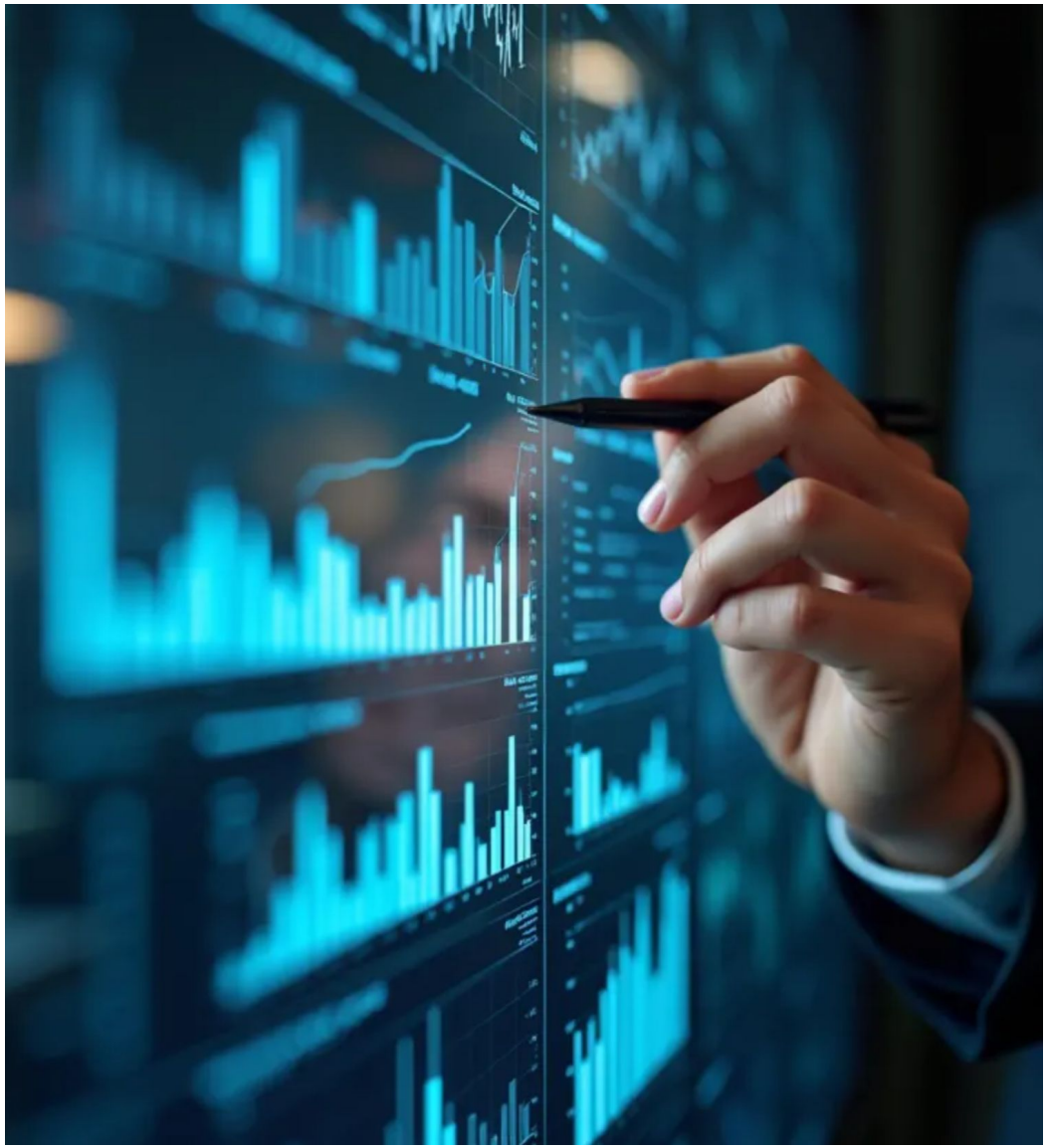
# US Smartphone Market Case Study

## Exploratory Data Analysis & Time Series Forecasting Model (2025)



# Content

- **Business Case** :

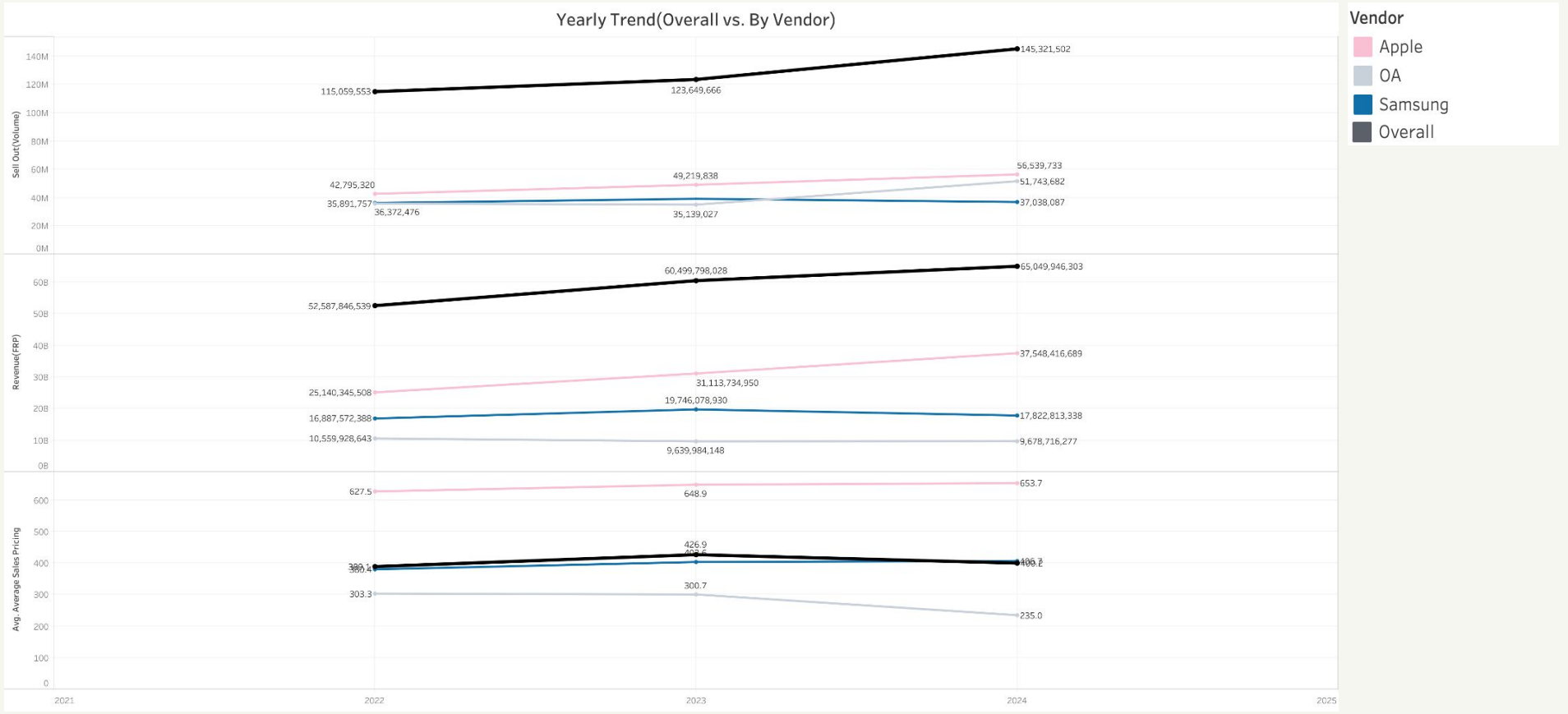
  **2025 US Smartphone market  Forecast**
  Analyze Yearly & Quarterly Trend of the US Smartphone market from Q1'22~Q4'24,
  and forecast the 2025 market focusing on **Volume(Sell Out), Revenue,** and **Average Sales Pricing**.

- **Data Acquisition** – US Smartphone market data was obtained in Excel format.
- **Data Preparation** – Unnecessary, redundant, or large missing data were dropped, numeric columns were cleaned for ML, ASP was derived from raw data, and external variables(macroeconomic indicators, holidays) were merged.
- **Data Visualization** – Graphs were created using Tableau and multiple data reports were created to understand the relation of features.
- **Forecasting** – ‘Meta Prophet’ was tuned and evaluated to predict the 2025 US Smartphone market.

# Data Preprocessing and Feature Engineering

- **Total number of records** = 88,708
- **Following missing values were found**:
  - ‘Program’(29,458 records), ‘Model CD’(656 records), ‘Market Name’(7,596 records), ‘FRP’(235 records), ‘Revenue’(FRP)(235 records)
- **Missing values treatment:**
  - Values with more than 20% missing(‘Program’) was dropped.
- **Merge of External Variables:**
  - US Holidays were factored in with the ‘holidays’ package in Python
  - GDP, CPI, Unemployment Rate, and Fed Rate were factored in with ‘pandas datareader’ package in Python
- **Numeric columns cleaning:**
  - Commas(,) were omitted and data type was set to numeric for values in SellOut, Revenue, ASP
- **Filter ‘SMART’ for Smartphones:**
  - The column ‘Device Sub’ was filtered to only display Smartphones for the purpose of this case study.
- **Create Future Data Points(weeks in 2025)**
  - 52 weeks in 2025 were created to forecast the three target variables.

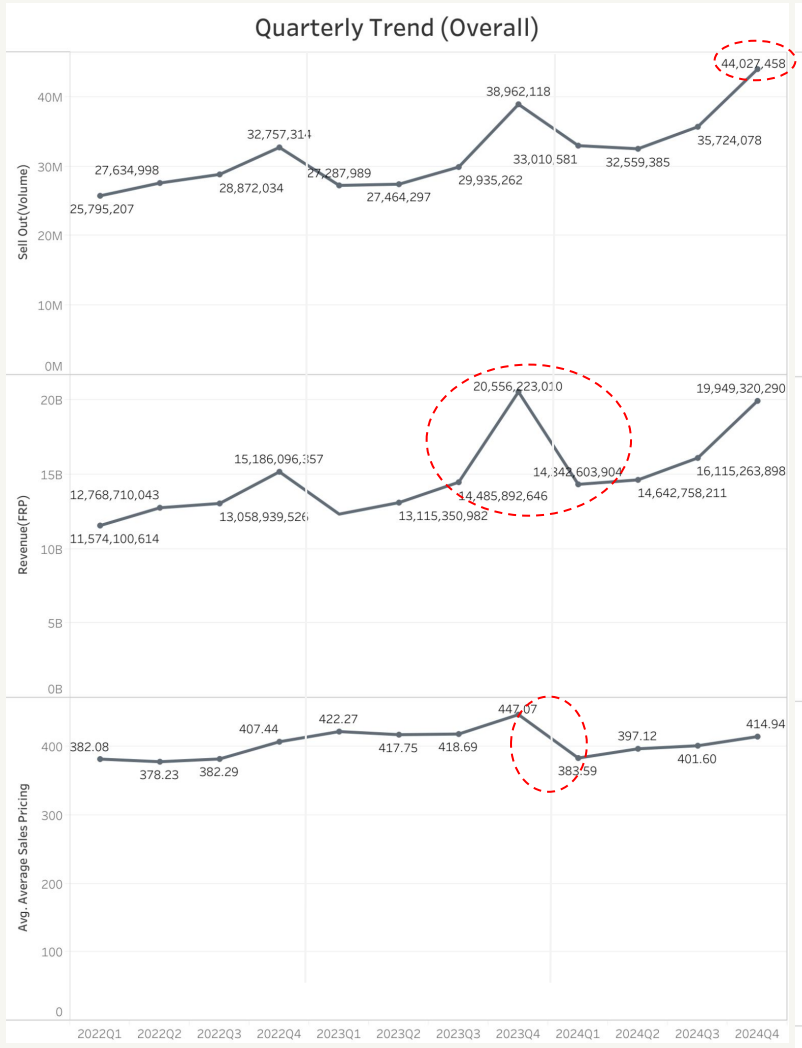
# Data Visualization

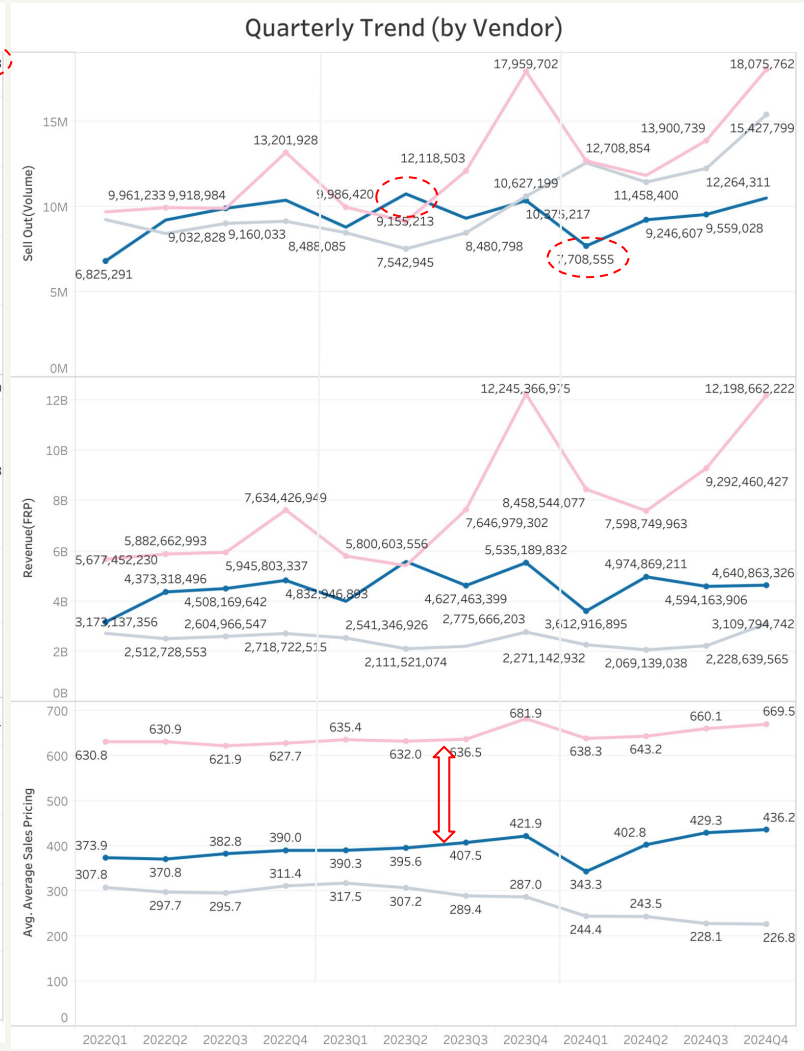



## Key Highlights

- **Volume:** Overall US Smartphone market volume grew steadily, increasing from **115M** units in 2022 to **145M** units in 2024.
- **Revenue:** Overall revenue followed a similar growth trajectory, with Apple dominating in revenue, through a combination of premium pricing (high ASP) and growing volume. Samsung showed volume stability but struggled to grow in 2024.
- **ASP(Average Sales Pricing):** Overall ASP remained stable, with a huge gap between Apple and the other vendors.

# Data Visualization

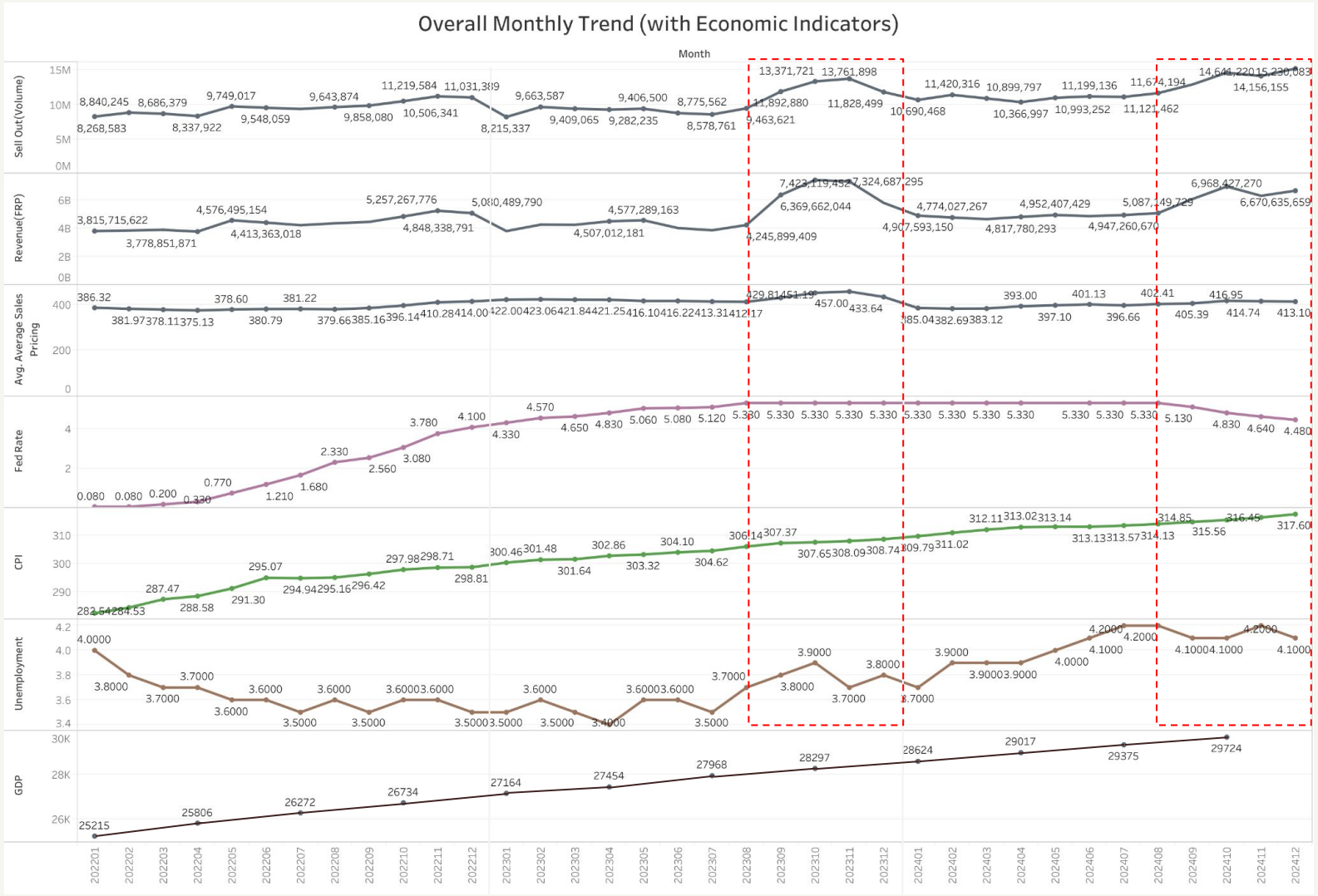



## Key Highlights

- **Volume:** Overall market volume peaked in **2024Q4**(**44M**), showing a strong rebound from the dip in **2024Q1(33M)**.
- Samsung showed more stable volume trend than Apple, with moderate growth between **2022Q1** to **2023Q4,** especially **dominating** the market in **2023Q2.** There was a noticeable drop in **2024Q1**, but then recovered steadily.
- Apple showed strong seasonality, with big spikes in **Q4** followed by sharp drops in each **Q1,** especially in **2022Q4(13.2M→9.9M )** and **2023Q4 (17.9M→12.7M)**.
- **Revenue:** Overall market revenue shows similar trend to volume, peaking in **2023Q4 ($20.5B)** followed by a big drop in **2024Q1($14.3B),** but rebounding strong through **2024 (to $19.9)**.
- **ASP:** Overall ASP steadily rose, with a sudden drop in **2024Q1** but recovered stably.
- Apple's ASP stayed high and stable(between $630-681)peaking at $681.9 in **2023Q4**. Samsung's ASP while consistently lower than Apple's, demonstrated steady growth over time, peaking at $436.2 in **2024Q4**.

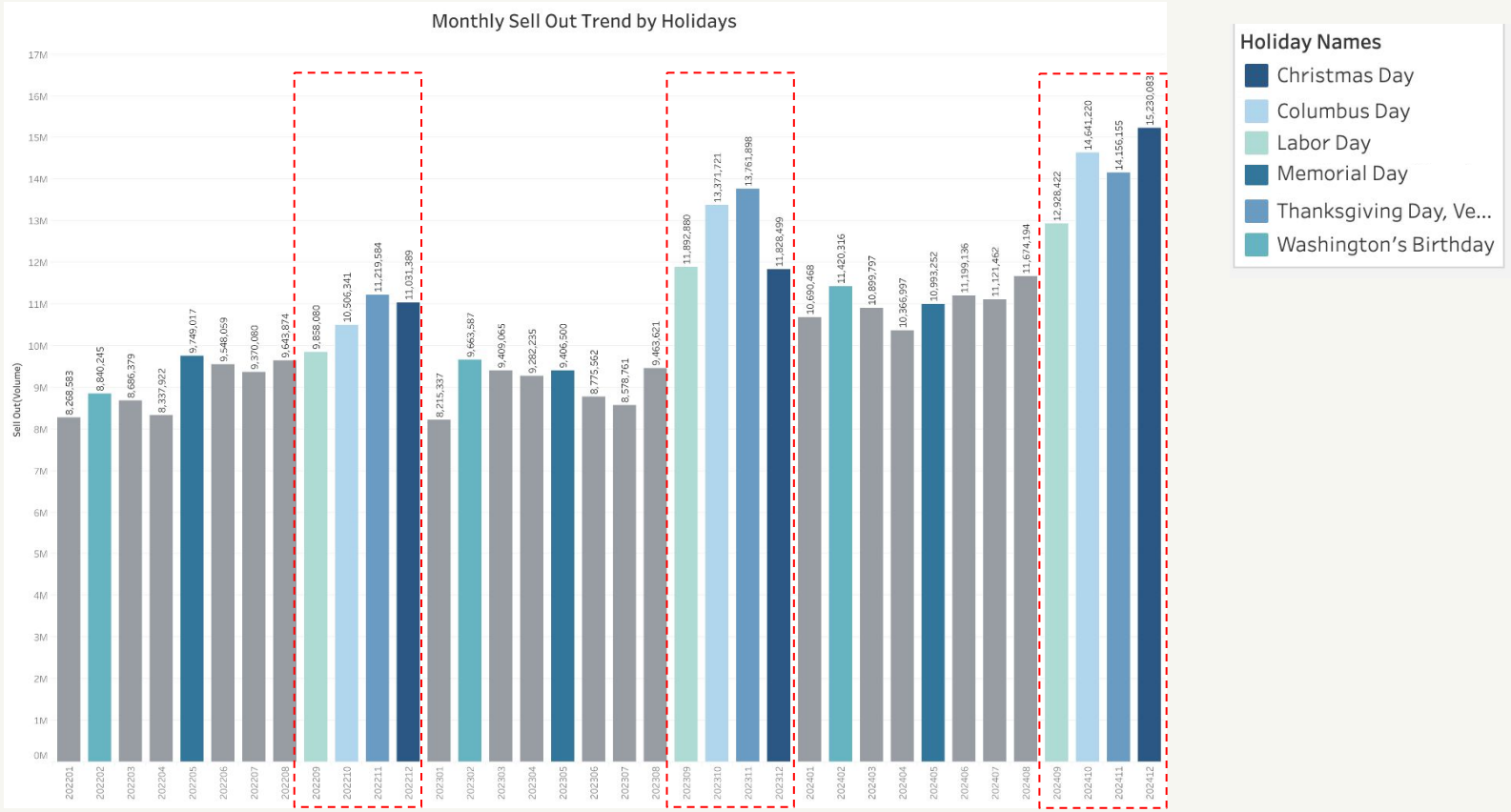
# Data Visualization




## Key Highlights

- Overall **volume** and **revenue** showed strong **resilience** even during high Fed rate, CIP, and unemployment periods.
- As **Fed Rate** and **unemployment rate** started to slightly decrease starting late 2024, **volume** and **revenue** started growing accelerated.
- **ASP** remained strong even during economic pressure, suggesting **low price sensitivity** and **continued demand**.

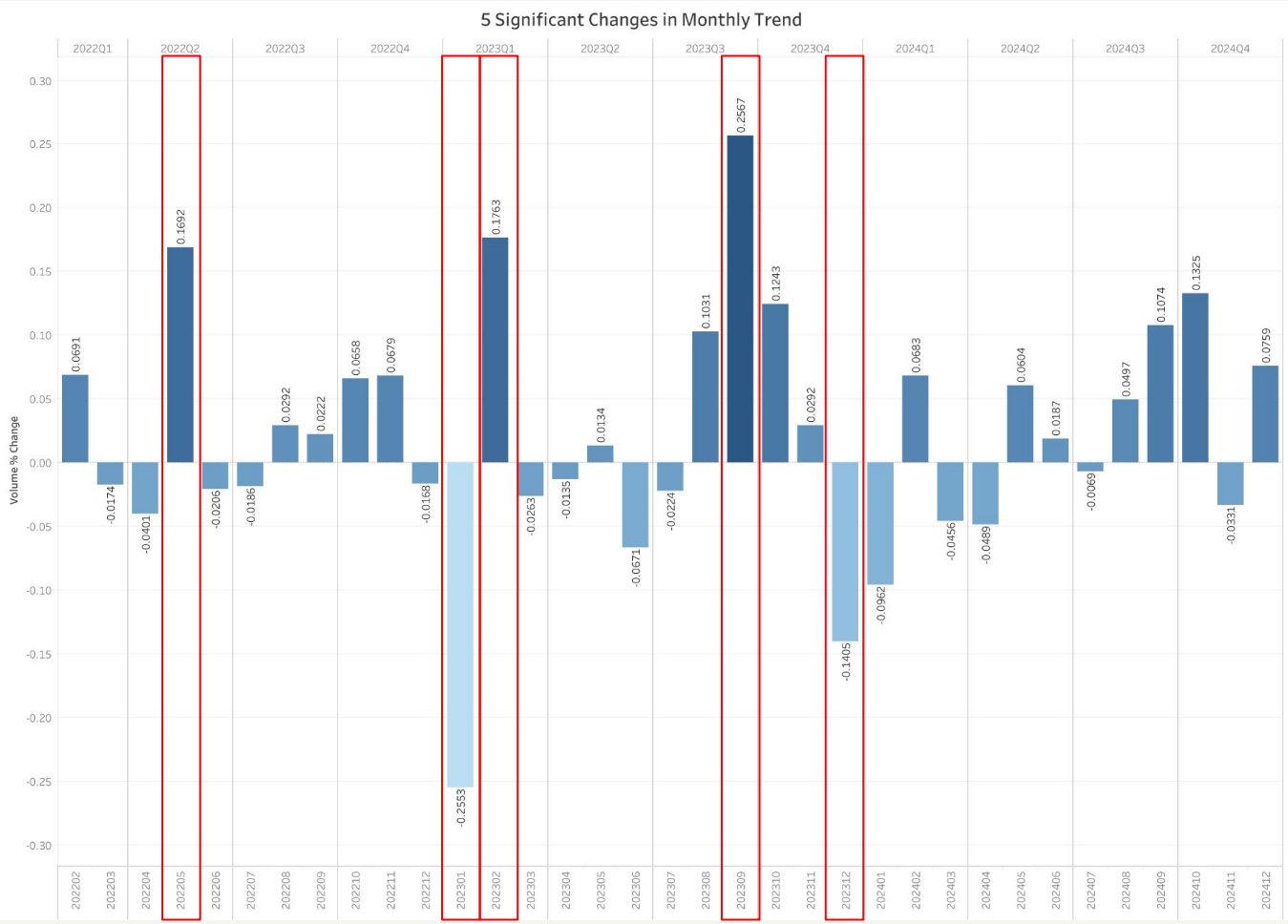
# Data Visualization




## Key Highlights

- The graph shows **clear volume spikes** in volume during **major holiday periods**, especially during **Christmas, Thanksgiving, Columbus Day, and Labor Day.**
- Comparing the same months across the years, there is a noticeable **upward trend** in volumes, especially in **Q4**'s volume, indicating **strong year-over-year growth** during the end-of-year sales.
- The seasonality also correlates with Samsung and Apple's major **launch dates** (Feb&**Aug** for Samsung and **Sep** for Apple).

# Identifying 5 Significant Changes




## Key Highlights

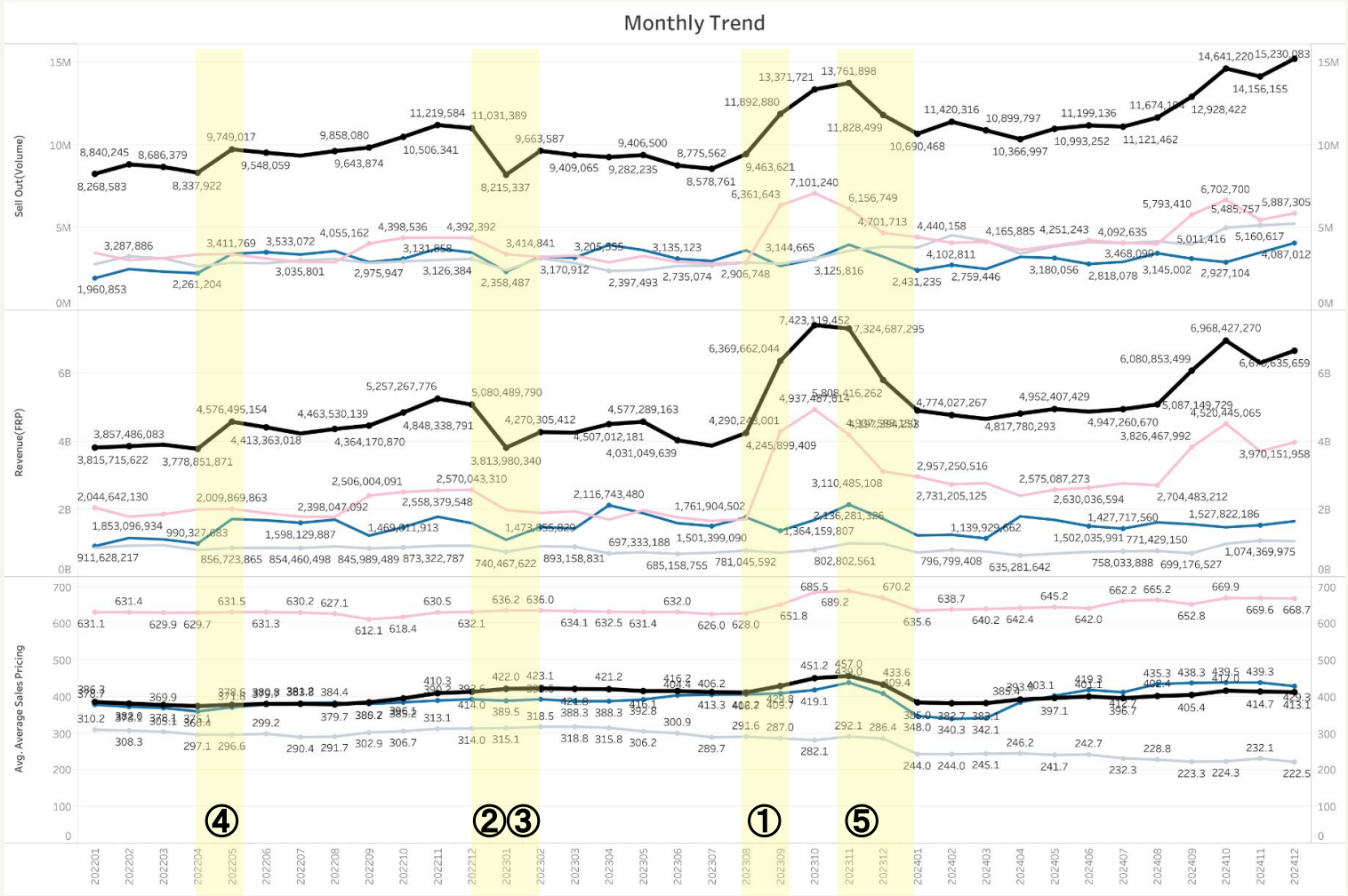
5 Significant changes in market volume were identified using the following formula on Tableau:

*(ZN(SUM([Sell Out(Volume)])) - ZN(LOOKUP(SUM([Sell Out(Volume)]), -1))) / ABS(ZN(LOOKUP(SUM([Sell Out(Volume)]), -1)))*

**The 5 Significant changes in Volume overtime:**

1. Sep 2023 (2023Q3) – Biggest Spike (+25.67%)
2. Jan 2023 (2023Q1) – Biggest Drop(-25.53%)
3. Feb 2023 (2023Q1) – Strong Rebound(+17.63%)
4. May 2022 (2022Q2) – High Growth(16.92%)
5. Dec 2023 (2023Q4) – Significant Drop(-14.05%)

# Identifying 5 Significant Changes(contd..)




Key Highlights

**① Sep 2023 (2023Q3) – Biggest Spike (+25.67%)**

This is the largest spike in the entire period, potentially linked to major price tier shift by Apple.

**② Jan 2023 (2023Q1) – Biggest Drop(-25.53%)**

This is the largest decline in the entire period, likely associated with recession fears.

**③ Feb 2023 (2023Q1) – Strong Rebound(+17.63%)**

This spike came after the largest drop, possibly influenced by increase in overall ASP and volume.

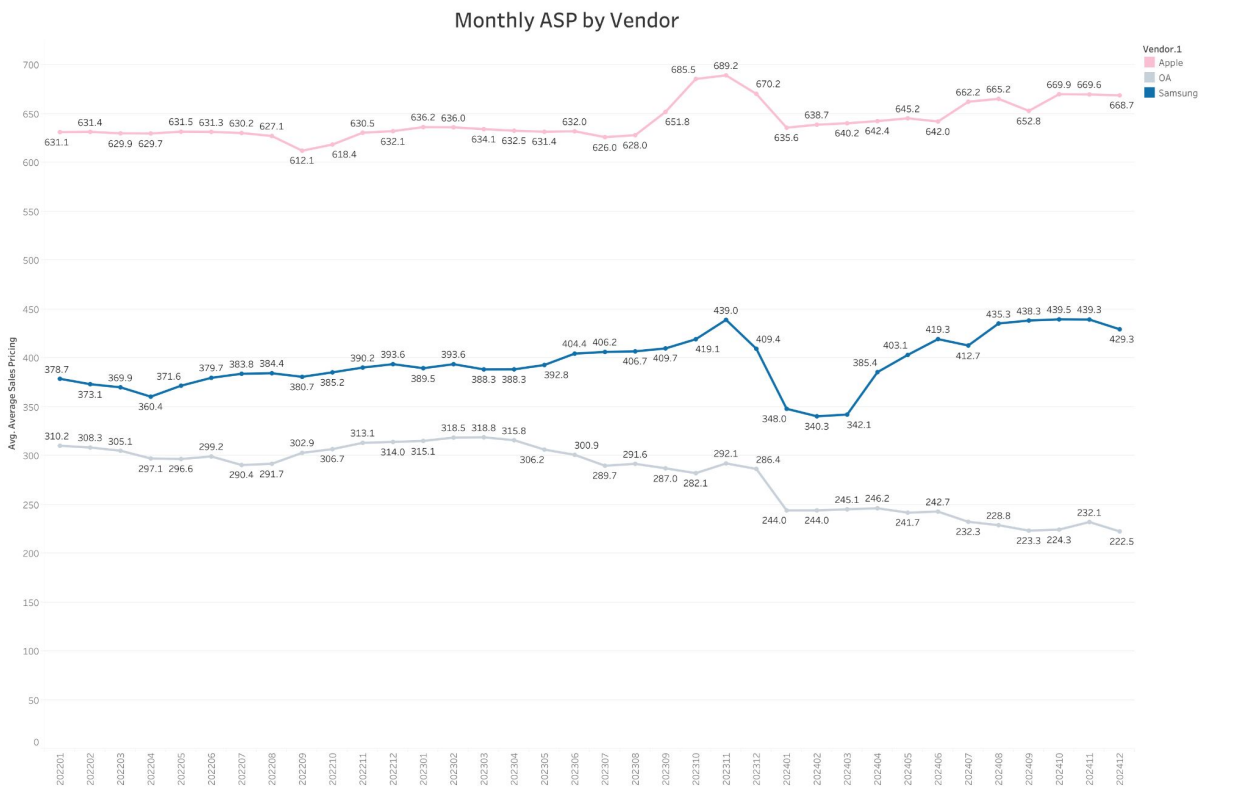
**④ May 2022 (2022Q2) – High Growth Again(16.92%)**

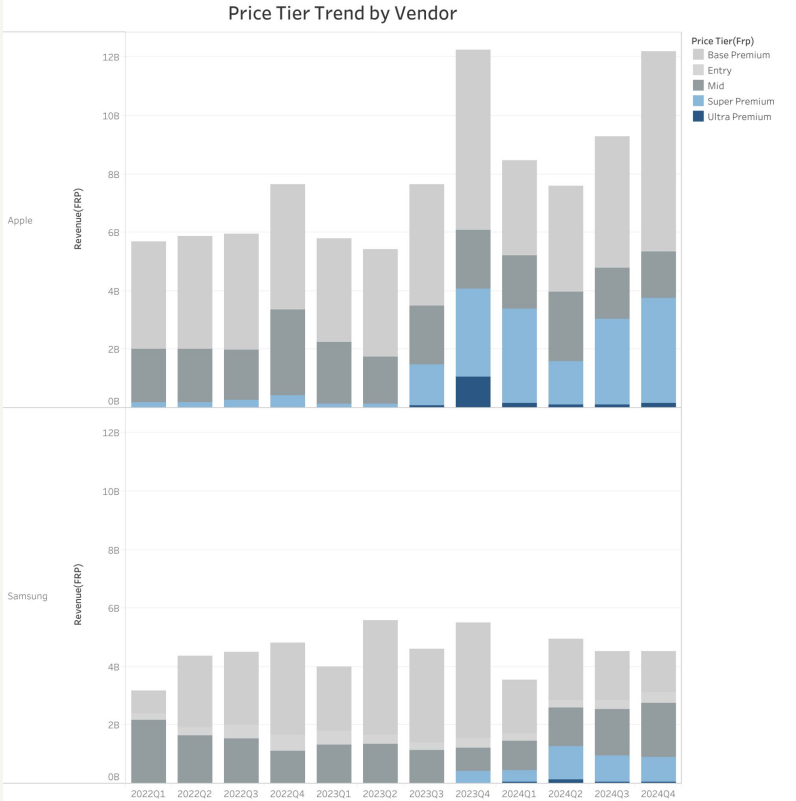
This spike came after a gradual drop in 2022Q1, possibly due to Samsung's volume and revenue growth from new model launches(S22 Ultra, M series, etc.)

**⑤ Nov 2023 (2023Q4) – Significant Drop(-14.05%)**

This happened just two months after the spike in Sep 2023, likely due to market saturation.

# Data Visualization

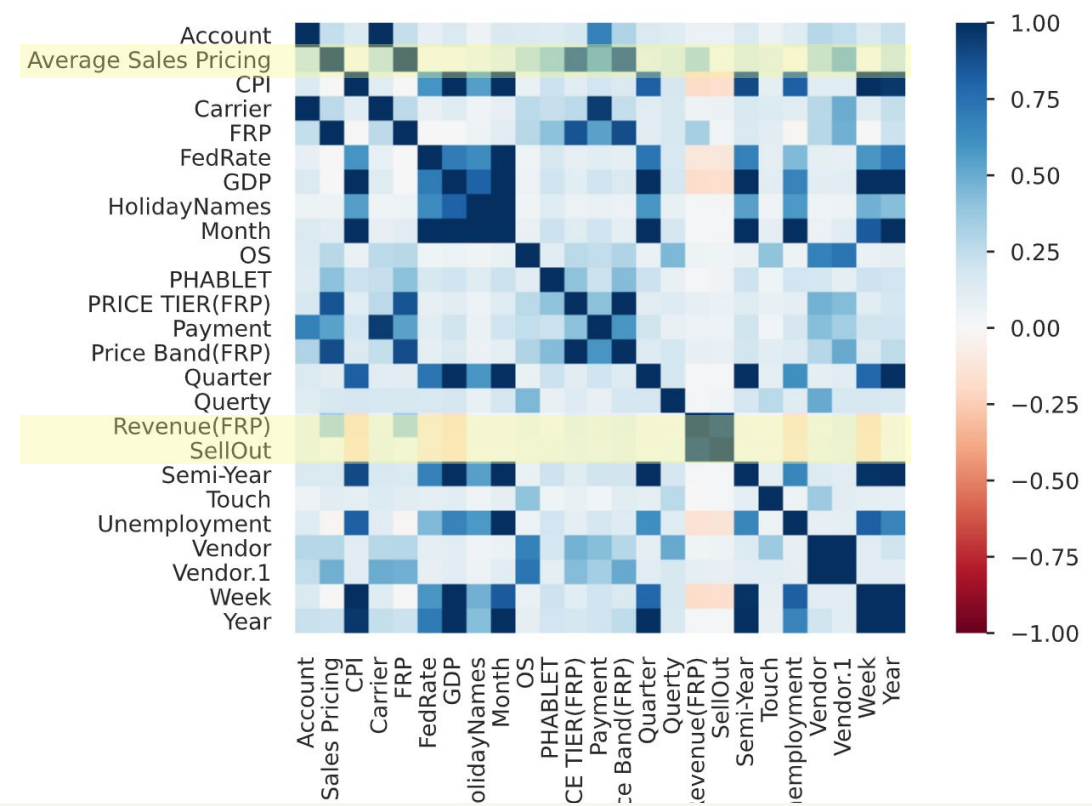



## Key Highlights

- Samsung's **ASP** started around **$380**, rose to **$439** by late 2024, with a dip to **$348** in early 2024. It slowly increased back to **$340** in late 2024. **Base Premium** and **Entry** tiers dominate for Samsung, being **less dependent on premium tiers,** indicating a broader portfolio but less pricing power.
- Apple consistently maintained the **highest ASP**, above **$600**, peaking near **$690** in late 2023. For Apple, revenue is heavily concentrated in the **Premium** tiers, with visible spikes in **Super and Ultra Premium** segments from **2023Q4**.

# Data Visualization




Key Highlights

- Correlation analysis revealed some correlations with **ASP** :
  - **Payment**(0.5),**Phablet**(0.4), **Vendor**(0.5)
- There were no significant correlation with **macroeconomic indicators** for the target variables(all R-values were < 0.3)

# Insights from Data

## ✅ Samsung Maintains Volume Stability but Faces ASP Pressure

- Samsung sustains **stable volume** with a **broad, mid-range portfolio**, but struggles to **close the ASP and revenue gap** with Apple.
- Strengthening the **premium and super-premium** segments with focused flagship launches, marketing, and trade-in promotions could drive improved market performance.

## ✅ Apple’s Premium Strategy Continues to Thrive

- Apple's combination of **high ASP** and **volume spikes** during **launch cycles** drives unmatched **revenue dominance.**
- Revenue is heavily concentrated in **Premium tiers**, which strengths its premium-focused portfolio.

## ✅ Resilience Against Economic Strains

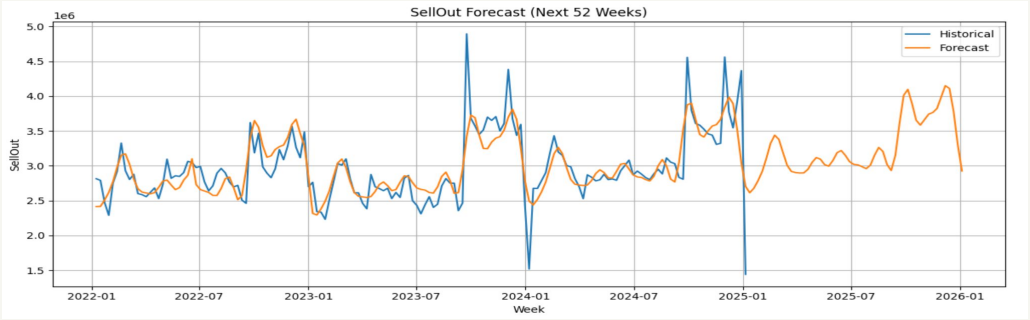
- Despite **high Fed rates, CPI, and unemployment**, smartphone **demand** — especially for **premium tiers** — remained strong.
- **Price sensitivity is low** among premium buyers, showcasing **consumer loyalty** to flagship models.

## ✅ Strong Seasonality and Launch Timing Impact

- **Major launches** and **holiday seasons (Q4)** are critical drivers of spikes in volume and revenue.
- **Optimizing product launch timing** (moving or amplifying the Samsung’s August launch to better capitalize on back-to-school and end-of-year holiday shoppers) could enhance volume and revenue growth.

# Forecast Model Analysis

**Prophet** time series forecasting model was setup to predict the Volume, Revenue, and ASP for 2025 US Smartphone market

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Evaluation Metrics for SellOut:
MAE: 199159.94
RMSE: 301457.69
MAPE: 6.95%
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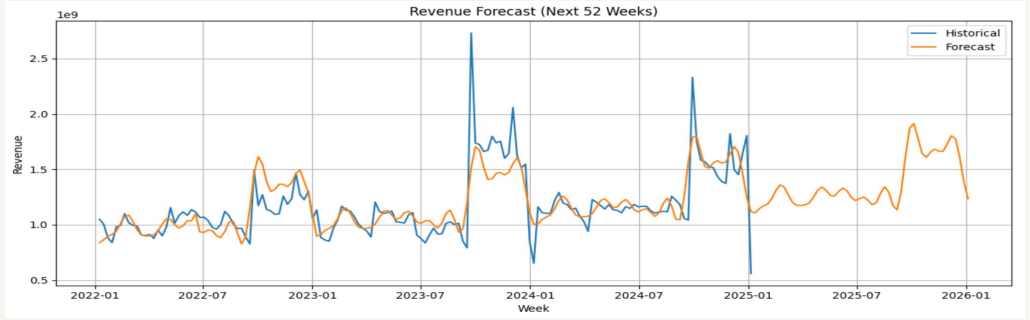


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Evaluation Metrics for Revenue:
MAE: 118184482.64
RMSE: 188157735.59
MAPE: 10.06%
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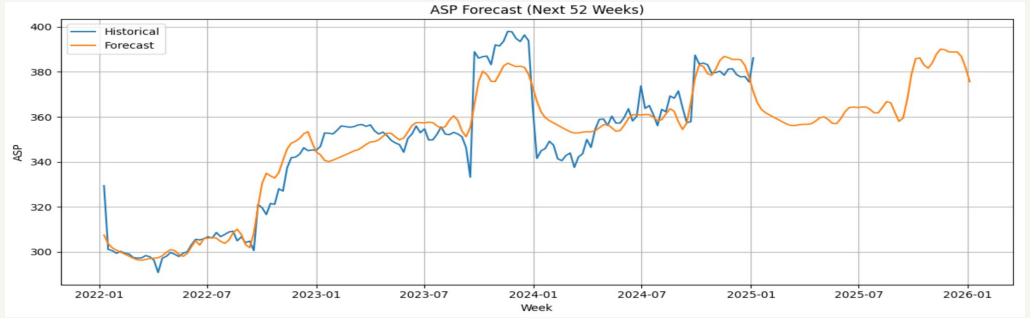


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Evaluation Metrics for ASP:
MAE: 6.35
RMSE: 8.35
MAPE: 1.80%
```

## Key Highlights

- Machine Learning forecasting model was created using '**prophet**' and cross-validation metrics were driven from the forecasted model.
- '**matplotlib**' was used to plot the original(historical) data and forecasted data.
- Overall **accuracy(MAPE)** for all three predictions were good (below 10%), with ASP prediction being the strongest.

**EOD**