MEAT DELI
REVENUE OPTIMIZATION

Exploratory Data Analysis & Model Engineering
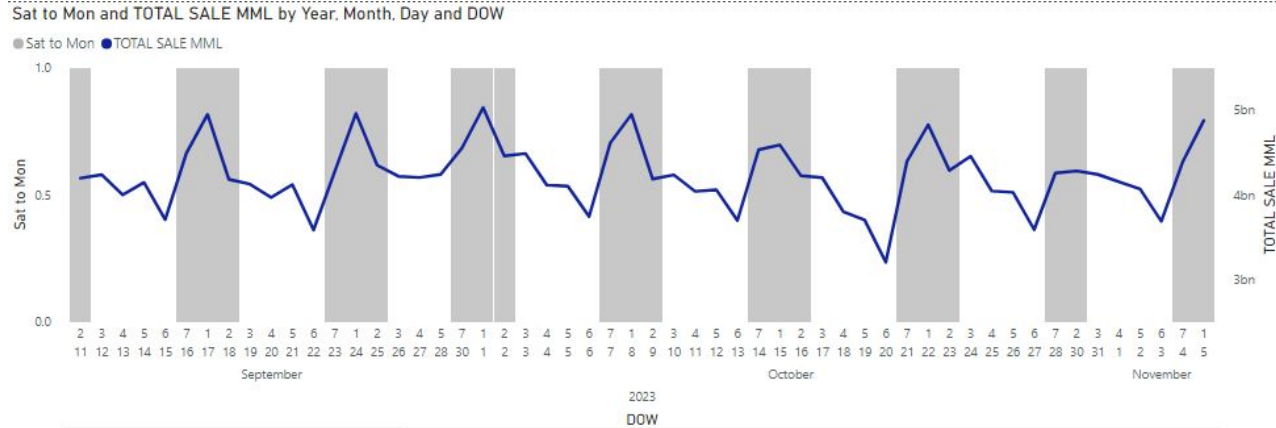
Data collection

I collected historical sales data for MML SKUs from WCM stores for the period from 2022/01/01 - 2024/04/21.

The dataset encompassed information on sales, transactions, product categories, store locations, and dates.

PURCHASING BEHAVIORS

EXPLORATORY DATA ANALYSIS - MML products

Sat to Mon and TOTAL SALE MML by Year, Month, Day and DOW

Overall, It's easy to notice that sales of MML products is peak on weekend (more exactly from Sat to Mon), meanwhile it dropped on weekdays (most significantly on Friday).

However, it might be the reason that sales on weekend is the highest due to the fact that more ppl visit to WCM stores on the weekend and less on weekdays (Friday particularly since we see huge drop of sales on Friday).

EXPLORATORY DATA ANALYSIS - All stores
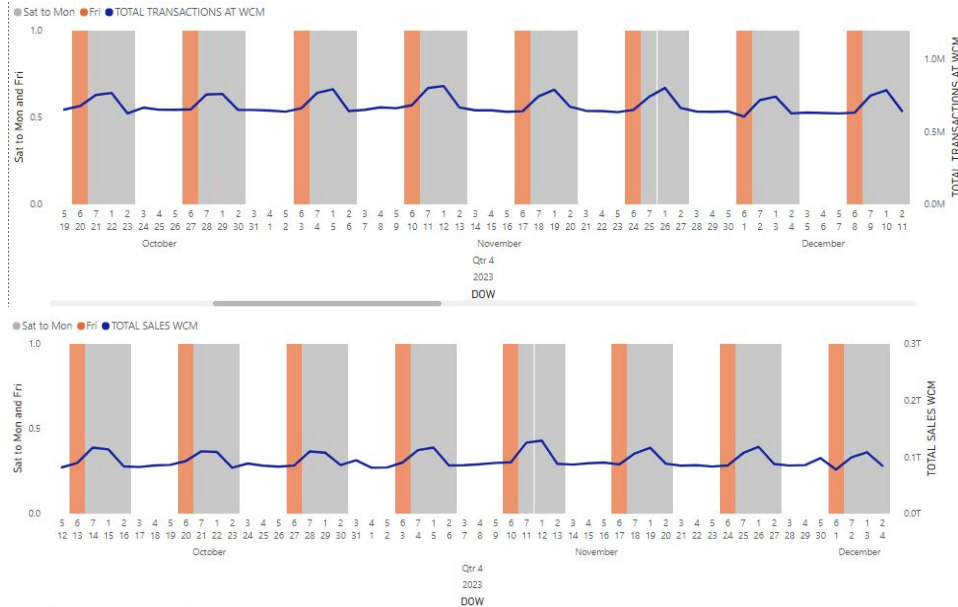
We can see that there are more visits to WCM stores on weekend (Sat and Sun), which correlates to sales of total products (incl. MML) => more visits on Sat and Sun result in higher sales of MML in Sat and Sun.

However, sales/visits on Fri and Monday seems stable, but the sales of MML on Fri/Mon are totally uncorrelated => there is some hidden patterns here and we want to dive deep into it.

EXPLORATORY DATA ANALYSIS - MML products

Sum of VALUE_SALE by PRODUCT_NAME

Top 6 MML products contribute to > 50% of total revenue, i focus on this group for deeper analysis.

I define some metrics that may reflect the purchasing behavior of buyers.

1. **Proba_purchase** = total MML transactions / total store transactions

2. **Basket_Share_MML** = total MML sales/ total store sales

3. **Avg_Sales_per_transaction_MML** = total MML sales / total MML transactions

4. **Avg_Sales_per_store_visit_MML** = total MML sales / total store transactions

MEAT DELI Thịt heo xay chuẩn ngon (S) - HÀ NỘI

MEAT DELI Ba rọi heo (S) - HCM

MEAT DELI [PRE] Sườn Thăn (sườn non) (S) - HÀ NỘI

PROBA OF PURCHASE by DOW

● Sat to Mon ● PROBA OF PURCHASE
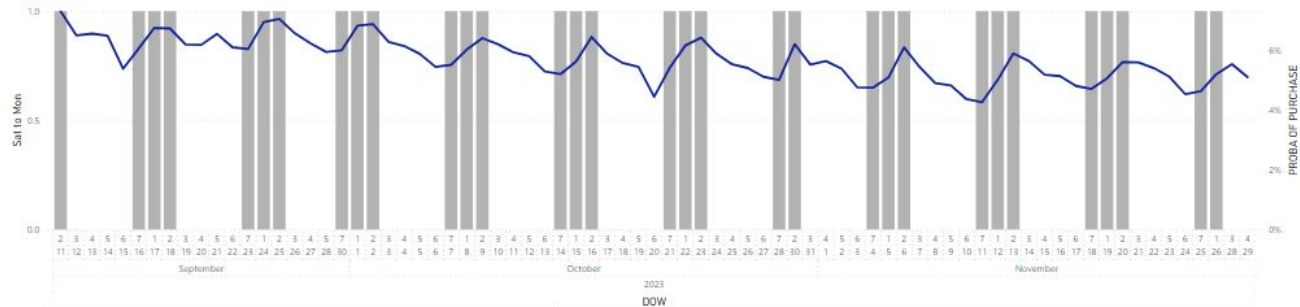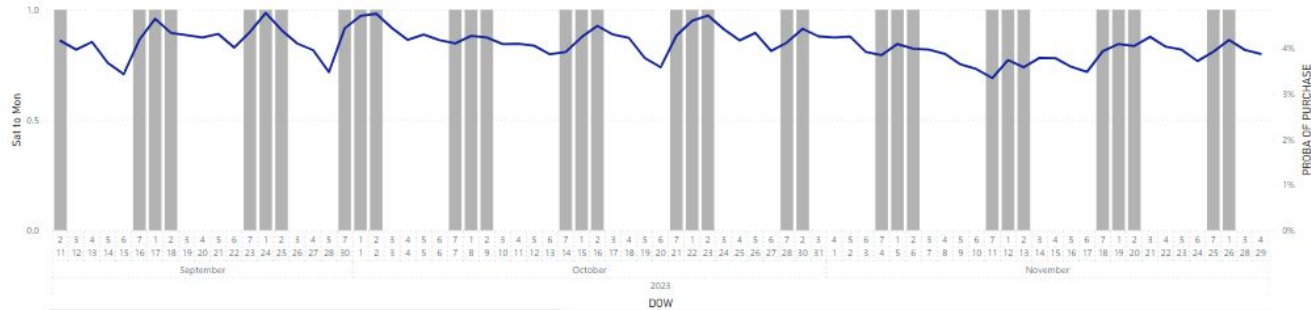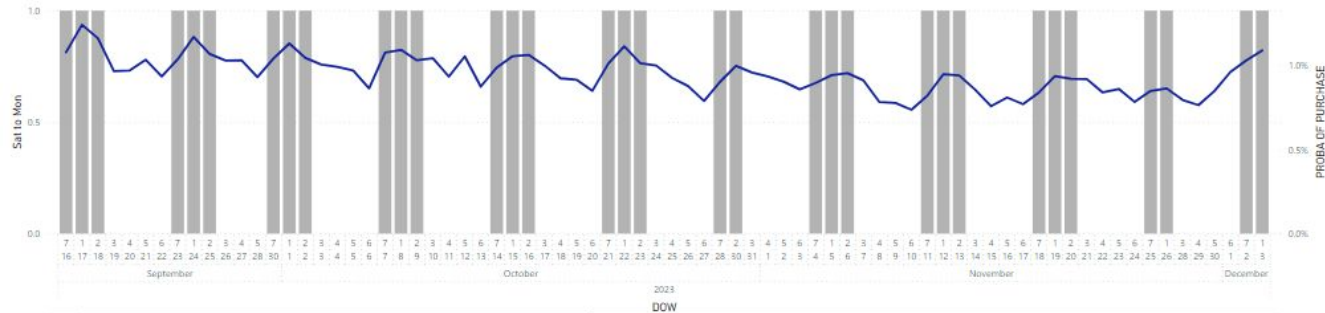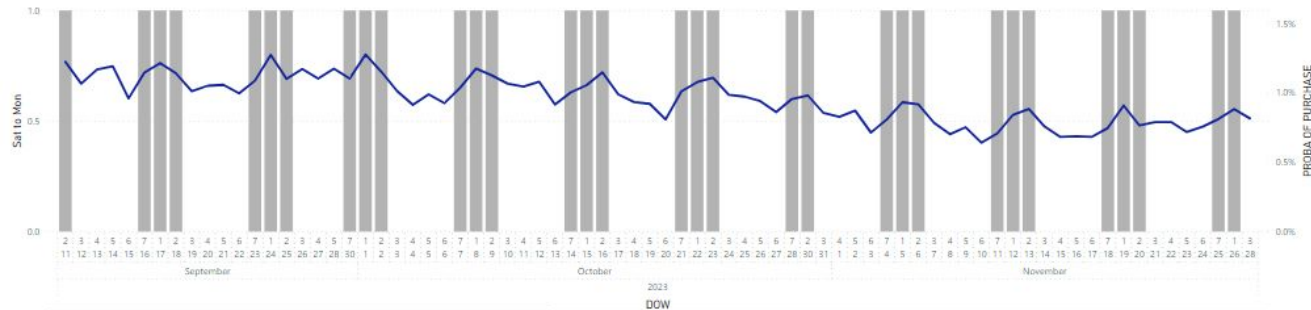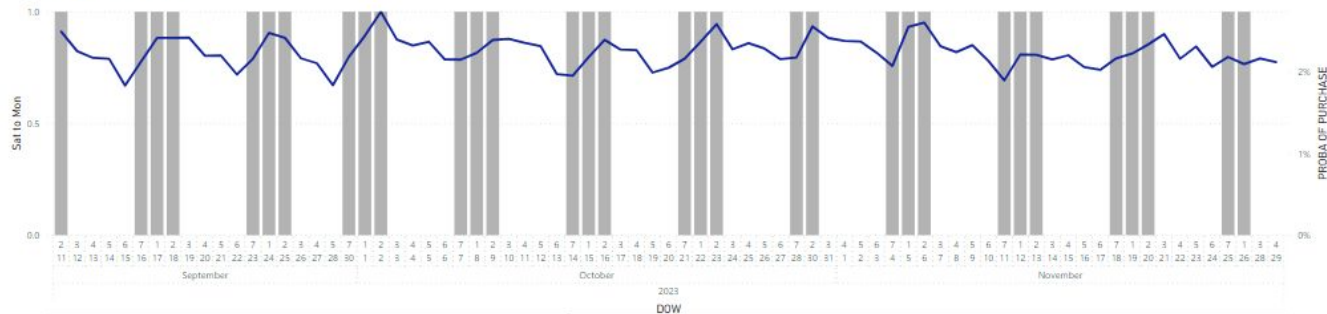
Probability of Purchase

PERIOD_TAG	1	2	3	4	5	6	7
Monday, September 11, 2023	1.24%	1.27%	1.09%	1.13%	1.18%	0.93%	1.08%
Monday, September 18, 2023	1.17%	1.16%	0.96%	0.97%	1.03%	0.93%	1.04%
Monday, September 25, 2023	1.13%	1.07%	1.03%	1.03%	0.93%	0.81%	1.04%
Monday, October 02, 2023	1.05%	1.04%	1.00%	0.99%	0.97%	0.86%	1.07%
Monday, October 09, 2023	1.05%	1.03%	1.04%	0.93%	1.05%	0.87%	0.99%
Monday, October 16, 2023	1.11%	1.06%	1.00%	0.92%	0.91%	0.85%	1.04%
Monday, October 23, 2023	1.03%	1.01%	1.00%	0.92%	0.88%	0.79%	0.90%
Monday, October 30, 2023	0.94%	1.00%	0.96%	0.93%	0.90%	0.86%	0.90%
Monday, November 06, 2023	0.95%	0.95%	0.91%	0.78%	0.78%	0.74%	0.81%
Monday, November 13, 2023	0.94%	0.94%	0.85%	0.76%	0.81%	0.77%	0.84%
Total	1.05%	1.00%	0.97%	0.94%	0.95%	0.86%	0.96%

Avg BASE_SALE_QTY of MML per Transaction

PERIOD_TAG	1	2	3	4	5	6	7
Monday, September 11, 2023	0.41	0.36	0.38	0.40		0.40	0.42
Monday, September 18, 2023	0.42	0.36	0.38		0.38	0.40	0.42
Monday, September 25, 2023	0.42	0.40	0.40			0.40	0.42
Monday, October 02, 2023	0.42	0.40	0.41	0.40	0.39	0.40	0.41
Monday, October 09, 2023	0.41	0.35	0.39		0.41	0.42	0.41
Monday, October 16, 2023	0.43	0.40	0.40	0.39	0.40	0.43	0.42
Monday, October 23, 2023	0.42	0.41	0.40	0.40	0.40	0.40	0.42
Monday, October 30, 2023	0.42	0.35	0.39	0.40	0.39		0.42
Monday, November 06, 2023	0.42	0.41	0.39	0.40	0.40		
Monday, November 13, 2023	0.42	0.40		0.40		0.41	0.42
Total	0.43	0.40	0.41	0.41	0.41	0.41	0.43

Avg Retail Price

PERIOD_TAG	1	2	3	4	5	6	7
Monday, November 20, 2023	214,467	214,824	215,144	214,245	214,251	214,763	214,864
Monday, November 27, 2023	214,833	214,402	213,622	213,837	213,857	214,356	214,585
Monday, December 04, 2023	215,040	214,347	213,939	214,695	214,859	214,726	214,731
Monday, December 11, 2023	214,435	214,405	214,304	214,646	215,123	215,208	214,995
Monday, December 18, 2023	214,417	214,948	215,371	214,994	214,953	215,025	215,095
Monday, December 25, 2023	214,181	214,631	214,967	214,143	213,586	214,543	214,408
Monday, January 01, 2024	215,685	213,536	213,683	211,930	213,780	214,438	215,667
Monday, January 08, 2024	215,920	215,344	214,595	214,923	214,637	215,371	215,615
Monday, January 15, 2024	214,809	215,646	215,361	215,649	215,340	215,086	215,235
Monday, January 22, 2024	215,384	214,508	215,052	215,355	214,866	215,309	215,433
Total	215,050	214,992	214,878	214,873	214,777	213,797	215,137

MEAT DELI [PRE] Thịt heo xay đặc biệt - HCM

MEAT DELI [PRE] Ba rọi đặc biệt (S) - HÀ NỘI

MEAT DELI [PRE] Nạc dăm heo (nạc vai) (S) - HCM

TREND ANALYSIS - DOW

We see that even in the weekend the purchase probability is consistently higher on Sat/Sun/Mon than in other weekdays (Friday particularly) => Ppl tend to buy and store fresh product on these days to consume for the whole week

PRICE ELASTICITY

PRICE ELASTICITY of DEMAND MODEL

As analysis from previous part, we discovered that shoppers have certain buying patterns for MML products (fresh meat) on specific days (Saturday/Sunday/Monday) and tend not to buy on Fridays. This suggests that price sensitivity varies throughout the week. Specifically, it is expected that price has less impact on demand on Sundays, while it has a greater impact on Fridays. This insight leads to the idea of increasing prices on Sundays without significantly affecting demand and reducing prices on Fridays to drive sales.

Additionally, I have a hypothesis that different store formats may exhibit varying price sensitivities due to different types of visitors. This effect is expected to be more prominent on weekends since shoppers tend to visit supermarkets more frequently during that time.

To measure the price elasticity of demand and simulate price optimization, you propose three different aggregation levels:

1.   Aggregate at CITY/PRODUCT/WEEK level (since intraweek price is static)
2.   Aggregate at CITY/PRODUCT/WEEK/BUSINESS_UNIT level
3.   Aggregate at CITY/PRODUCT/WEEK/BUSINESS_UNIT/DOW level

To simulate the price optimization, I will measure the incremental gain of revenue from each model. The price changes will be measured relative to the GT price (market price). The assumptions made are that shoppers are rational and make decisions based on their expectations. Shoppers are aware of the general market price and have an acceptance price based on that information.

CITY/PRODUCT/WEEK

GAM DIFF_PRICE_GT vs BASE_SALE_QTY
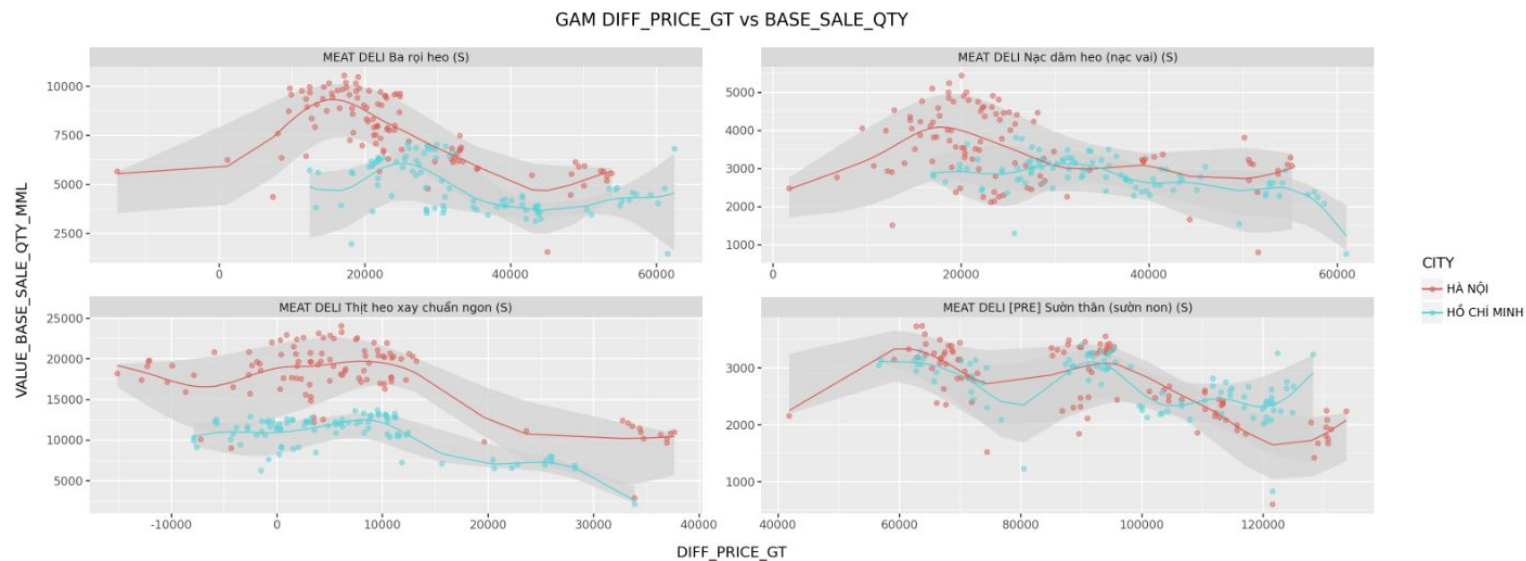
Different products at different city have the different sensitivity of price. For example **MEAT DELI Ba rọi heo (S)** and **MEAT DELI [PRE] Sườn thăn (sườn non) (S)** are less sensitive with price in HCM than in HN. It can be explained due to preference and regional differences.

CITY/PRODUCT/WEEK/BUSINESS_UNIT

GAM DIFF_PRICE_GT vs BASE_SALE_QTY - HÀ NỘI
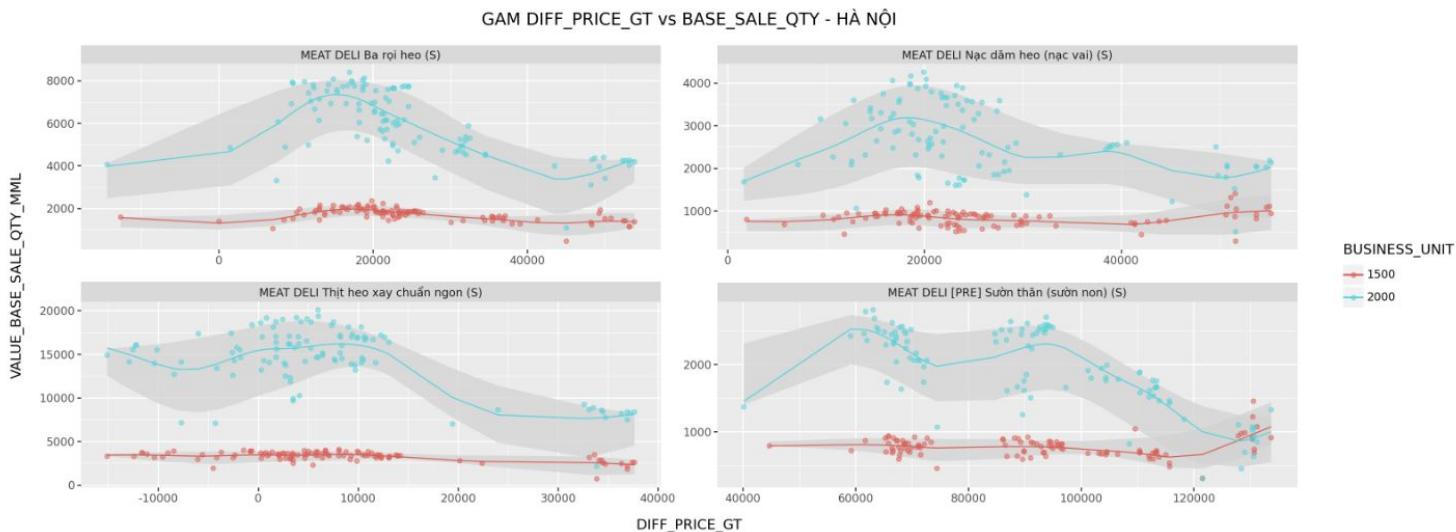
Demand is less sensitive with price at supermarket format (BUSINESS_UNIT = 1500) than in mini-mart/grocery store (BUSINESS_UNIT = 2000)

CITY/PRODUCT/WEEK/BUSINESS_UNIT

GAM DIFF_PRICE_GT vs BASE_SALE_QTY - HỒ CHÍ MINH

CITY/PRODUCT/WEEK/BUSINESS_UNIT/DOW

SIMULATION

CITY/PRODUCT/WEEK - Demand vs Price

MEAT DELI - PRICE OPTIMIZATION (GAP to GT PRICE) - HỒ CHÍ MINH

Optimal Median BASE_SALE_QTY (Red) - Current Pricing (Green) - 95% Maximum Confidence Interval (Blue)

CITY/PRODUCT/WEEK - Demand vs Price

MEAT DELI - PRICE OPTIMIZATION (GAP to GT PRICE) - HÀ NỘI

Optimal Median BASE_SALE_QTY (Red) - Current Pricing (Green) - 95% Maximum Confidence Interval (Blue)

CITY/PRODUCT/WEEK - Rev vs Price

MEAT DELI - PRICE OPTIMIZATION (GAP to GT PRICE) - HÀ NỘI

Maximum Median Revenue (Red) - Current Pricing (Green) - 95% Maximum Confidence Interval (Blue)

CITY/PRODUCT/WEEK - Rev vs Price

MEAT DELI - PRICE OPTIMIZATION (GAP to GT PRICE) - HỒ CHÍ MINH

Maximum Median Revenue (Red) - Current Pricing (Green) - 95% Maximum Confidence Interval (Blue)

CITY/PRODUCT/WEEK/BUSINESS_UNIT - Rev vs Price

MEAT DELI - PRICE OPTIMIZATION (GAP to GT PRICE) - HÀ NỘI

Maximum Median Revenue (Red) - Current Pricing (Green) - 95% Maximum Confidence Interval (Blue)

CITY/PRODUCT/WEEK/BUSINESS_UNIT - Rev vs Price

MEAT DELI - PRICE OPTIMIZATION (GAP to GT PRICE) - HỒ CHÍ MINH

Maximum Median Revenue (Red) - Current Pricing (Green) - 95% Maximum Confidence Interval (Blue)

CITY/PRODUCT/WEEK/BUSINESS_UNIT - Demand vs Price

MEAT DELI - PRICE OPTIMIZATION (GAP to GT PRICE) - HÀ NỘI
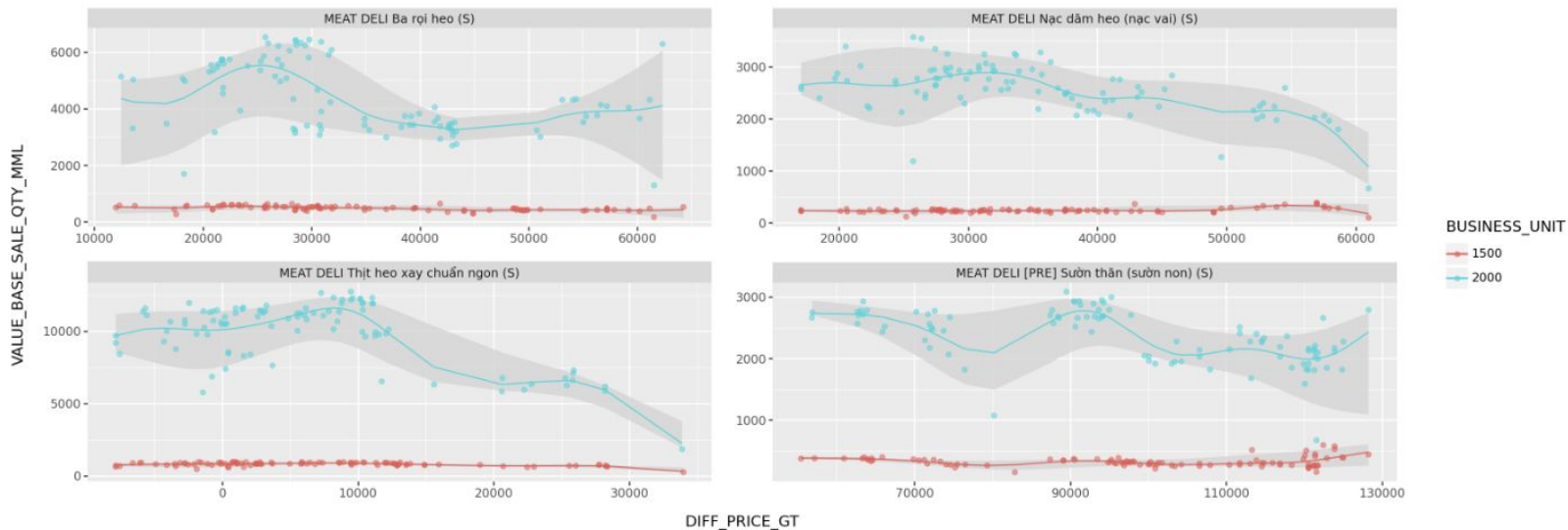
Optimal Median BASE_SALE_QTY (Red) - Current Pricing (Green) - 95% Maximum Confidence Interval (Blue)

CITY/PRODUCT/WEEK/BUSINESS_UNIT - Demand vs Price

MEAT DELI - PRICE OPTIMIZATION (GAP to GT PRICE) - HỒ CHÍ MINH

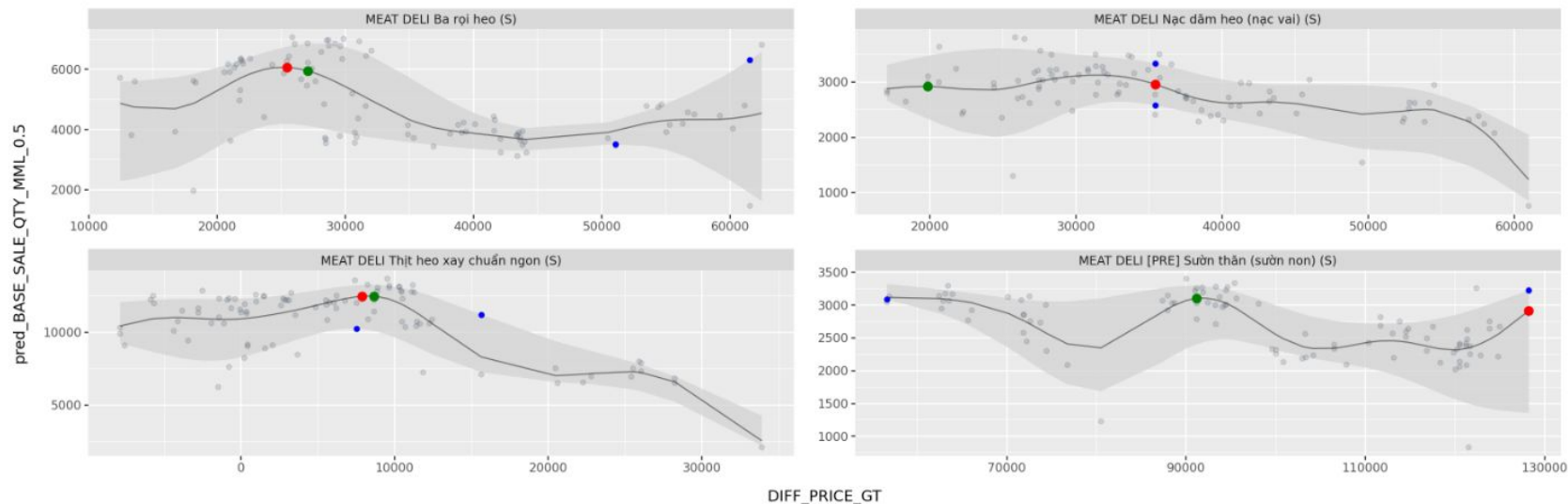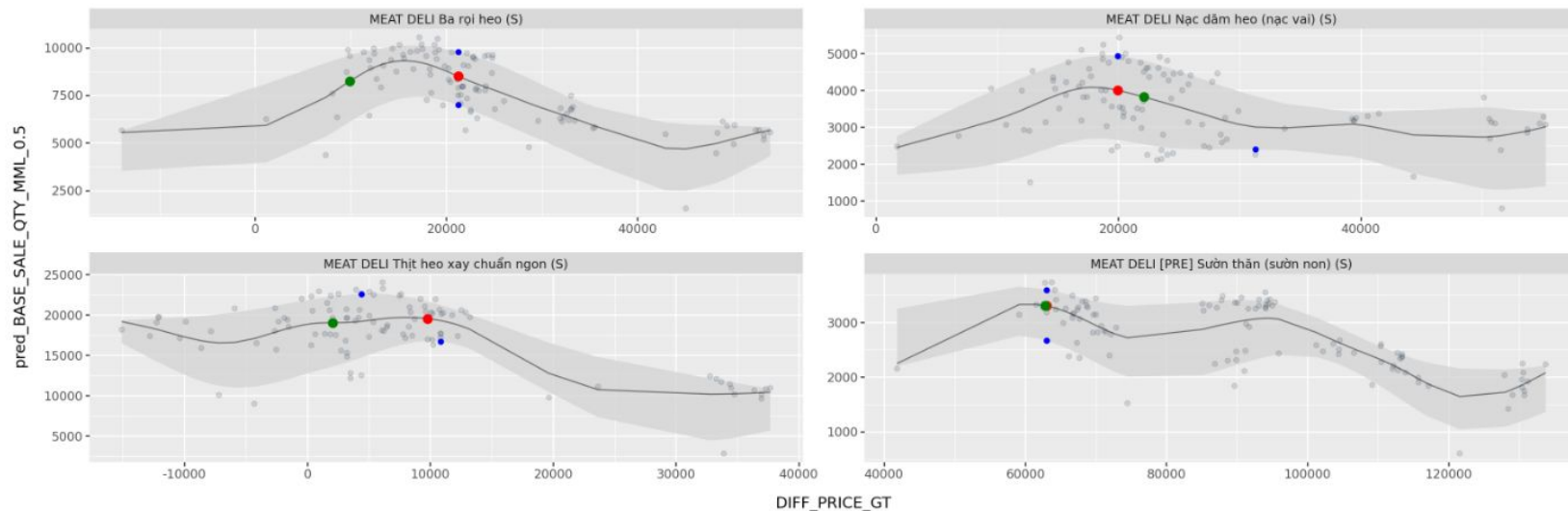Optimal Median BASE_SALE_QTY (Red) - Current Pricing (Green) - 95% Maximum Confidence Interval (Blue)

CITY/PRODUCT/WEEK/BUSINESS_UNIT/DOW

MEAT DELI - PRICE OPTIMIZATION (GAP to GT PRICE) - HÀ NỘI - 1500

Maximum Median Revenue (Red) - Current Pricing (Green) - 95% Maximum Confidence Interval (Blue)

CITY/PRODUCT/WEEK/BUSINESS_UNIT/DOW
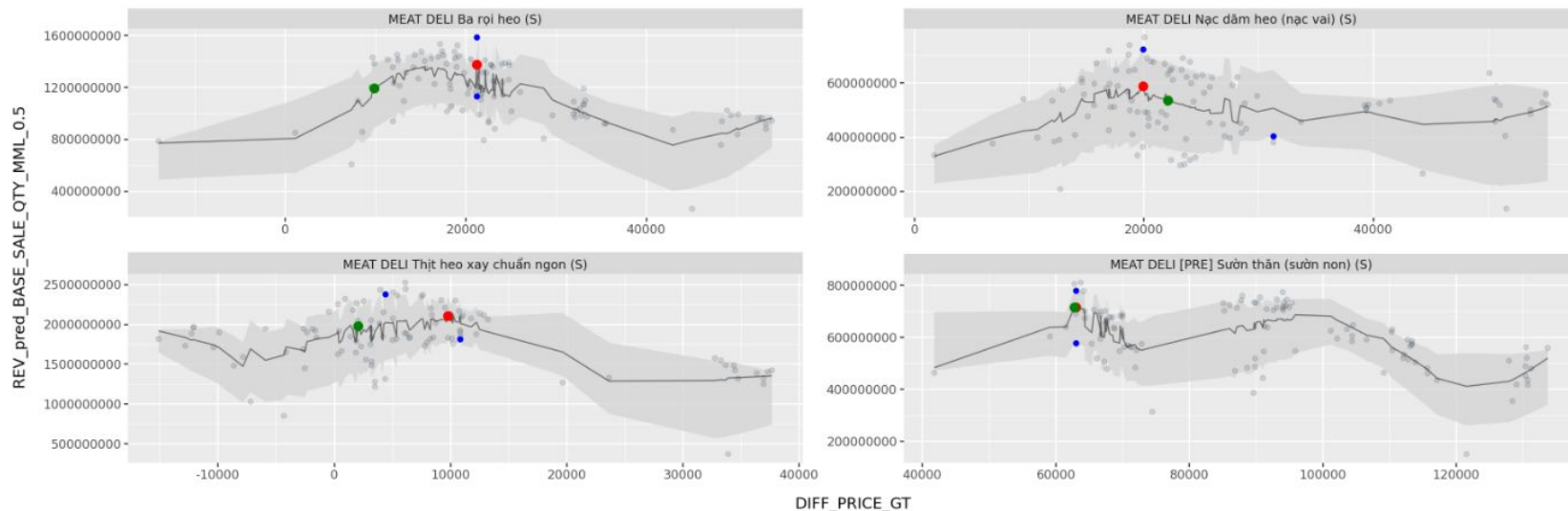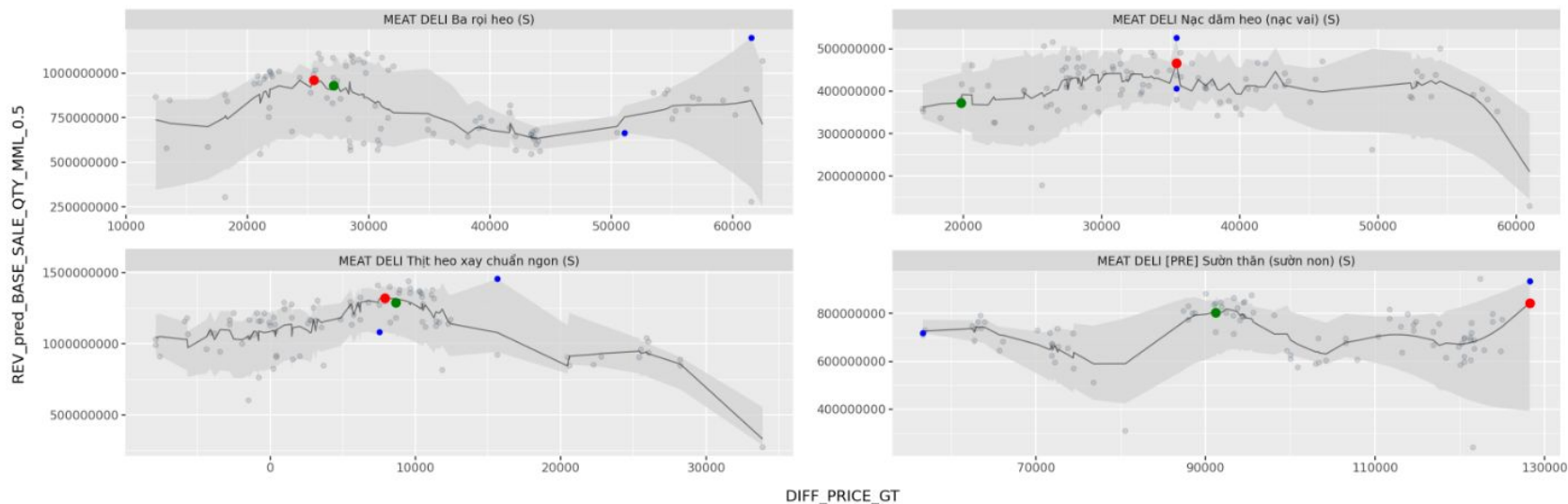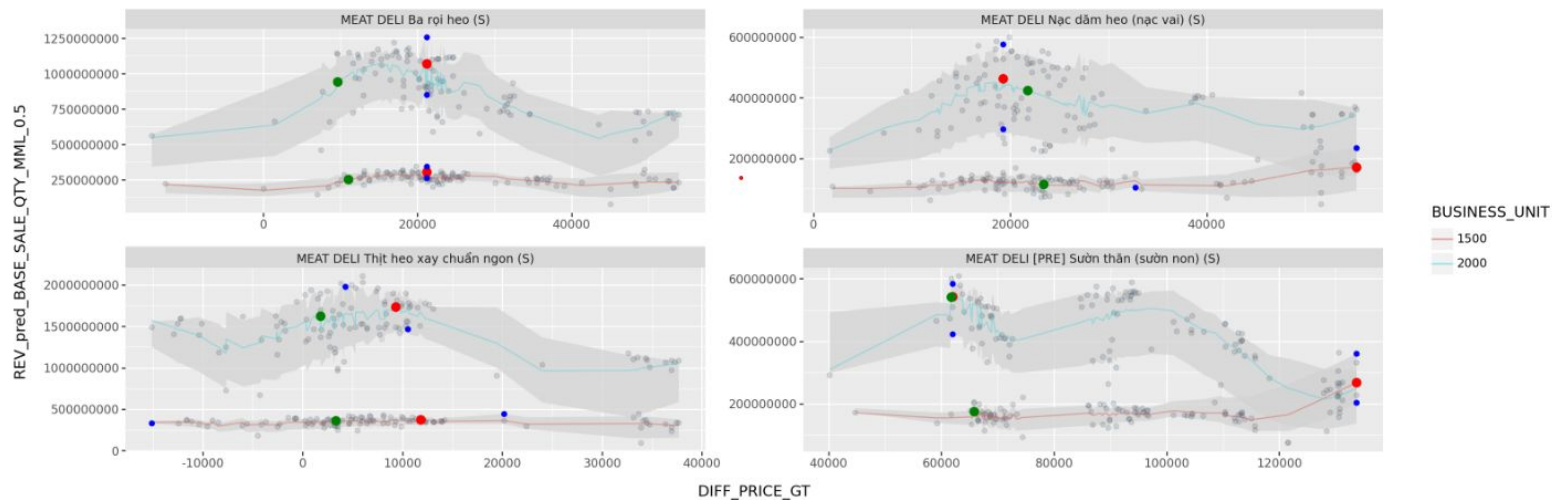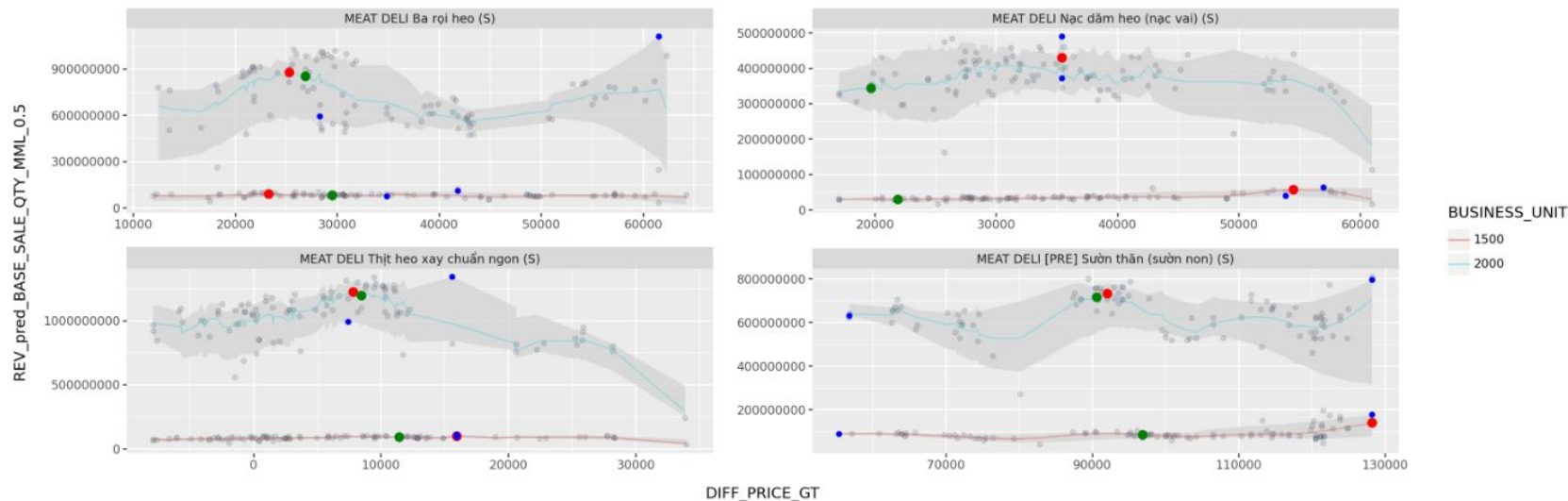

MEAT DELI - PRICE OPTIMIZATION (GAP to GT PRICE) - HỒ CHÍ MINH - 1500
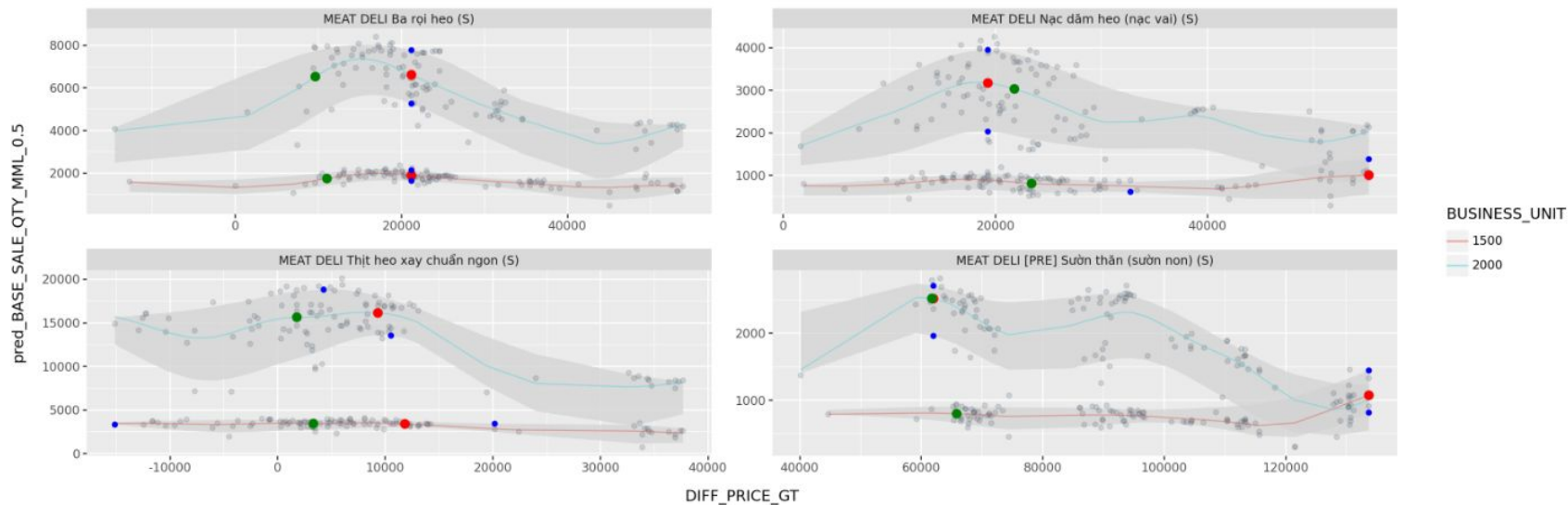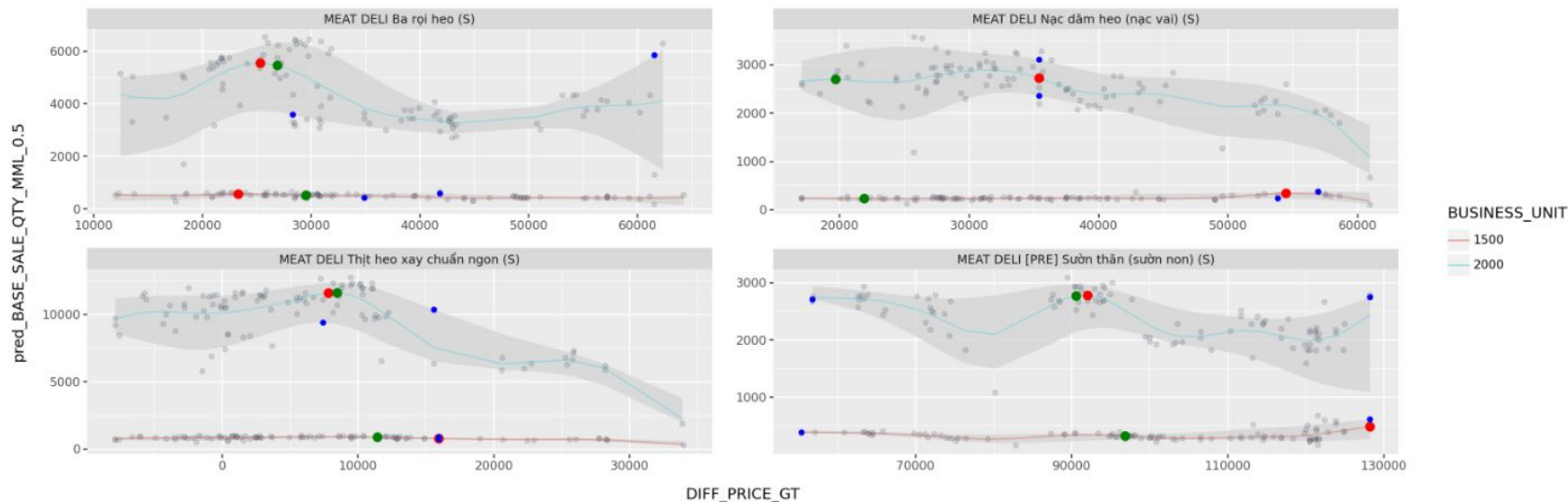
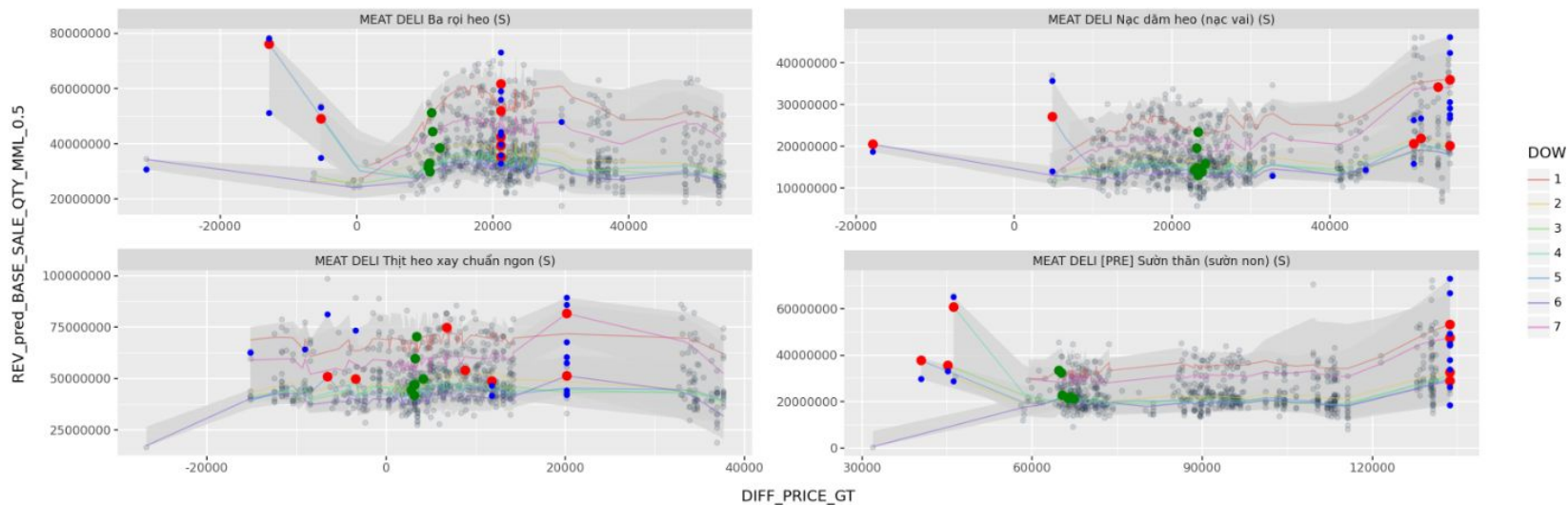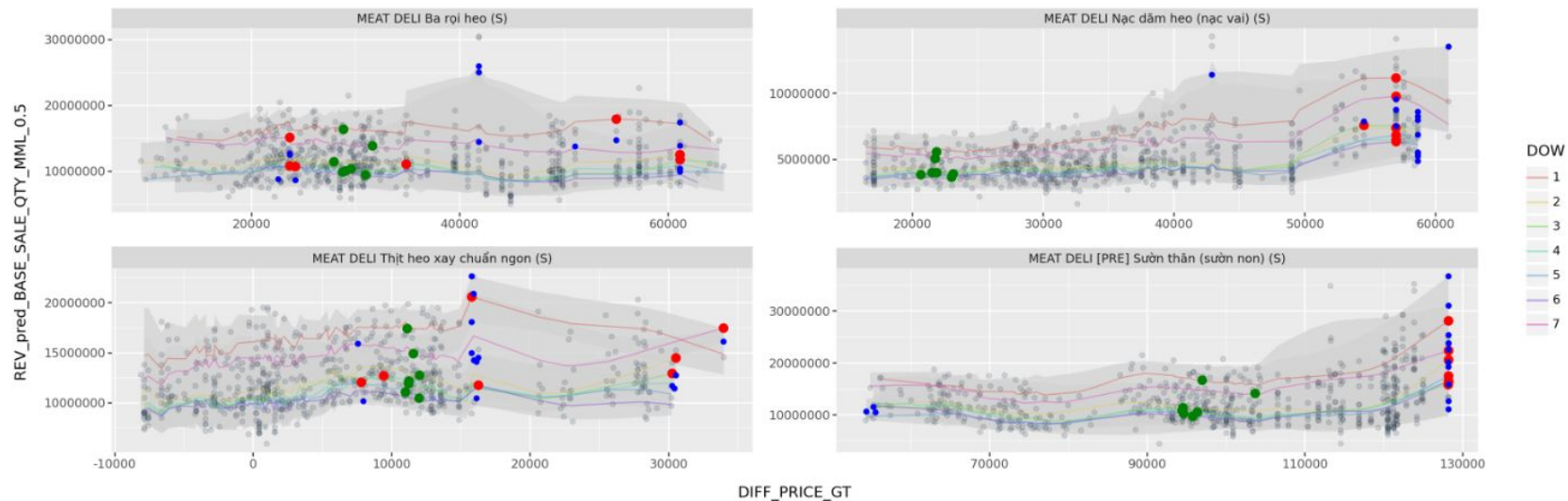Maximum Median Revenue (Red) - Current Pricing (Green) - 95% Maximum Confidence Interval (Blue)

SUMMARY SIMULATION

CITY	PRODUCT_NAME	OPTIMAL_FORECAST_RE	OPTIMAL_FORECAST_RE	OPTIMAL_FORECAST_RE	CURRENT_FORECAST_RE	% _gain_OPTIMAL	% _gain_OPTIMAL_BUSINESS_UNIT	% _gain_OPTIMAL_BUSINESS_UNIT_DOW
HÀ NỘI	MEAT DELI Ba rọi heo (S)	1,375,716,879	1,374,590,874	1,442,276,514	1,192,496,622	15.4%	15.3%	20.9%
HÀ NỘI	MEAT DELI Nạc dăm heo (nạc vai) (S)	587,026,143	632,586,826	628,692,215	535,618,021	9.6%	18.1%	17.4%
HÀ NỘI	MEAT DELI Thịt heo xay chuẩn ngon (S)	2,106,605,392	2,102,526,810	2,135,956,947	1,980,184,530	6.4%	6.2%	7.9%
HÀ NỘI	MEAT DELI [PRE] Sườn thăn (sườn non) (S)	715,999,213	809,472,487	851,198,678	714,704,737	0.2%	13.3%	19.1%
HỒ CHÍ MINH	MEAT DELI Ba rọi heo (S)	960,134,773	965,212,828	965,960,025	929,415,175	3.3%	3.9%	3.9%
HỒ CHÍ MINH	MEAT DELI Nạc dăm heo (nạc vai) (S)	466,276,541	485,815,524	489,122,051	372,292,408	25.2%	30.5%	31.4%
HỒ CHÍ MINH	MEAT DELI Thịt heo xay chuẩn ngon (S)	1,317,222,040	1,320,285,056	1,336,646,503	1,288,207,553	2.3%	2.5%	3.8%
HỒ CHÍ MINH	MEAT DELI [PRE] Sườn thăn (sườn non) (S)	842,841,410	870,259,399	892,915,208	803,611,067	4.9%	8.3%	11.1%
	TOTAL	**8,371,822,393**	**8,560,749,803**	**8,742,768,142**	**7,816,530,111**	**7.1%**	**9.5%**	**11.8%**

I used GAM model to measure the price elasticity of demand and simulate the REVENUE by median forecasted BASE_SALE_QTY for the period from 2022jan - 2024mar.

It suggests that GAM optimal price may uplift revenue by **7%**, and if we adjust the price dynamically by BUSINESS_UNIT / BUSINESS_UNIT & DOW we gain **9.5%** and **11.8%** respectively of the revenue.

Please note that the forecast sale volume and revenue is simulated and take the median out of it.

For more details please check the following link:
https://docs.google.com/spreadsheets/d/1NbGe_sgsk3S0Hqbbs93sajistms5Bj2A/edit?usp=drive_link&ouid=112118046433686324010&rtpof=true&sd=true

REVENUE OPTIMIZATION ALGORITHM WITH ML-BASED PRICE ELASTICITY MODEL

Including 2 models:

(1) Price Elasticity price with sale qty as dependent variables, and selling price, competitor price, pig price etc. as independent variables at weekly level
(2) Revenue optimization model considering both B2C and B2B revenues