records with **zero sales quantity** indicate **inactive or non-performing products/vendors**, which are irrelevant for performance ranking.
- **Negative GrossProfit or ProfitMargin** imply **loss-making transactions** — depending on analysis goals, we may:
  - ☒ Include them to highlight poor performance
  - ☒ Exclude them if focusing only on **top-performing vendors**

In this notebook, we focus on **top-performing vendors**, so we exclude:

- Records with TotalSalesQuantity = 0
- Loss-making records where GrossProfit <= 0 or ProfitMargin <= 0

## Correlation Insights



## Correlation Insights

- purchaseprice shows very weak negative correlations with both totalsalesdollars (-0.012) and gross\_profit (-0.016), indicating that changes in purchase cost have little impact on revenue or profit.

- totalpurchasequantity and totalsalesquantity have an extremely strong positive correlation (0.999), suggesting a tightly aligned purchasing and sales cycle — a sign of efficient inventory management.
- totalsalesprice shows a moderate negative correlation with profit\_margin (-0.179), implying that higher sales prices may be associated with lower margins — possibly due to discounting, promotions, or competitive pricing strategies.
- stock\_turnover has a weak negative correlation with both gross\_profit (-0.038) and profit\_margin (-0.055), suggesting that faster inventory movement does not always translate to higher profitability.

## Research Questions & Key Findings

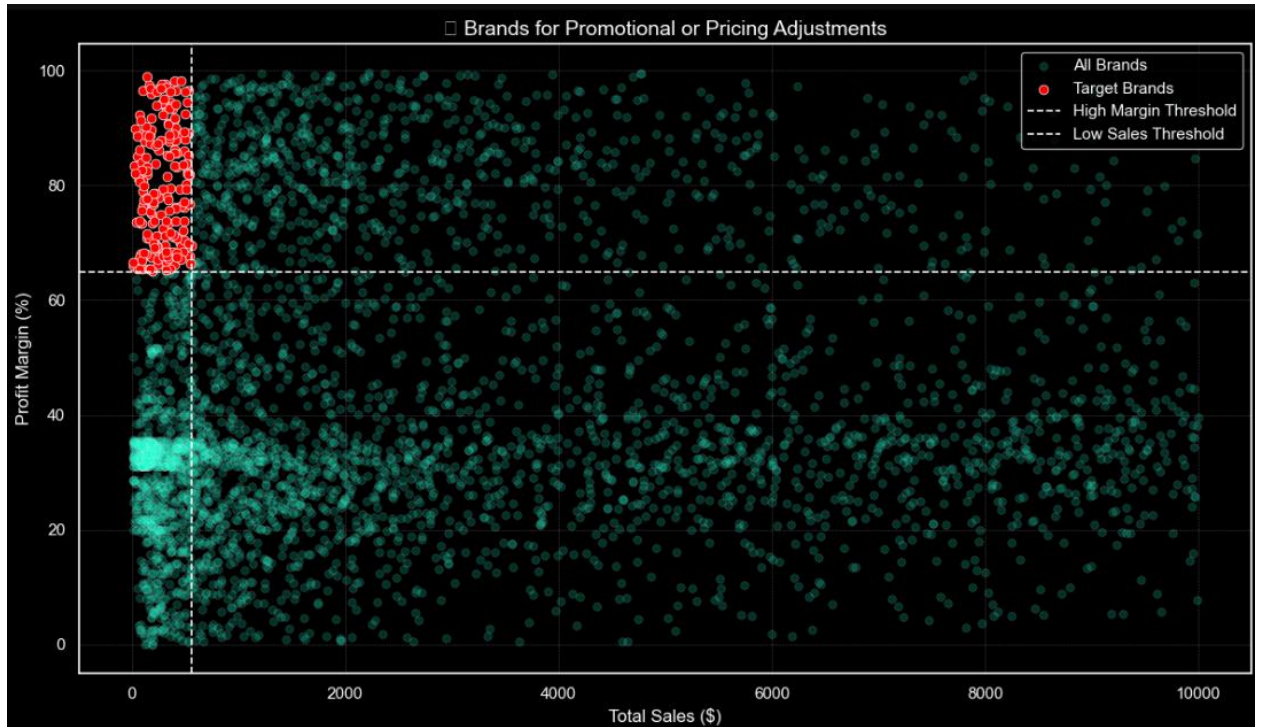
### 1. Brands for Promotional or Pricing Adjustments

	description	totalsalesdollars	profit_margin
5485	Pepperjack Barossa Red	191.92	0.020842
2954	Flint & Steel Svgn Bl Napa V	119.92	0.033356
2179	Croft Tawny Porto	191.84	0.041701
2561	Douglass Hill Merlot	143.76	0.083472
5385	Parducci 13 True Grit Chard	24927.81	0.121190
...	...	...	...
4568	M Chiarlo Gavi Wh	1208.90	99.393664
657	Beniotome Sesame Shochu	4768.41	99.534226
6449	Skinnygirl Tangerine Vodka	2368.42	99.544844
2411	DiSaronno Amaretto	4781.16	99.553246
5528	Pezzi King Svgn Bl Dry Creek	2221.29	99.604734

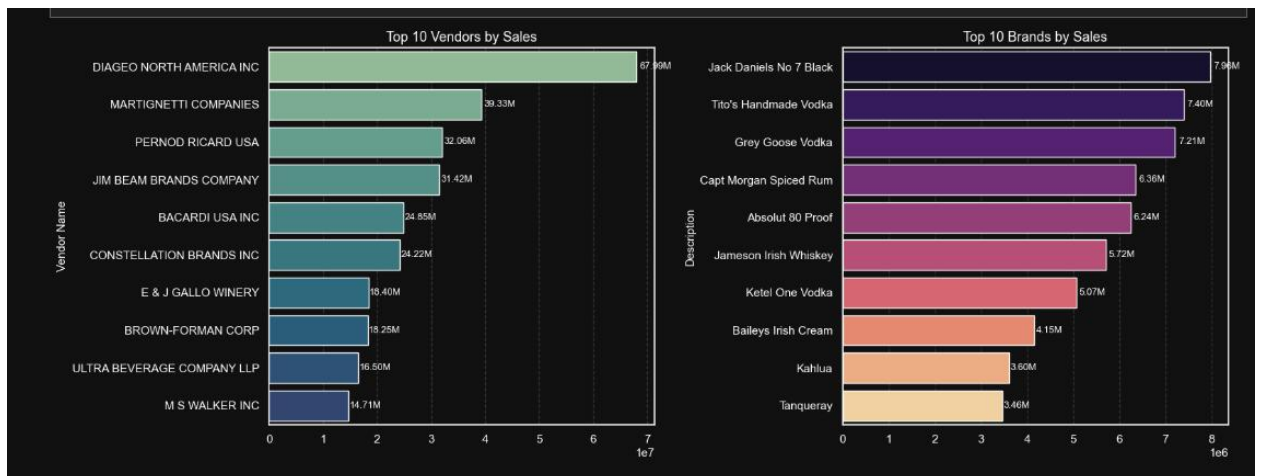
198 brands exhibit lower sales but higher profit margins, which could benefit from targeted marketing, promotions, or price optimizations to



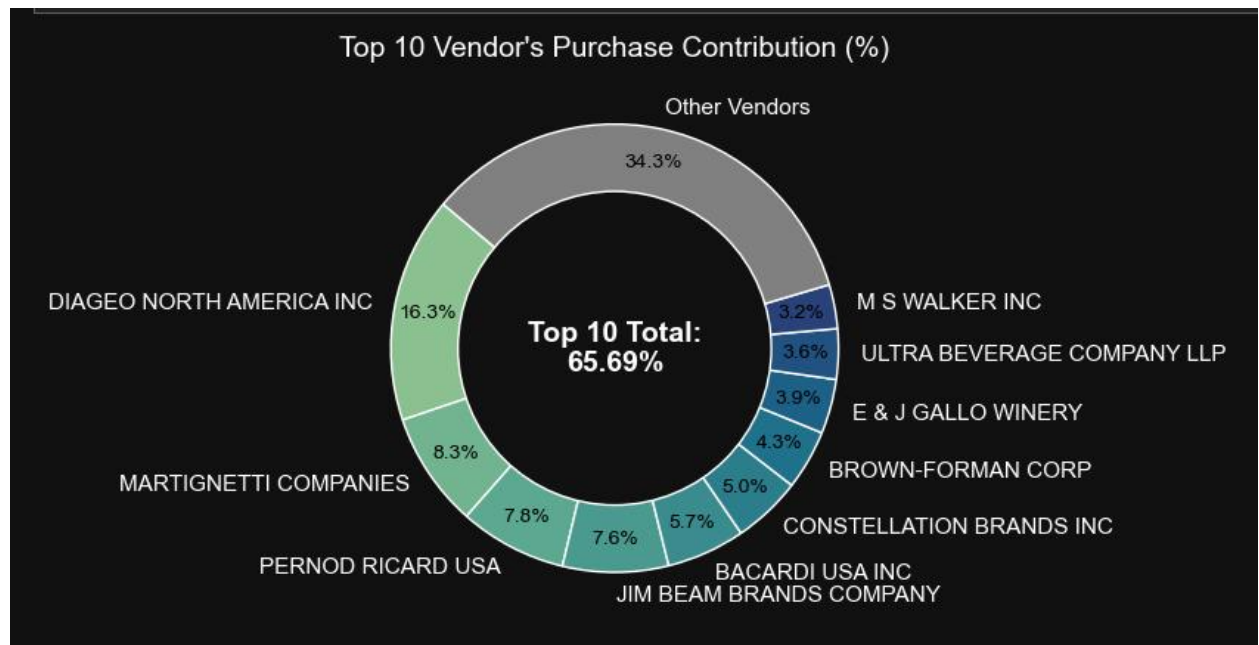
increase volume without compromising profitability.



## 2. Which vendors and brands demonstrate the highest sales performance?



### 3.Top Vendors by Sales & Purchase Contribution



#### Vendor Contribution Analysis

- The **top 10 vendors** contribute a substantial **65.69%** of total purchase dollars.
- The **remaining vendors** account for only **34.31%**, suggesting they may be underutilized or less competitive in terms of pricing, reliability, or product mix.

#### Recommendations

- Strengthen relationships with top-performing vendors through strategic partnerships or bulk deals to maintain procurement efficiency.
- However, a **65%+ dependency on a few vendors** poses a supply chain risk.
- Evaluate and activate underutilized vendors or consider onboarding new suppliers to improve competitiveness and reduce over-reliance.

## 4.Impact of Bulk Purchasing on Cost Savings

Vendors making **large purchases** (Large Order Size) pay the **lowest unit price** (around **\$10.78 per unit**), indicating potential for higher profit margins if inventory is managed well.

There's a significant **unit cost difference** between Small and Large orders — nearly **72% reduction**, highlighting the impact of bulk deals.

This confirms that **bulk pricing strategies are effective** in encouraging larger orders, which boosts total sales volume even if per-unit revenue decreases.

💡 Average Unit Purchase Price by Purchase Volume Group:

	<code>purchase_volume_group</code>	<code>unit_purchase_price</code>
0	Low Volume	39.07
1	Medium Volume	15.49
2	High Volume	10.78

## 5. Identifying Vendors with Low Inventory Turnover

Total Unsold Inventory Capital: \$2.71M

Slow-moving inventory increases storage costs, reduces cash flow efficiency, and affects overall profitability.

Identifying vendors with low inventory turnover enables better stock management, minimizing financial strain.



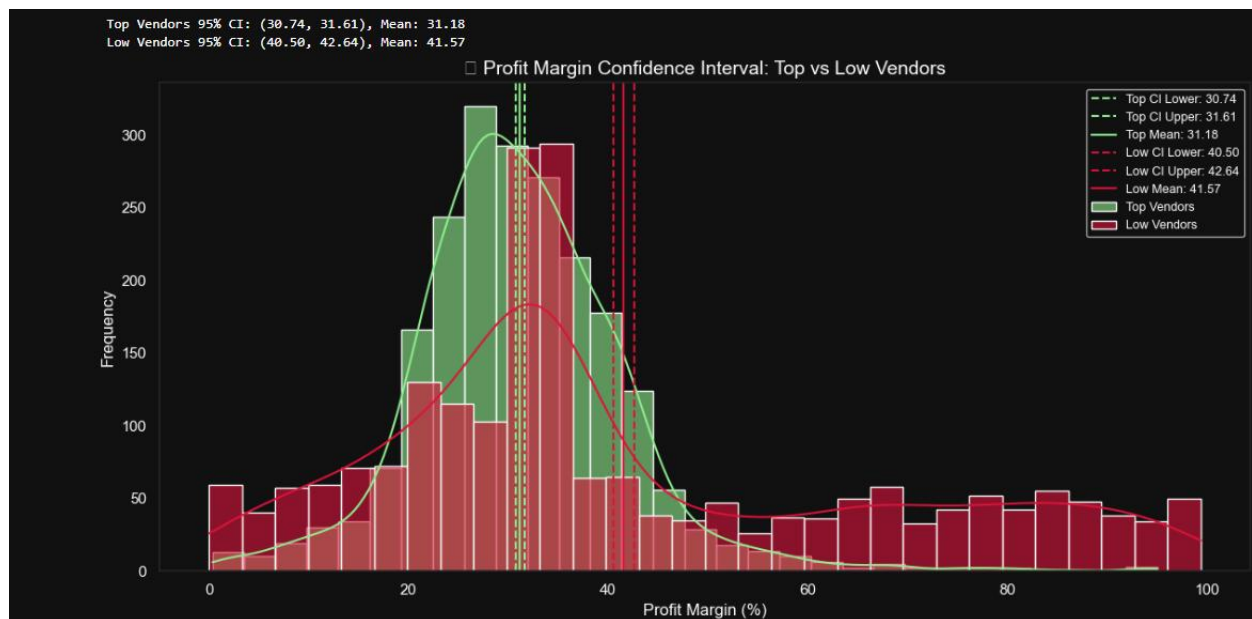
	vendorname	stock_turnover
0	ALISA CARR BEVERAGES	0.615385
36	HIGHLAND WINE MERCHANTS LLC	0.708333
60	PARK STREET IMPORTS LLC	0.751306
19	Circa Wines	0.755676
26	Dunn Wine Brokers	0.766022
15	CENTEUR IMPORTS LLC	0.773953
78	SMOKY QUARTZ DISTILLERY LLC	0.783835
90	TAMWORTH DISTILLING	0.797078
91	THE IMPORTED GRAPE LLC	0.807569
101	WALPOLE MTN VIEW WINERY	0.820548

## 6. Profit Margin vs Vendor Performance

- The **confidence interval** for low-performing vendors (**40.48% to 42.62%**) is significantly higher than that of top-performing vendors (**30.74% to 31.61%**).
- This suggests that vendors with **lower sales tend to maintain higher profit margins**, potentially due to premium pricing or lower operational costs.

### Strategic Recommendations:

- **For High-Performing Vendors:**  
Explore selective price adjustments, cost optimization, or bundling strategies to improve profitability.
- **For Low-Performing Vendors:**  
Despite higher margins, their low sales volume might indicate a need for better marketing, competitive pricing, or improved distribution strategies.



## 7. Statistical Validation of Profit Margin Differences

### Hypothesis Testing:

$H_0$  (Null Hypothesis): No significant difference in profit margins between top and low-performing vendors.

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

**Result:** The null hypothesis is rejected, confirming that the two groups operate under distinctly different profitability models.

### 💡 Implication

High-margin vendors could benefit from **refined pricing strategies**, while top-selling vendors should focus on **improving cost efficiency**.

### ☑ Final Recommendations

- **Reassess pricing** for low-sales, high-margin brands to increase sales volume without compromising profitability.
- **Diversify vendor relationships** to reduce reliance on a few suppliers and minimize supply chain risks.
- **Capitalize on bulk purchasing** to sustain competitive pricing while optimizing inventory management.

- **Address slow-moving inventory** by adjusting order quantities, running clearance promotions, or revising storage practices.
- **Boost marketing and distribution efforts** for low-performing vendors to drive sales growth while maintaining profit margins.

By applying these strategies, the company can ensure **sustainable profitability**, minimize operational risks, and enhance overall efficiency.