**📌 Question 1: Trends in R² and MAE Over Time**

**✅ R-Squared (Model Fit)**

**Plot title: R-Squared of Model in Production**

* **General trend**: There is a clear **downward trend** in R² after **2010**, with **significant drops between 2015 and 2020**, reaching below 0.3 in several years.
* **Lowest performance**: Around **2017 to 2021**, R² frequently dips below 0.3, suggesting weaker predictive performance.
* **Partial recovery**: There’s a slight recovery post-2021, but it remains well below the original ~0.6 baseline.

🟡 **Interpretation**:

* Model accuracy has **declined over time**, especially during 2015–2020.
* This suggests a growing misalignment between the model and changing real-world patterns—possibly due to data drift or outdated training assumptions.

**✅ Mean Absolute Error (MAE)**

**Plot title: Mean Absolute Error of Model in Production**

* **General trend**: Gradual **increase in MAE from 2002 through 2018**, with a plateau and **slight decline post-2021**.
* **Peak error**: Around **2018–2020**, MAE exceeds 4000.
* **Improvement**: MAE appears to slightly decrease after 2021, suggesting either model retraining or stabilization in data.

🟡 **Interpretation**:

* Prediction error grew steadily for over a decade, again suggesting **degradation in model accuracy**.
* Post-2021 improvements may be due to either model updates or data normalization.

**📌 Question 2: Actual vs. Predicted Purchases (Quantiles Over Time)**

**Plot title: Predictions vs Observed Quantiles for Model in Production**

* **Time periods of divergence**:
  + **2008–2010**: Observed values drop below predicted, creating a visible gap.
  + **2016–2020**: Observed values (red) trend **lower than predicted** (blue), suggesting overestimation by the model.
  + **2022–2024**: Gap **closes**, with predicted and observed values almost aligning.

🟡 **Interpretation**:

* **Cause of deviation** (2015–2020): Appears primarily due to a **drop in actual observed purchases**, while the model continued predicting at similar levels.
* This could indicate external shocks or behavioral changes not captured in training data.
* The fact that predictions remained stable while actuals declined suggests that **the model did not adapt to the new behavior**—likely due to concept drift or lack of retraining.