WALRUS Data Analysis: Optimization Strategies

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Outline

- Introduction
- Exploratory Data Analysis
- Artist Performance
- Hypothesis Testing
- Optimization Strategies
- Recommendations
- Conclusion
- Appendix

Introduction

Welcome to an exploration of data-driven strategies to optimize WALRUS’s business operations in the art gallery industry. In this presentation, we delve into comprehensive data analyses, hypothesis testing, and strategic recommendations tailored to enhance performance and profitability.

The objective is to explore WALRUS's sales data (2021-2023) for targeted optimizations and to find actionable insights to drive strategic decisions for enhanced performance.

EXPLORATORY DATA ANALYSIS

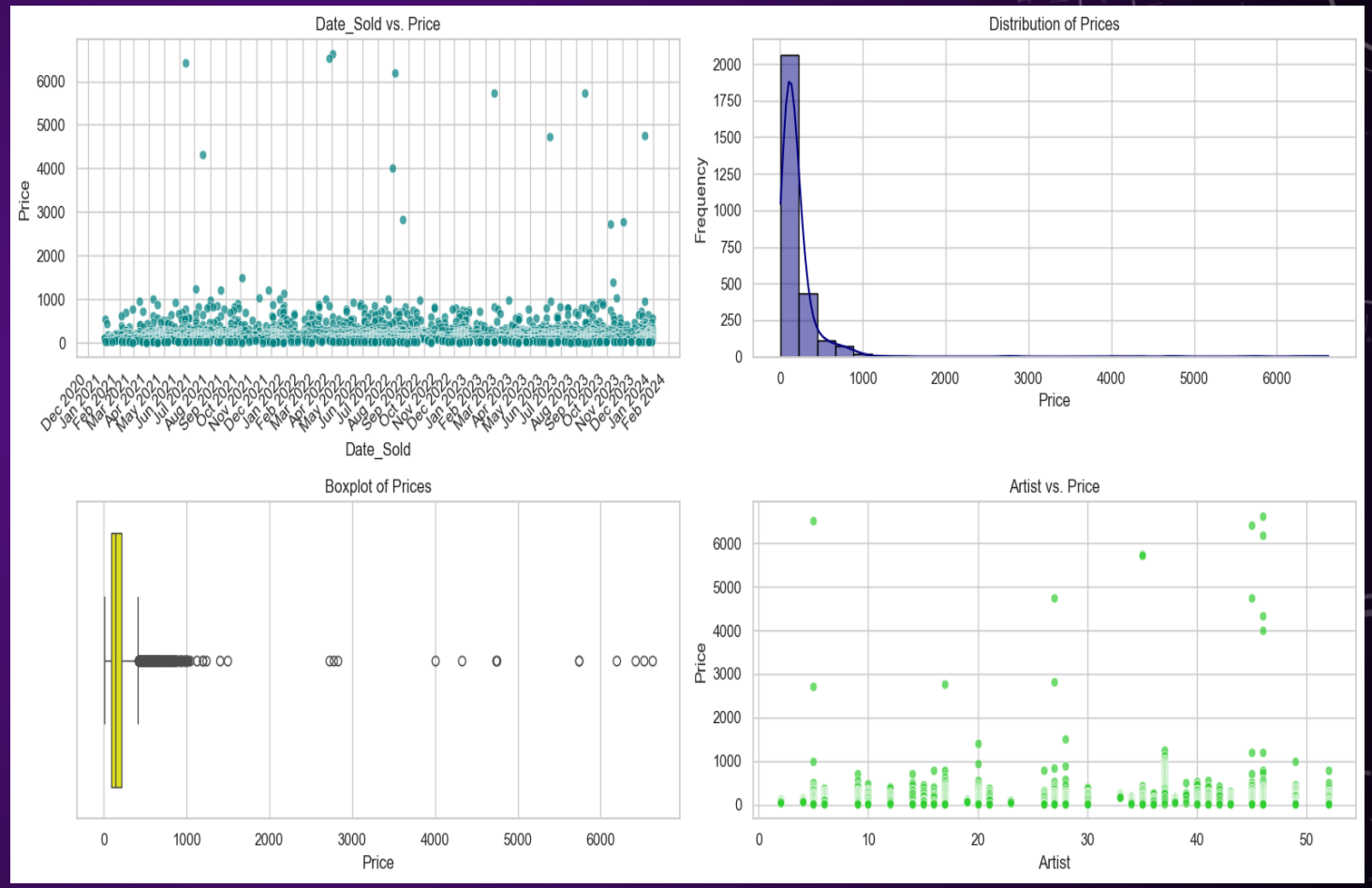
DATA OVERVIEW

Dataset Snapshot

- **Source:** WALRUS Art Gallery
- **Period Covered:** 2021-2023
- **Key Features:** Date of sale, artist details, pricing, intake dates, unique artwork IDs.

Exploratory Data Analysis (EDA)

- **Rows and Columns:** 2721 rows, 5 columns
- **Data Types:** Dates, integers

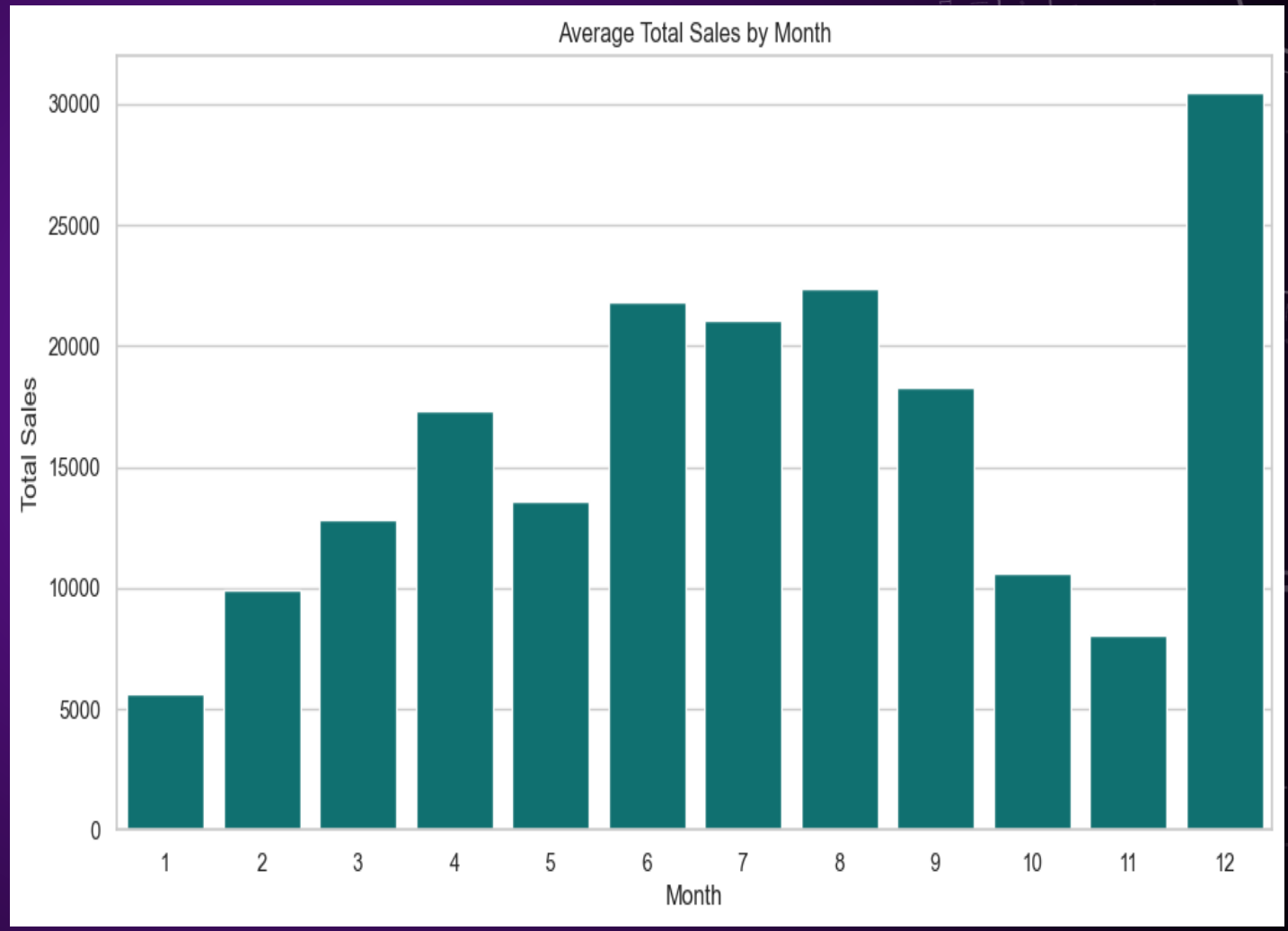


MONTHLY SALES ANALYSIS

Key Insights:

- Highest priced items sold in February and June.
- December has the highest count of sales.
- A slight upward trend in sales from April to August.

Higher sales in certain months may align with art events or promotions. The December spikes likely correspond to holiday shopping.

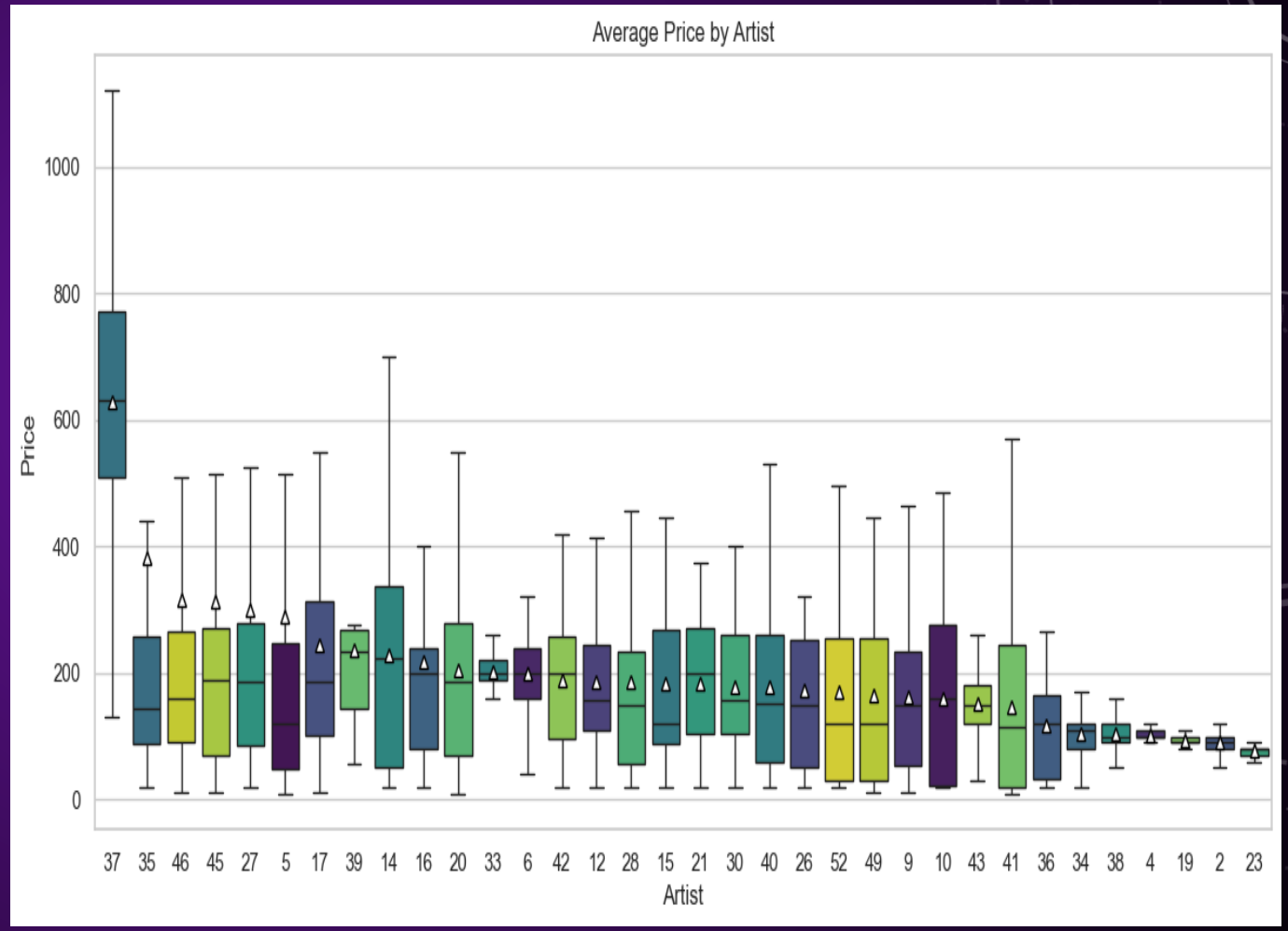


ARTIST PERFORMANCE

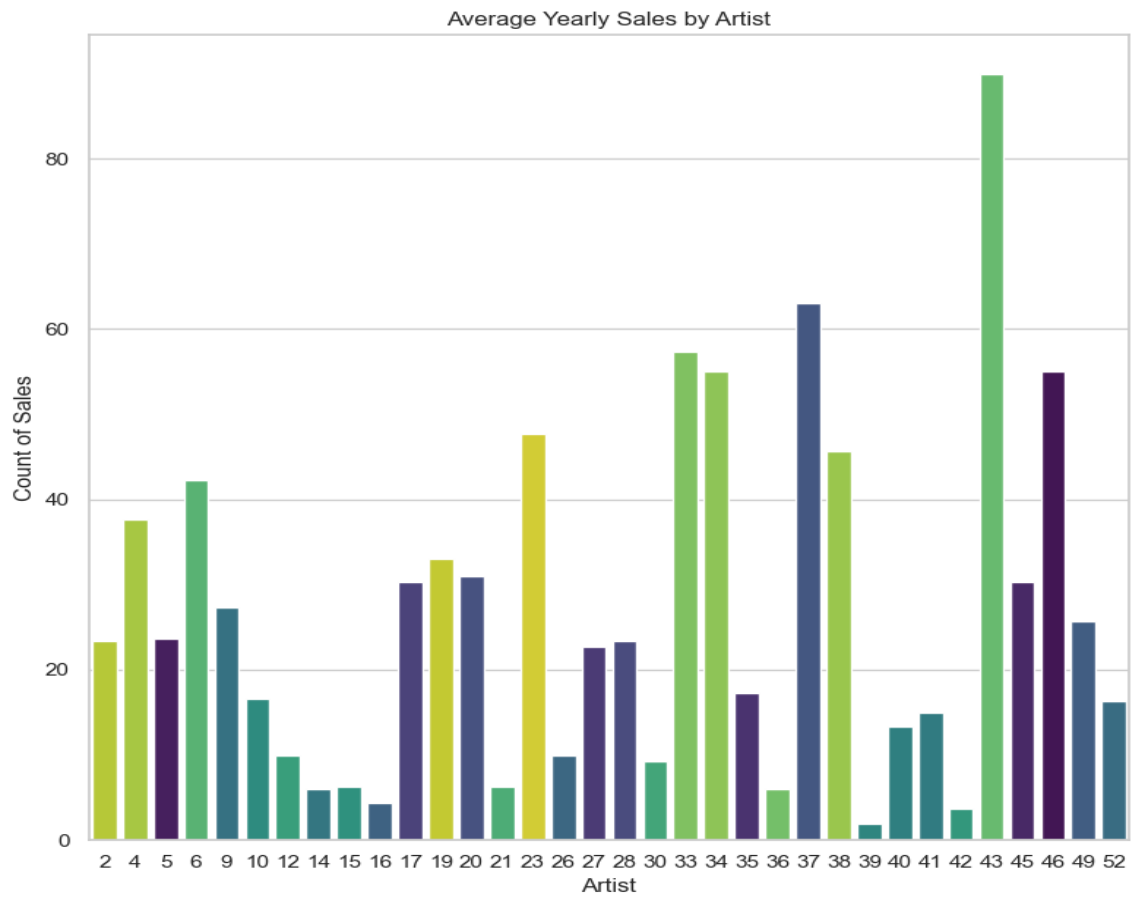
ARTIST PRICES ANALYSIS

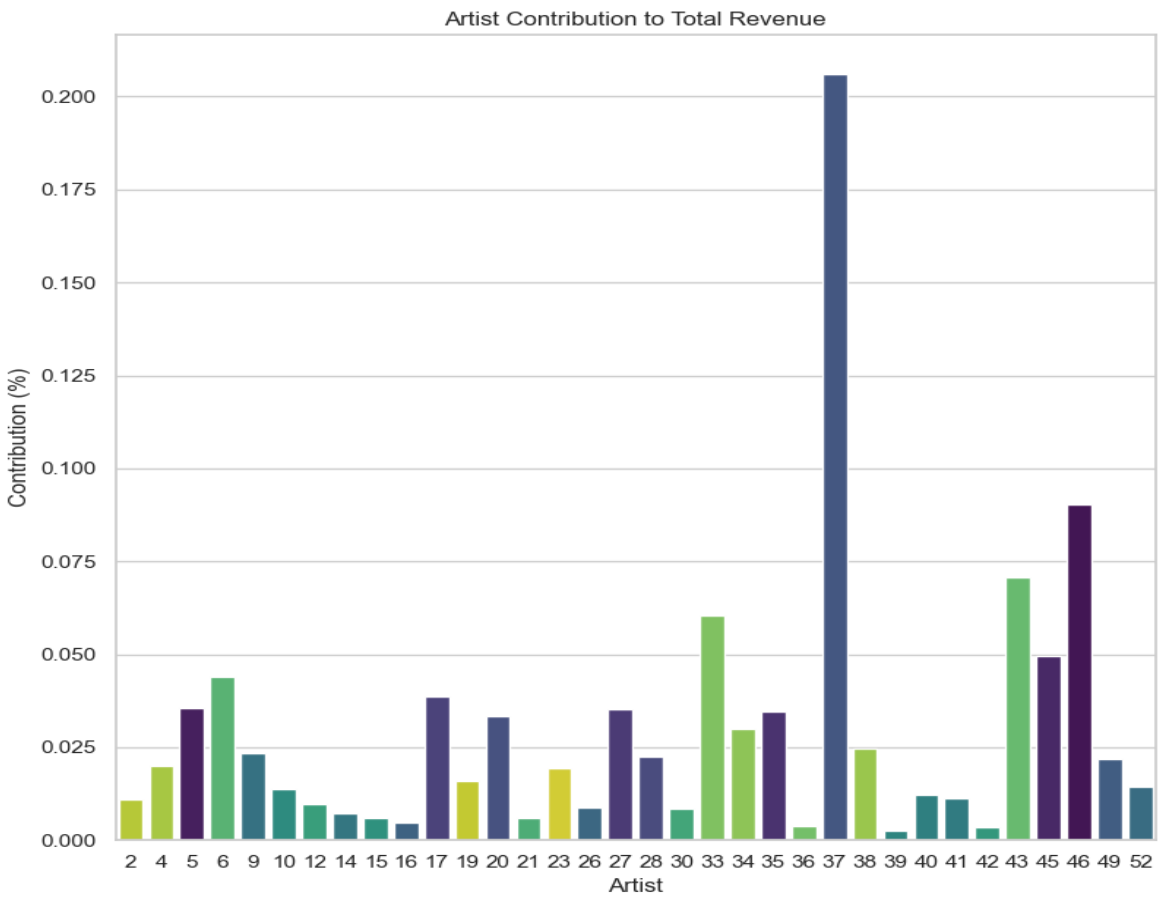
Some artists appear to focus on lower-priced artworks, while others have a more diverse range.

37 stands out with the highest inner quartile but also one of the largest range of prices.



ARTISTS YEARLY SALES AND PROFIT CONTRIBUTIONS





43 is the top-selling artist but not the top contributor to overall revenue.

Artist 37 continues to emerge as a powerhouse, driving substantial revenue.

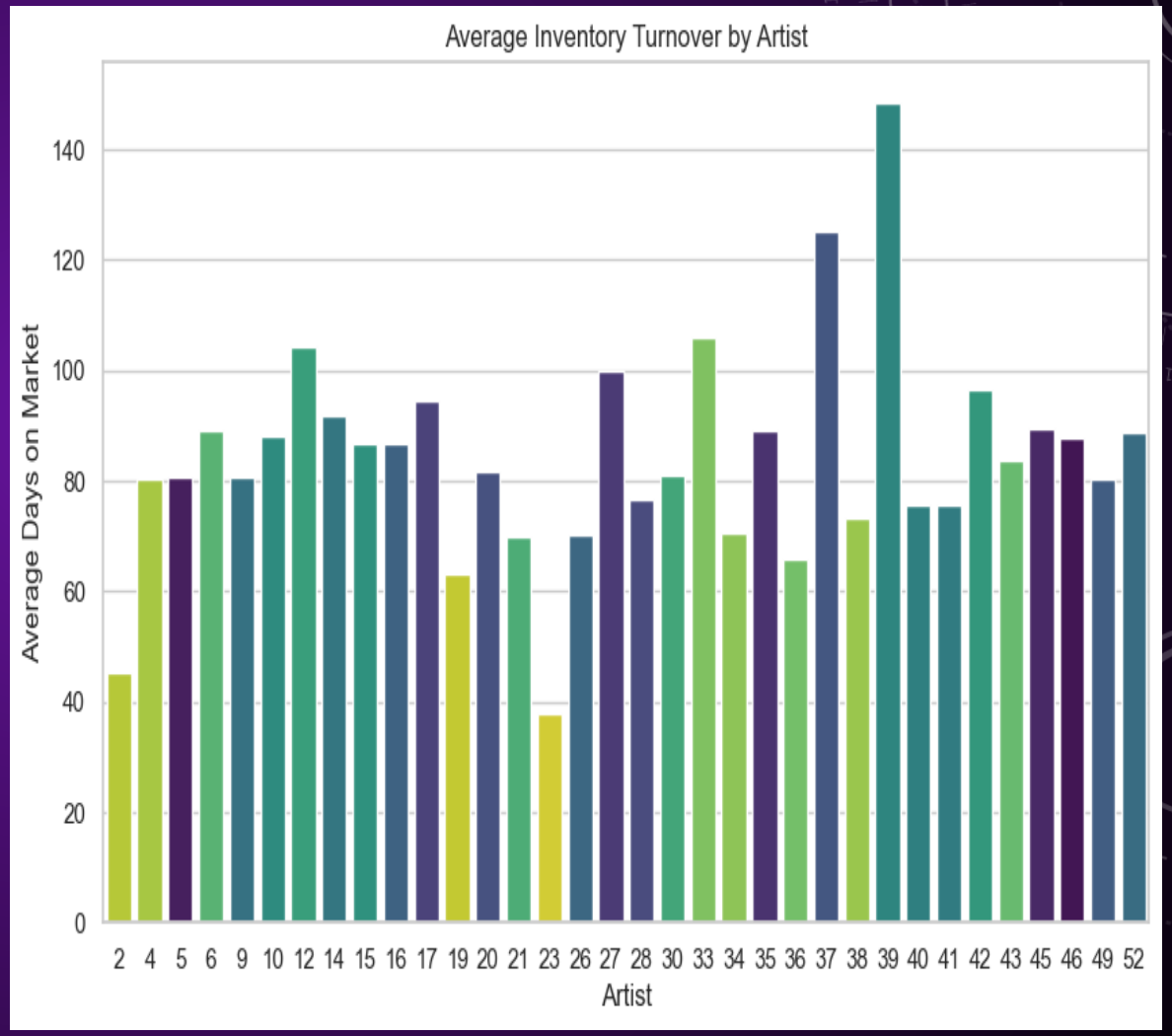
TURNOVER FOR ARTISTS

Shorter Days on Market:

Artists with a lower average number of days on the market, such as Artist 2, demonstrate quicker inventory turnover. This may indicate a higher demand for their artworks or effective pricing strategies.

Longer Days on Market:

Artists with a higher average number of days on the market, like Artist 39, may have a slower inventory turnover. This could be influenced by factors such as price or demand.



HYPOTHESIS TESTING FOR KEY BUSINESS METRICS

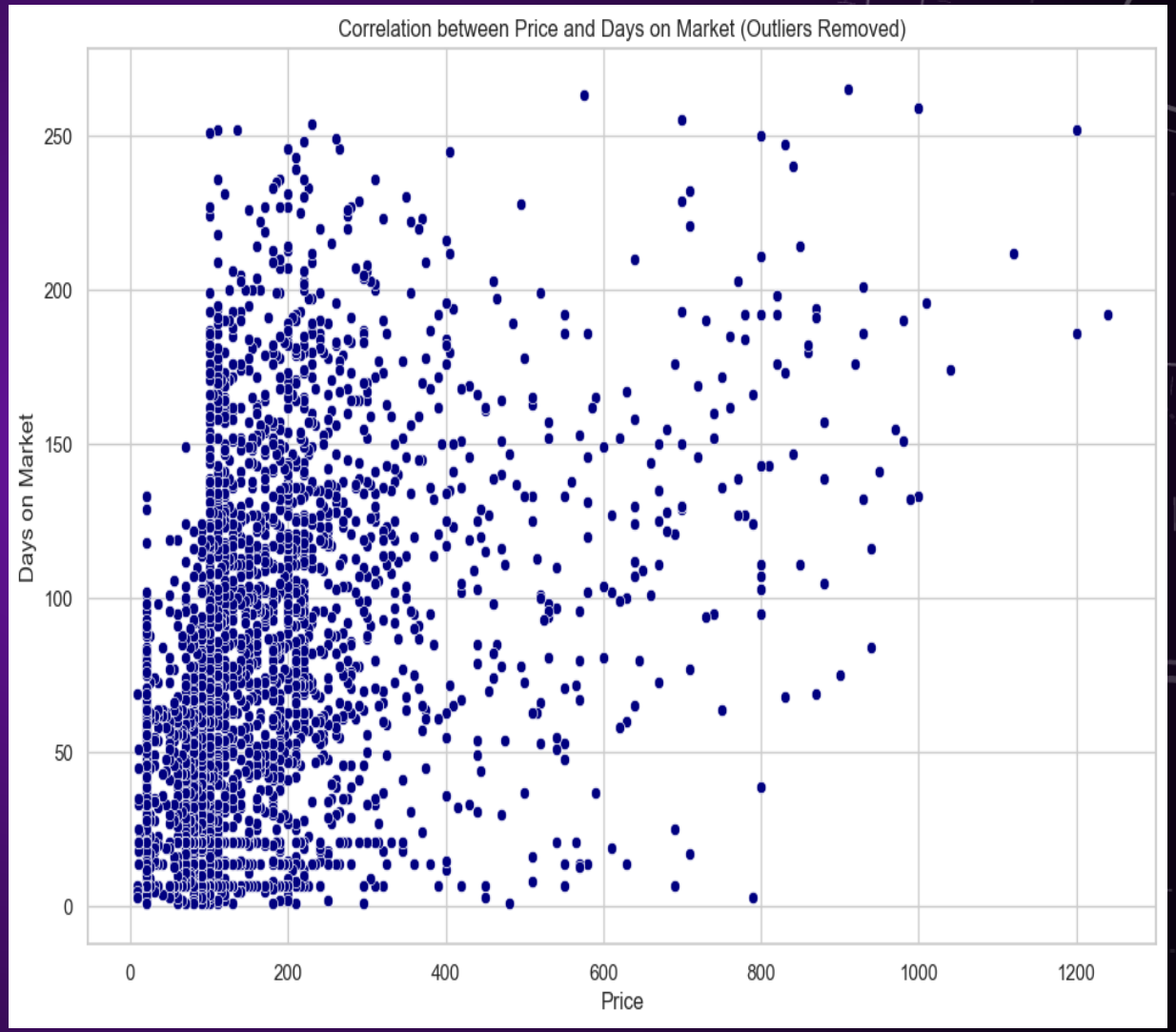
DAYS ON MARKET VS. PRICE

Null Hypothesis (H_0):

There is no significant correlation between the price of artworks and the days they spend on the market.

Alternative Hypothesis (H_1):

There is a significant correlation between the price of artworks and the days they spend on the market.



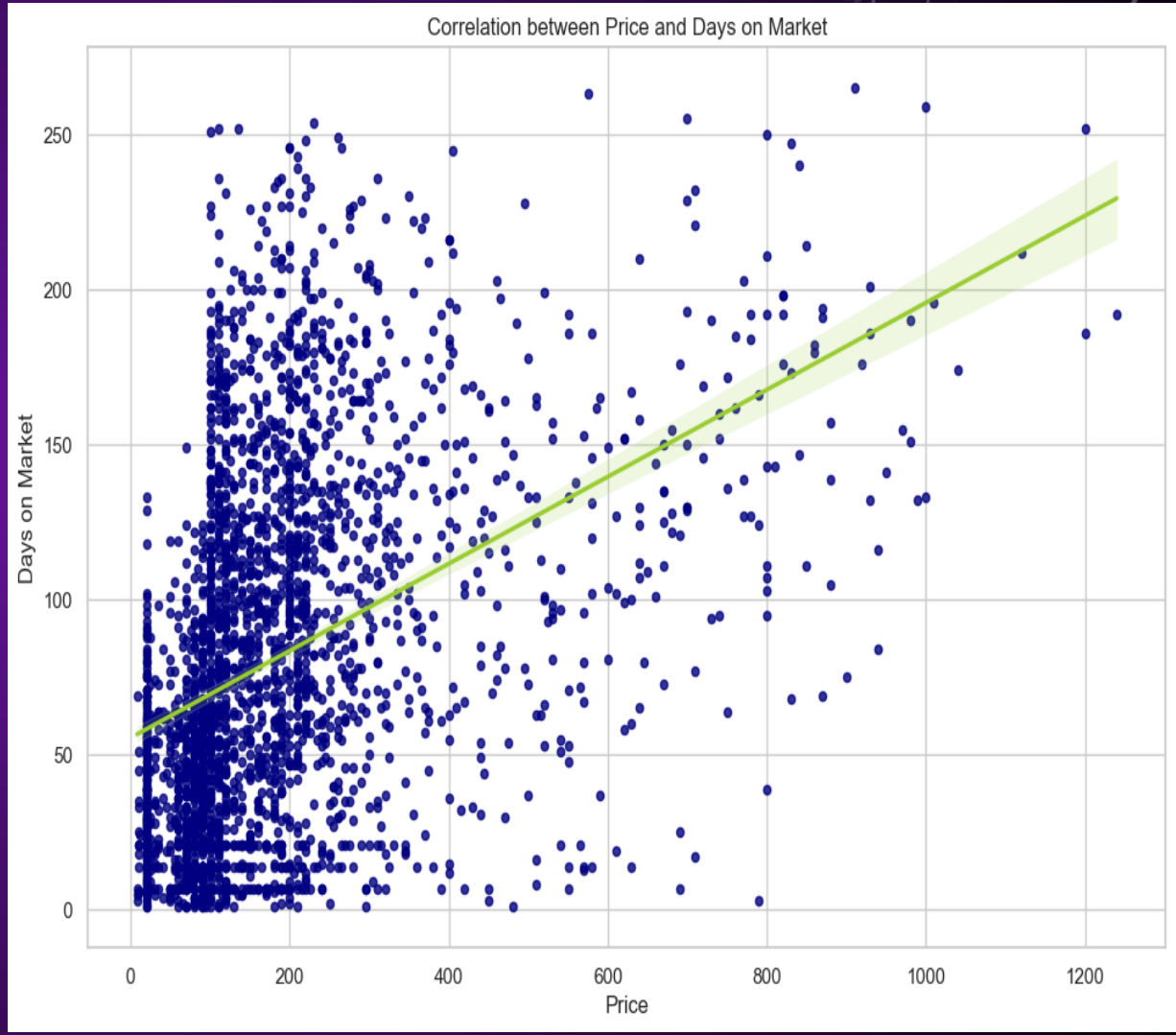
DAYS ON MARKET VS. PRICE

Correlation: 0.35

p-value: 3.46e-86

The extremely low p-value suggests strong evidence to reject the null hypothesis.

- Higher-priced artworks take longer to sell.



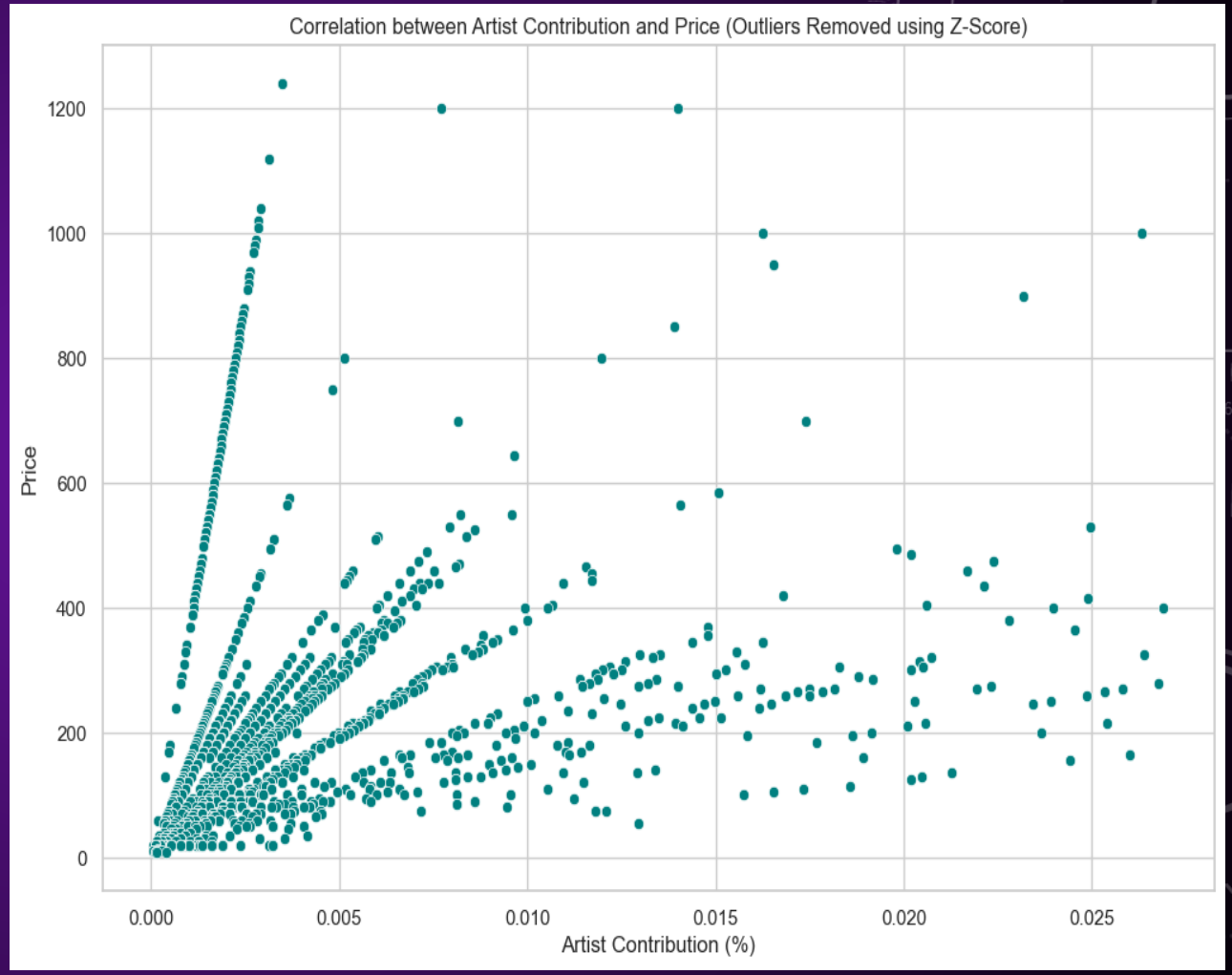
ARTIST CONTRIBUTION VS. PRICE

Null Hypothesis (H_0):

The price of an artwork does not significantly impact the artist's contribution percentage.

Alternative Hypothesis (H_1):

The price of an artwork significantly influences the artist's contribution percentage.



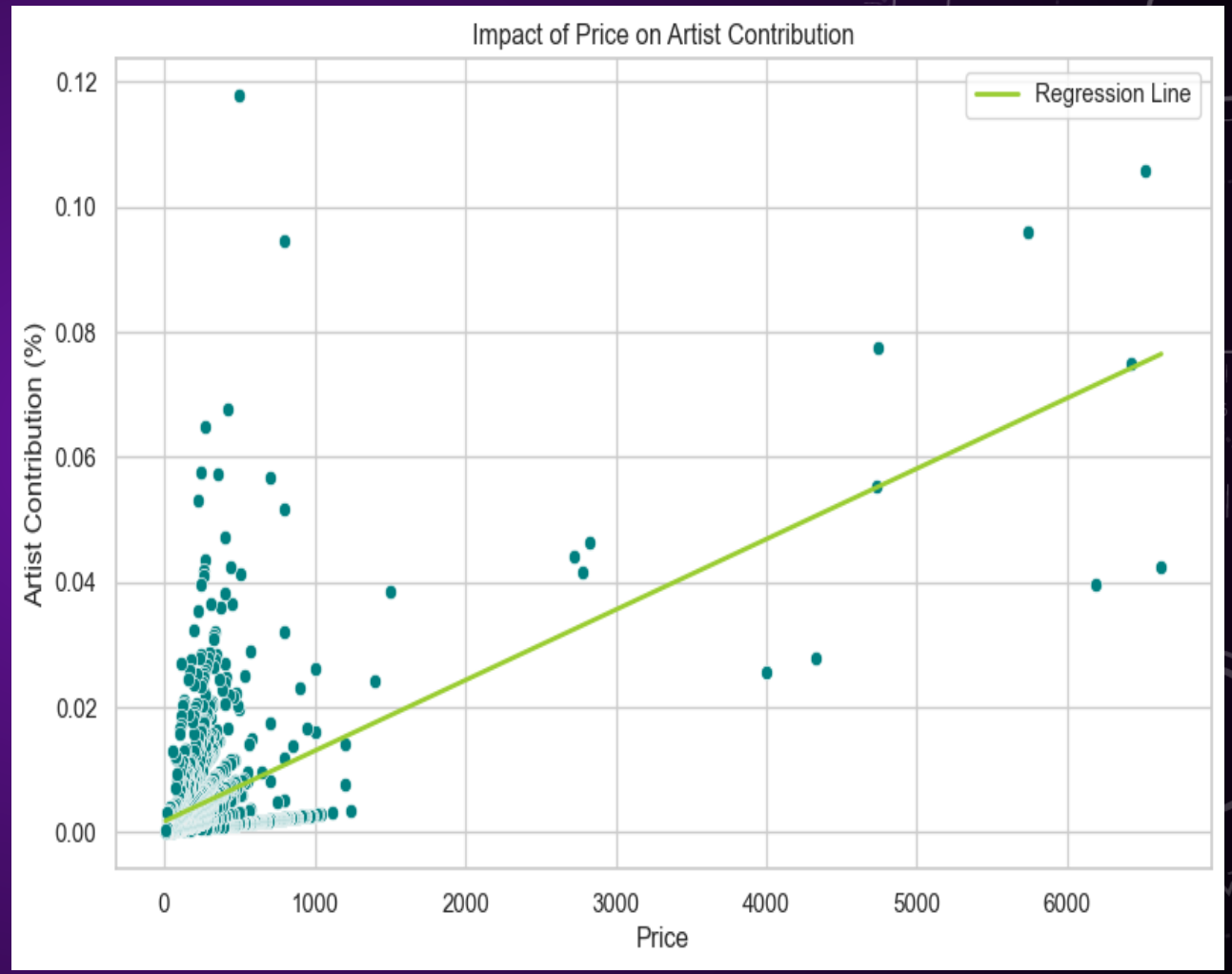
ARTIST CONTRIBUTION VS. PRICE

Correlation: 0.56

p-value: 3.2e-227

The extremely low p-value suggests strong evidence to reject the null hypothesis.

- Higher-priced artworks contribute more significantly to the artist's percentage of total gallery earnings.



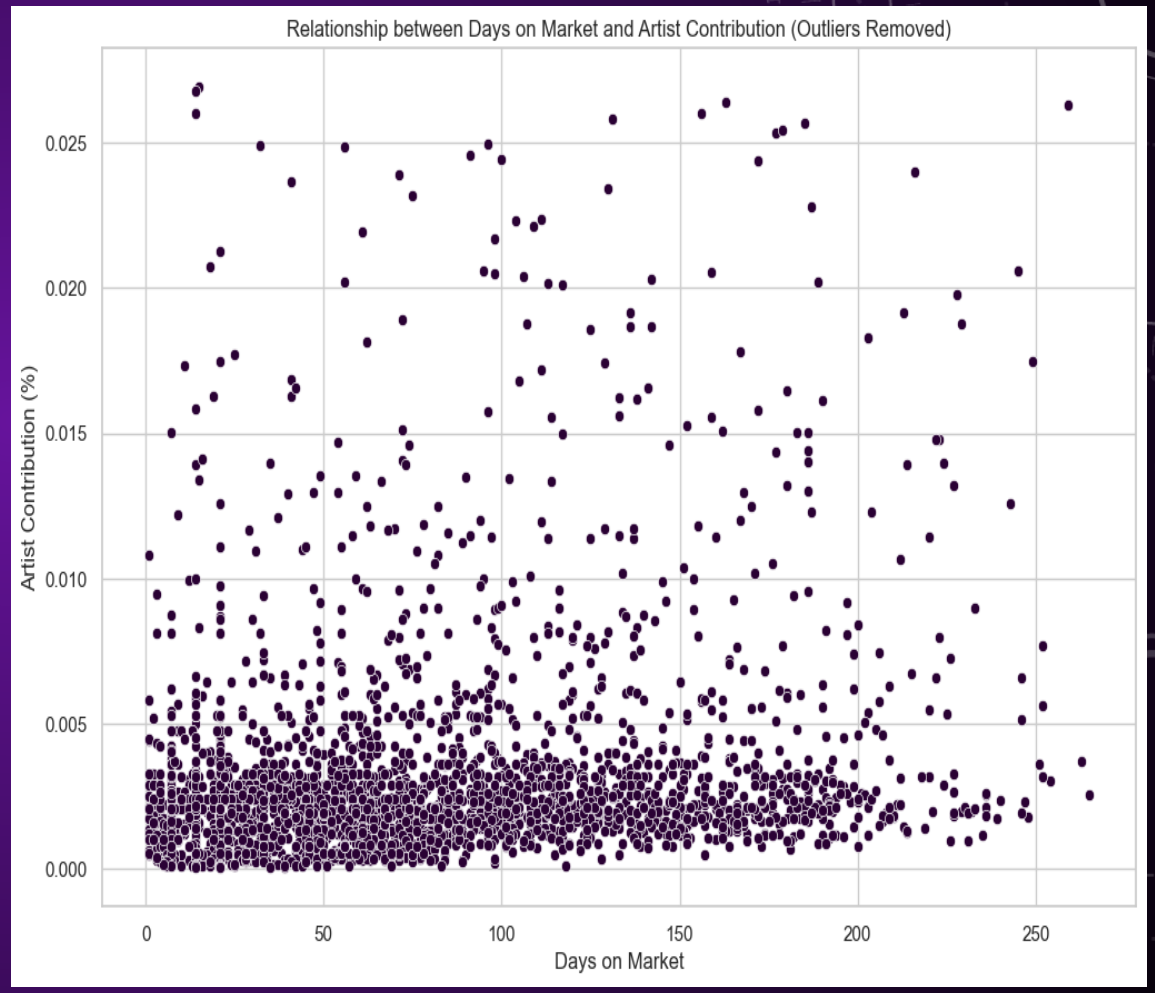
ARTIST CONTRIBUTION VS. DAYS ON MARKET

Null Hypothesis (H_0):

There is no significant relationship between the days an artwork spends on the market and the artist's contribution percentage.

Alternative Hypothesis (H_1):

There is a significant relationship between the days an artwork spends on the market and the artist's contribution percentage.



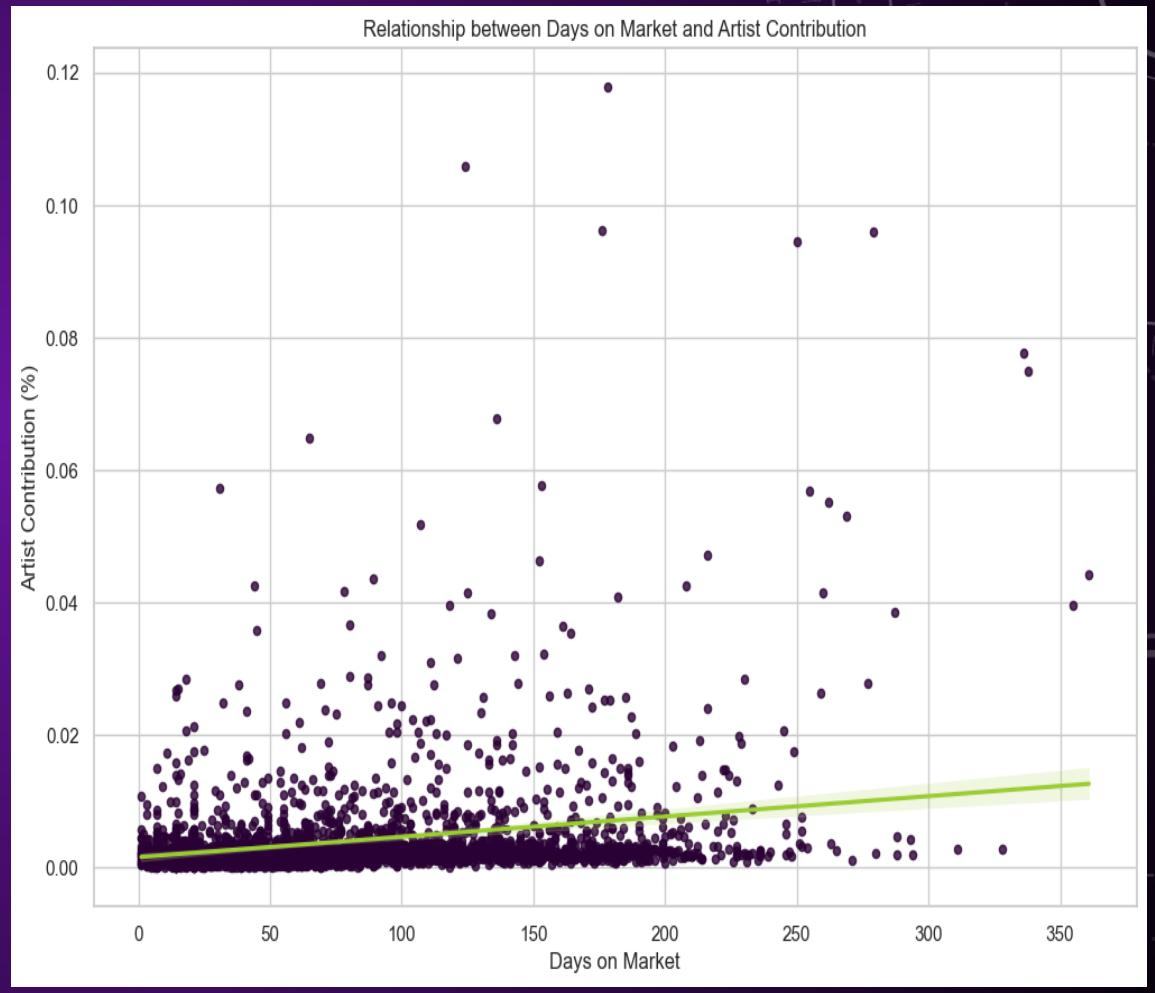
ARTIST CONTRIBUTION VS. DAYS ON MARKET

Correlation: 0.25

p-value: 7.2e-40

Reject H_0: There is a significant relationship between days on market and artist contribution.

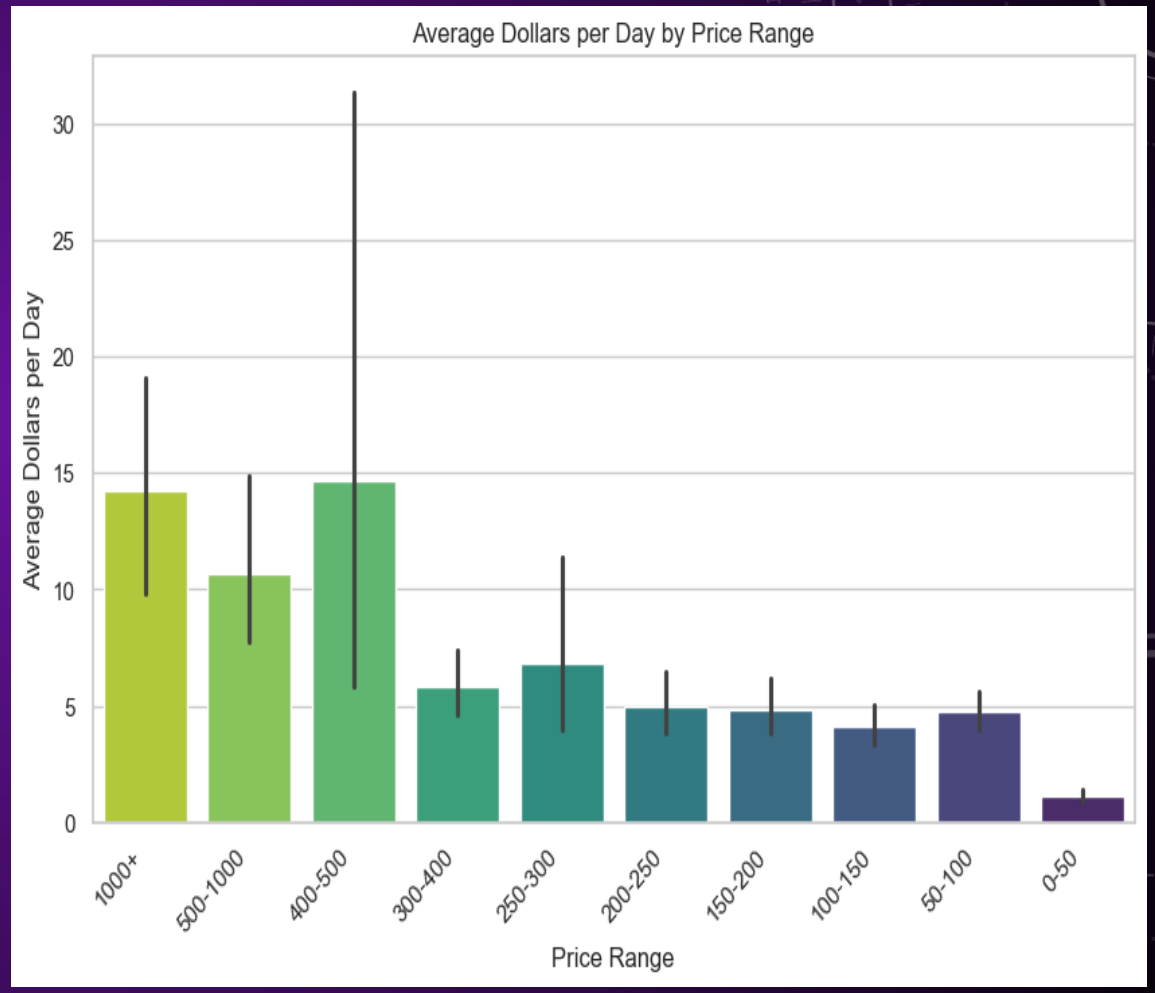
- Artworks that spend more days on the market contribute more significantly to the artist's percentage of total gallery earnings.



KPI – DOLLARS PER DAY RATIO

I added this metric to measure how much revenue was generated per day an artwork spent on the market. It is calculated by sale price/days on market.

- The $400-$500 price range has the highest returns for the amount of time spent in the gallery's inventory.
- Artworks in the higher price ranges, especially those above $400, yield significantly higher average profits per days spent on market.



OPTIMIZATION STRATEGIES

IDEAL INVENTORY LEVEL FORECASTING

Goal of Stock Forecasting

Anticipate Market Demand and Maximize Potential Revenue:

Predict sales trends to optimize inventory levels, taking into account the changes in demand over time and the days on market before sale.

Strategic Purpose

Business Optimization:

Inform inventory decisions by adjusting stock levels based on anticipated future demand.

Key Outcomes

Efficient Resource Allocation:

Minimize overstocking and reduce carrying costs.

Business Impact

Proactive Decision-Making:

Stay ahead of market trends.

Properly manage the larger days on market required for the more profitable artworks.

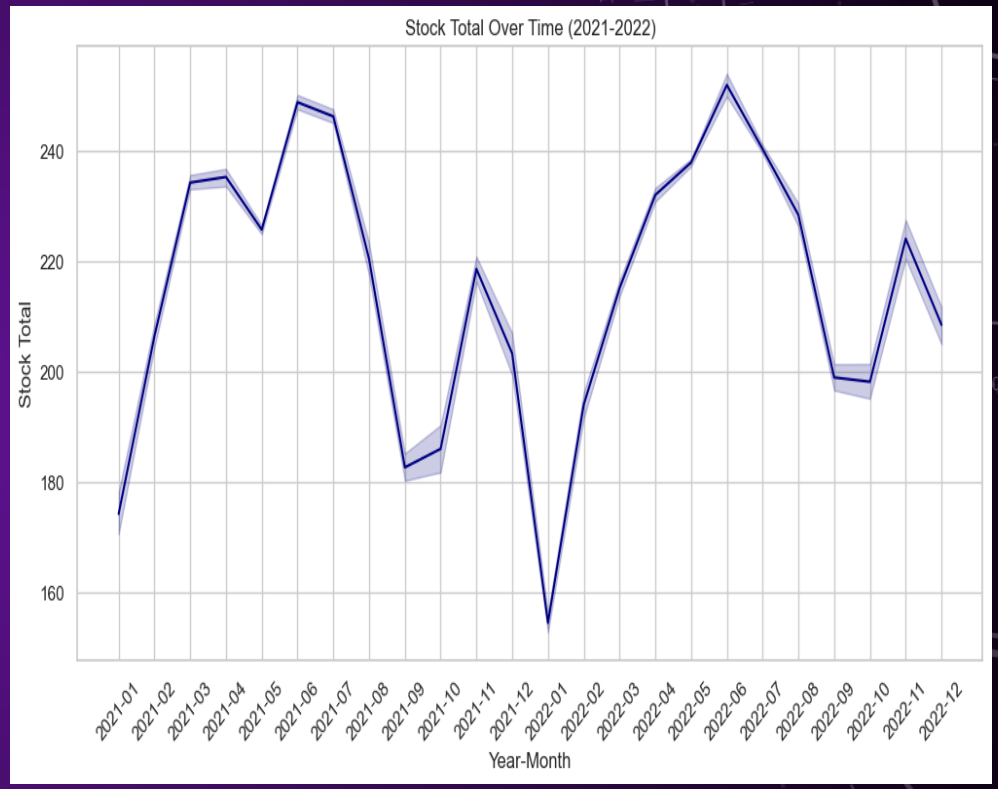
INVENTORY FORECASTING - METHODOLOGY

Market Segmentation

- Categorized market strength (Normal, Strong, Weak)
- Analyzed sales patterns, artist performance, inventory turnover, and calculated known stock levels at time of sale.

Predictive Modeling

- Derived insights for demand forecasting.
- Created demand simulations based on historic sales, then used them to test the profitability of predicted ideal stock levels.



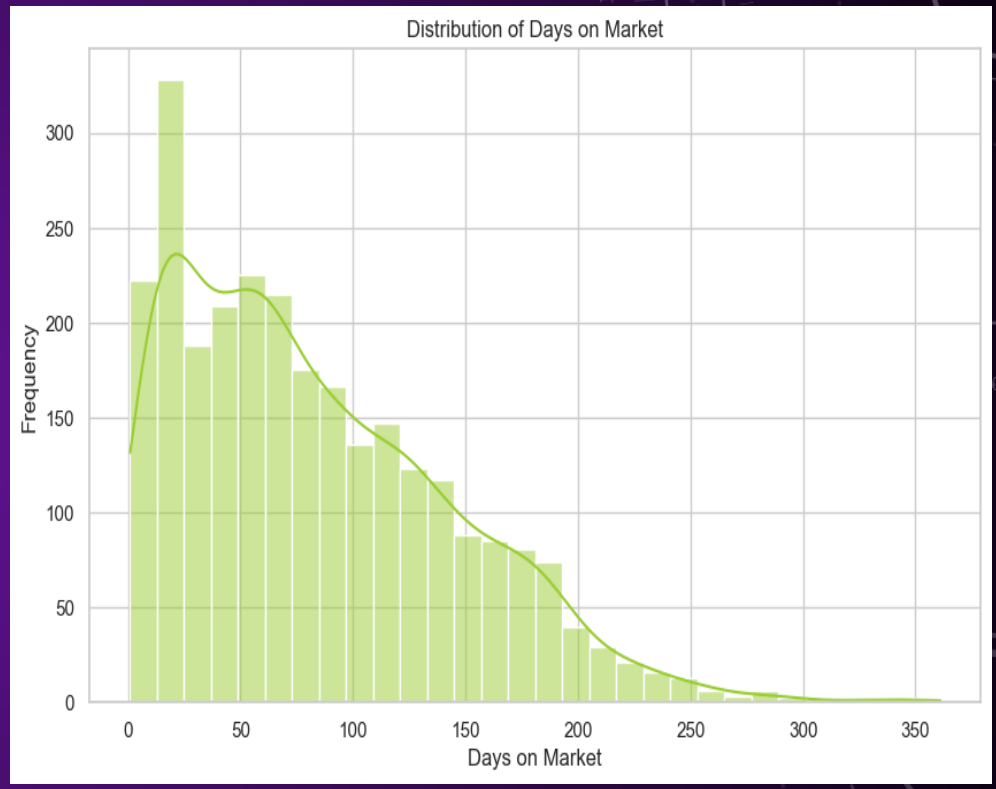
INVENTORY FORECASTING - METHODOLOGY

Days on Market

Average days on market was used with the predicted sales for each month to calculate when should be added to the inventory.

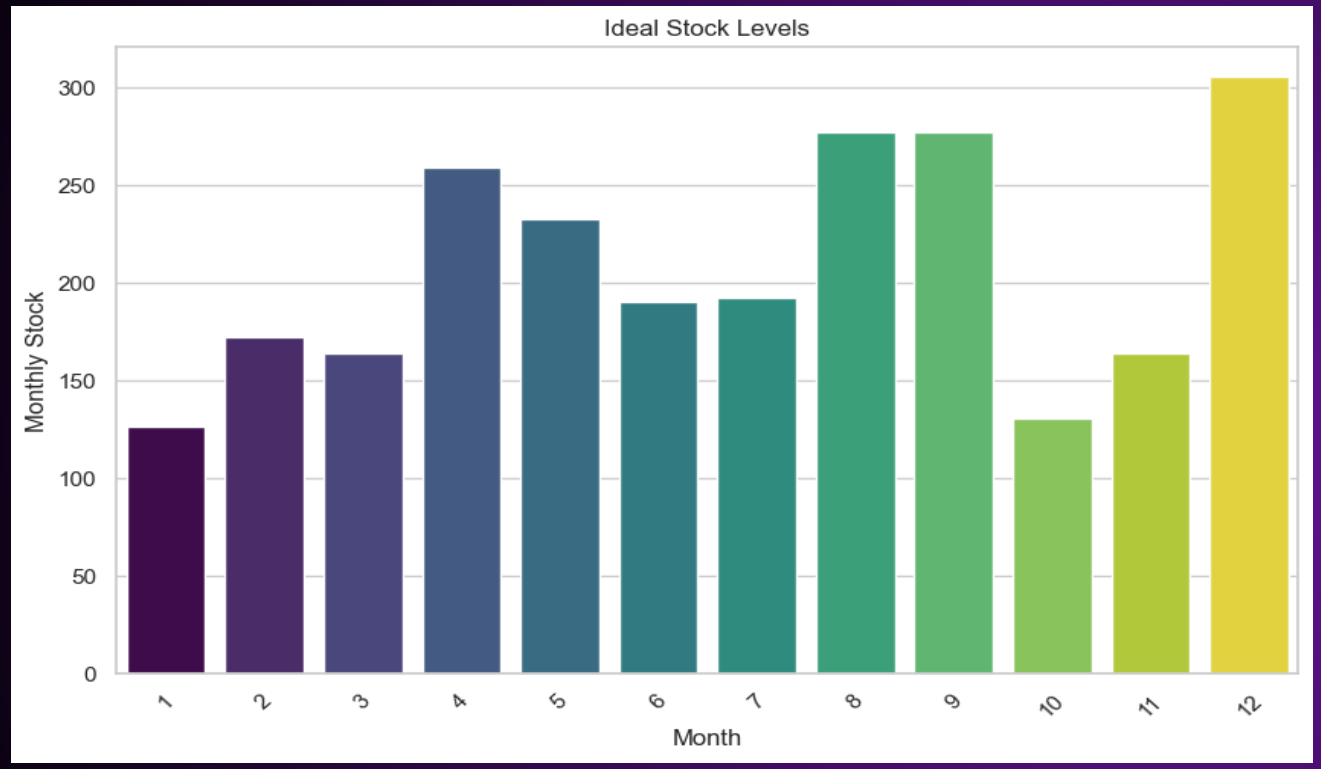
Predictive Modeling

Combining expected sales for various market types, observed seasonal trends, and the average days on market for those periods, ideal monthly inventory levels were predicted.



INVENTORY FORECASTING – RESULTS

(RANDOMLY SIMULATED MARKETS)



Strong Market Monthly Average

Ideal Quantity: 230

Expected Sales: 115

Expected Profit: $10,505

Weak Market Monthly Average

Ideal Quantity: 154

Expected Sales: 39

Expected Profit: $3,304

Strategic Implications

These ideal monthly stock levels will have the desired inventory in stock to match peak sales for artworks in the gallery.

Further optimization of the price ranges and artists spotlighted can focus on the dollars per day ratio and further optimize inventory.

PRICE RANGE OPTIMIZATION

Now that we know the ideal quantity of inventory for each month, we can leverage that information to further optimize the available artwork in the gallery.

Goal of Price Range Optimization

Tailor Inventory to Market Segments:

Optimize the quantity of artworks in specific price ranges during different market strengths.

Strategic Purpose

Maximize Profitability:

Align inventory composition with market-specific demand.
Enhance sales during strong, weak, and normal market periods.

Key Outcomes

Fine-Tuned Inventory Strategy:

Identify ideal quantities for each price range.
Minimize carrying costs while maximizing revenue.

Business Impact

Strategically Diversified Inventory:

Respond dynamically to varying market strengths.
Ensure profitability through targeted price range optimization.

PRICE RANGE OPTIMIZATION - METHODOLOGY

Market Segmentation

Strong, Weak, Normal.

Analyzed sales trends, prices, and days on market during different market strengths.

Market-Specific Analysis

Sorted sales data into strong, weak, and normal market periods.

Calculated average and standard deviation after removing outliers for prices and days on market.

Price Range Quantification

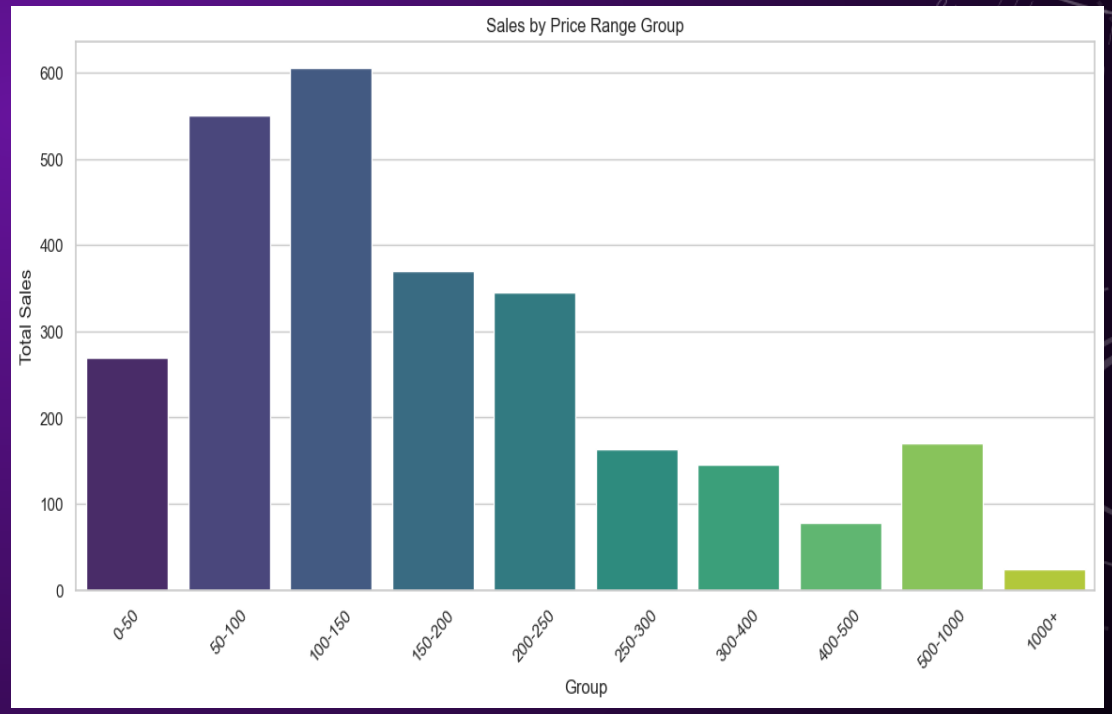
Split prices into 10 bins (0-50, 50-100, ..., 1000+).

Calculated demand for each price range based on past market performance during the different market strengths.

Optimization Modeling

Utilized ideal quantities for each market strength.

Calculated most profitable quantities for each price range using the dollars per day ratio.



PRICE RANGE OPTIMIZATION – MONTHLY

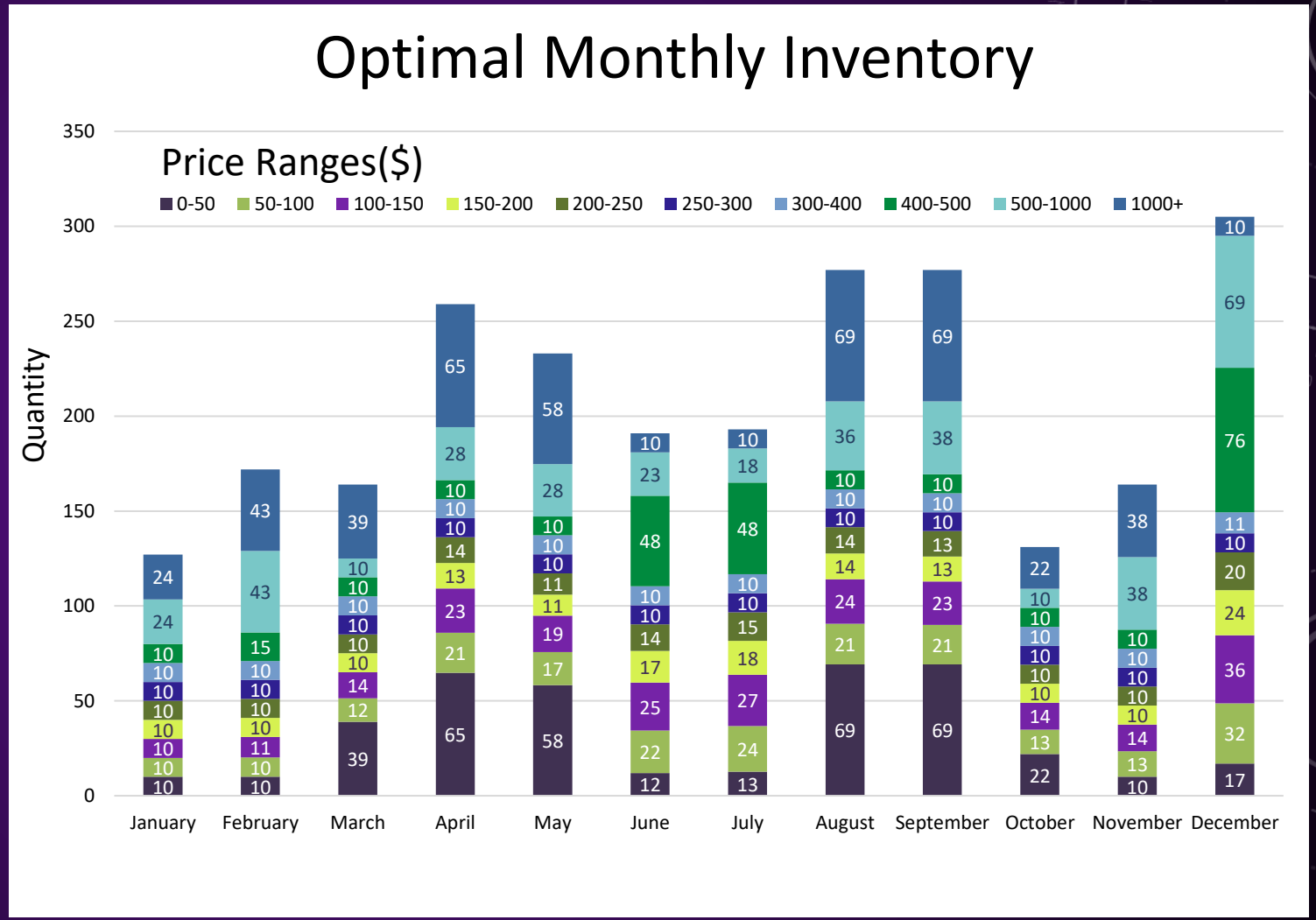
Target

- Maximize Average Dollars per Day

  Through our EDA and hypothesis testing, we've derived that for WALRUS, the best KPI to focus on is dollars per day.

Restrictions

- A minimum of 10 items in each price range
- No price range can be more than 25% of the total inventory
- Each price range must have a minimum of 2x the standard deviation of it's expected demand.



PRICE RANGE OPTIMIZATION – AVERAGE MARKETS

Strong Month

- Ideal Total Quantity 230
- Expected Profit **$12,240** +$1,735

Price Range	Ideal Qty
0-50	19
50-100	35
100-150	39
150-200	26
200-250	22
250-300	10
300-400	12
400-500	46
500-1000	12
1000+	10

Weak Month

- Ideal Total Quantity 154
- Expected Profit **$3,940** +$236

Price Range	Ideal Qty
0-50	10
50-100	11
100-150	11
150-200	10
200-250	10
250-300	10
300-400	10
400-500	10
500-1000	36
1000+	36

Normal Month

- Ideal Total Quantity 224
- Expected Profit **$7,885** +$34

Price Range	Ideal Qty
0-50	51
50-100	24
100-150	26
150-200	15
200-250	15
250-300	10
300-400	10
400-500	10
500-1000	10
1000+	51

* For better comparison, the same predicted total sales by market type are used for all models. No assumptions were made about increased or decreased sales. Profits are in comparison to historical average profits for market type.

ARTIST OPTIMIZATION

Goals of Artist Optimization

Focus on Specific Artists:

The criteria for the artists are flexible and can be tailored to different goals (e.g. highlighting specific art styles, gender, race, etc)

Since the data revealed specific artists that were outperforming, I used the highest sum of sales and chose the top 5 for each market strength (normal, strong, weak.)

Strategic Purpose

Maximize Profitability:

Allocate inventory based on artists' historical performance.

Enhance sales by emphasizing top contributors during different market strengths.

Key Outcomes

Tailored Artist Strategy:

Assign optimal quantities to top-performing artists.

Optimize artist focus for strong, weak, and normal market scenarios.

Business Impact

Profit-Driven Artist Allocation:

Maximize revenue potential by emphasizing top artists.

Improve inventory management by matching artists to market conditions.

Artist optimization directs inventory emphasis toward top-performing artists, maximizing profitability in different market segments.

ARTIST OPTIMIZATION - METHODOLOGY

Artist Contribution Analysis:

Identified top 5 artists for each market strength based on the sum of the prices of their artworks sold during similar market strengths.

Artist Performance Metrics:

Evaluated demand, average sales price, and average days on market for each top artist.

Inventory Allocation:

Assigned 33.33% of the demand for inventory to top 5 artists, breaking that down by the shown demand for their artworks during similar market periods in past sales data.

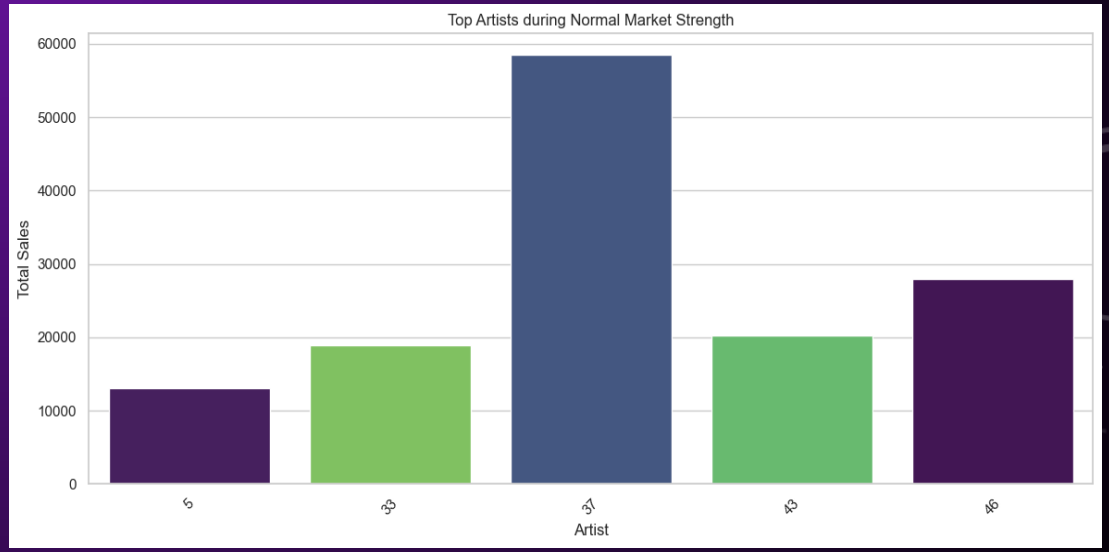
Remaining 66.66% allocated to all other artists.

Demand was used to calculate the minimum number of artworks each artist should have available for purchase.

Flexibility Measures:

Additional constraints (e.g. maximum or artworks per artist, percent of total inventory) can be added for more refined allocation.

This methodology tailors inventory focus to the highest-selling artists, optimizing sales potential during various market strengths.



ARTIST OPTIMIZATION - RESULTS

Target

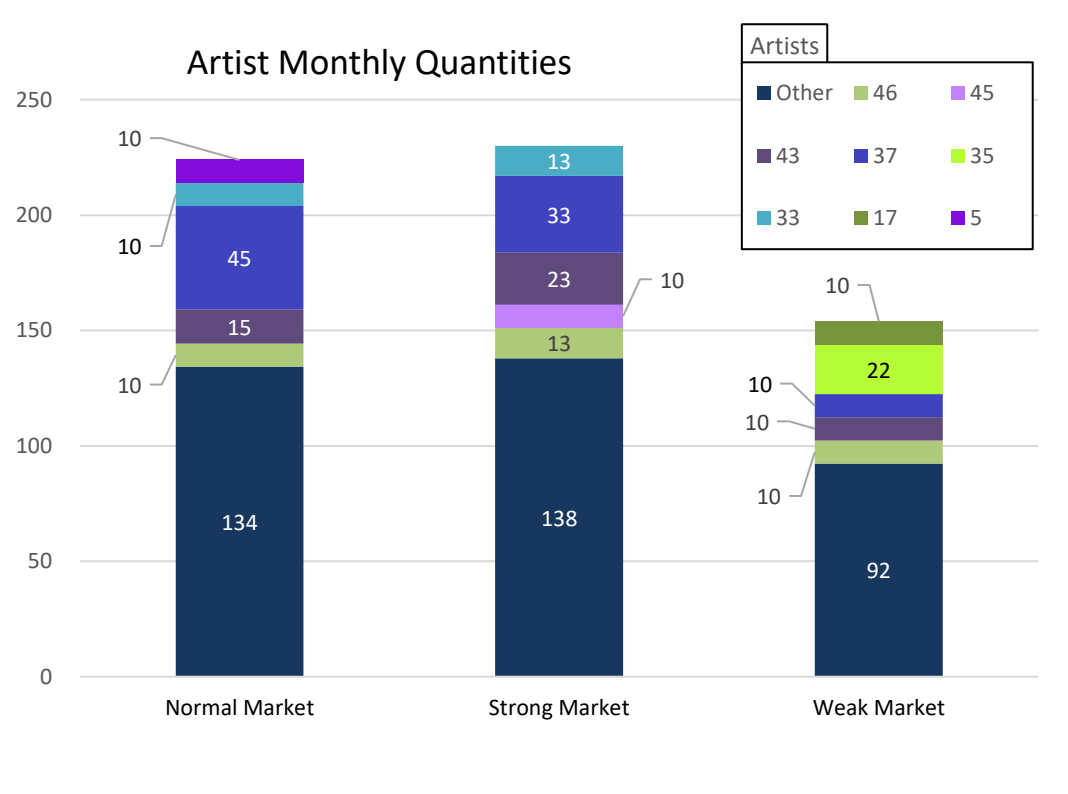
- Maximize Average Dollars per Day

Restrictions

- A minimum of 10 items for each artist.
- The total quantity of the spotlighted artists must equal 40% of total inventory
- Each artist must have a minimum of 2x the standard deviation of their expected demand.

Assumption

- I assumed an increase in demand for highlighted artists proportional to their increase in presence.
- I did not assume an increase in overall sales, instead shifting the demand percentages.
- Data should be collected on the changes in demand and sales for highlighted artists to increase accuracy of predicted profits.



Normal Market

Ideal Total Quantity 224

Expected Profit **$8,442**

+$591

Strong Market

Ideal Total Quantity 230

Expected Profit **$13,531**

+$3,026

Weak Market

Ideal Total Quantity 154

Expected Profit **$3,791**

+$487

Artists 37, 43, and 46 are in the top 5 at all market strengths, showcasing a demand for their artworks regardless of market status.

RECOMMENDATIONS AND CONCLUSION

RECOMMENDATIONS

Optimized Inventory Management

These tailored inventory levels can be used to plan for future market trends and quickly adapt to changes.

Balance demand, pricing, and profitability. The dollars per day metric makes sure that the inventory that doesn't sell that month will result in the largest profits when it does.

Strategic Artist Focus

Align artist selection with market demand.

Maximize profits through targeted inventory. In this exploration, artists were chosen based on total sales. If other results are desired, a different set of artists can be chosen based on other criteria, and the ideal makeup can be calculated to maximize profit.

This could be extremely useful for artist promotions or trailering artists to events.

Balanced Method

I recommend using a mixture of the price range and artist optimizations. The split of 33% focus on specifically chosen artists offered comparable profits to only price range optimization. Utilizing price range optimization with the remaining 66% could add further benefit. This ratio can be adjusted to create more or less of an artist spotlight.

Further Exploration

1. **Artist Partnerships**
   Enhance relationships with top-performing artists. Further investigation into what factors are leading to their success, such as art style or size of artwork compared to price. Incorporate strategies of top-performing artists with underperforming artists and monitor changes.
2. **Continuous Monitoring**
   Implement real-time monitoring for adaptive strategies. Stay on top of evolving market dynamics.

CONCLUSION

In optimizing WALRUS Gallery's operations, we started with an analysis of sales patterns, identifying monthly and quarterly trends, and delving into correlations for a better understanding. Next, we evaluated individual artist performances, pinpointing top contributors. Hypothesis testing followed, offering essential statistical evidence for decision-making. We then created the KPI to base our optimizations on.

We tailored predictive modeling to the results of this analysis, enabling inventory optimization for current and future profitability. Using the observed sales patterns for different price points and artists during varying market strengths, we fine-tuned inventory management.

In conclusion, we have presented actionable models for WALRUS to apply during different market strengths and optimize potential revenue. Continuous monitoring for any changes in sales patterns or market trends is crucial and the models should be updated accordingly.

Appendix

- Jupyter Notebook – EDA, Visualizations, and Hypothesis Testing
- Jupyter Notebook – Predicting Demand and Inventory Levels
- Excel Price Range Optimizer
- Excel Artist Optimizer