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Appendix A: Exploratory Data Analysis Results

A.1 Null and Constant Value Columns

Specific columns identified with entirely null values:

- 'Unit Sales Special Pack Only'
- 'Volume Sales Special Pack Only'
- 'Dollar Sales Special Pack Only'
- 'Price per Unit Special Pack Only'
- 'Price per Volume Special Pack Only'
- 'ACV Weighted Distribution Special Pack Only'
- 'Meat Source'

Action Taken:

These columns are completely dropped from the dataset, as they provide no usable information for analysis.

A.2 Sales Metrics Insights

Evaluation of top brands and manufacturers from 2020 to 2024.

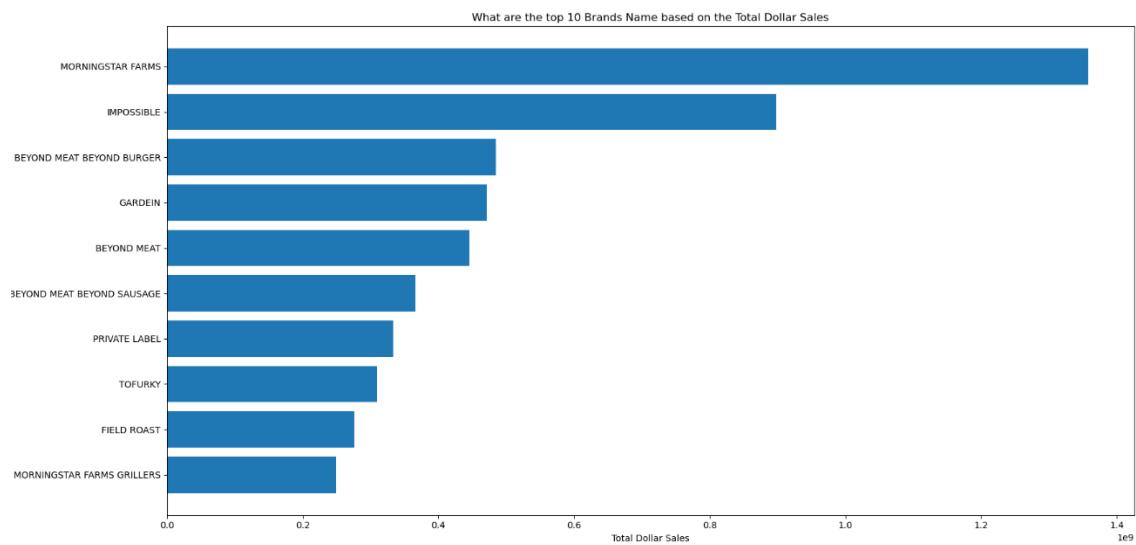


Fig 1. top 10 brands' names based on their total dollar sales over four years from 2020 to 2024.

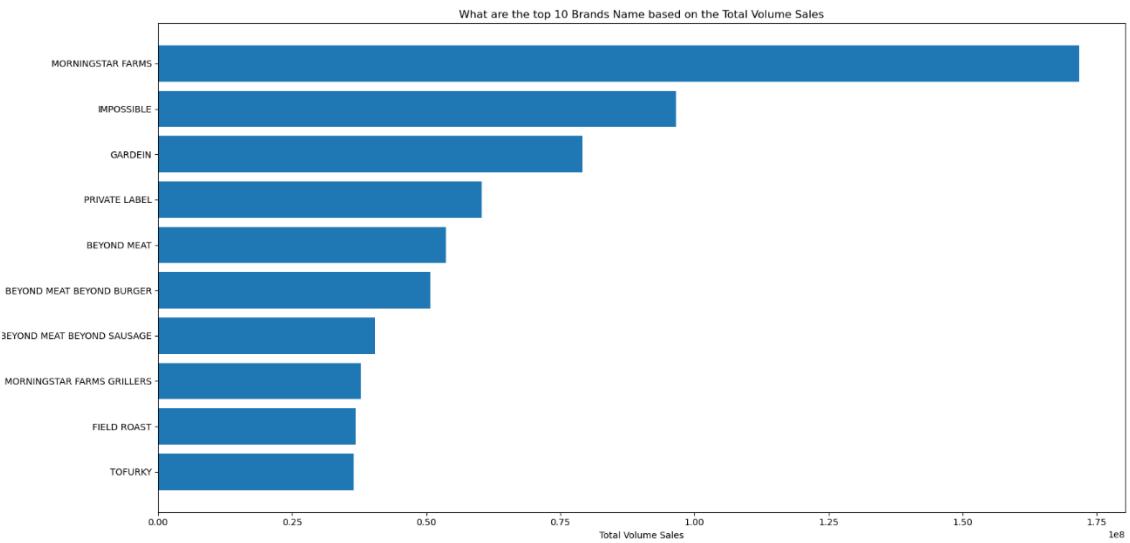


Fig2. Top 10 brands' names based on their total Volume sales over four years from 2020 to 2024.

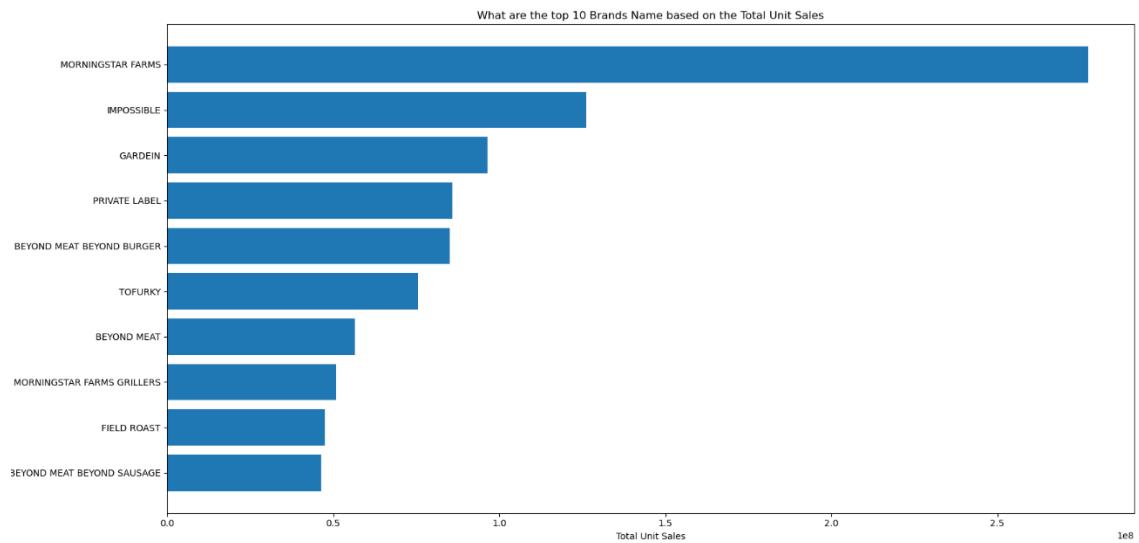


Fig 3. Top 10 brands' names based on their total unit sales over four years from 2020 to 2024.

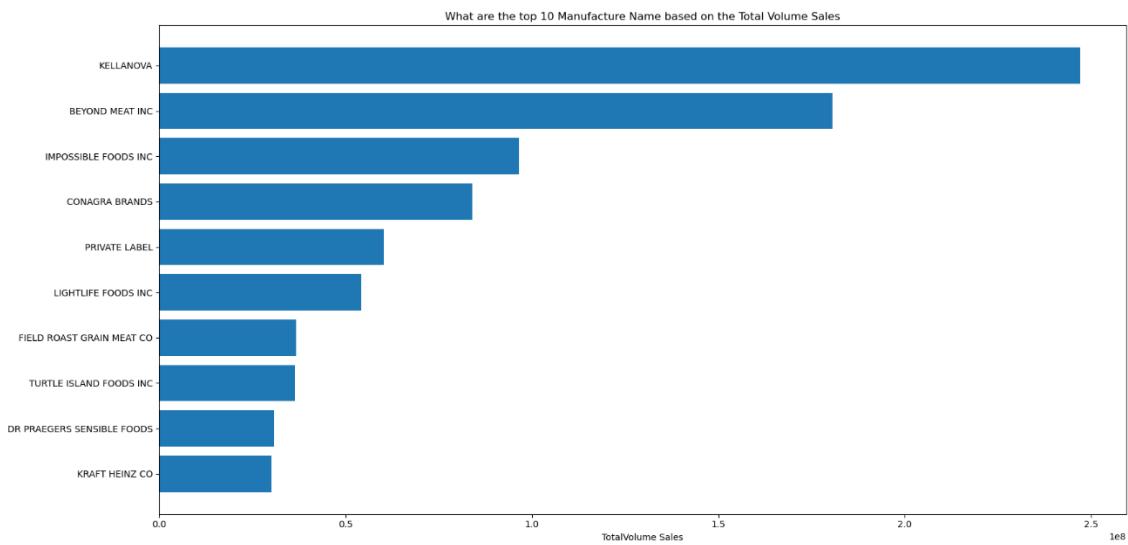


Fig 4. top 10 manufacturers' names based on their total volume sales over four years from 2020 to 2024.

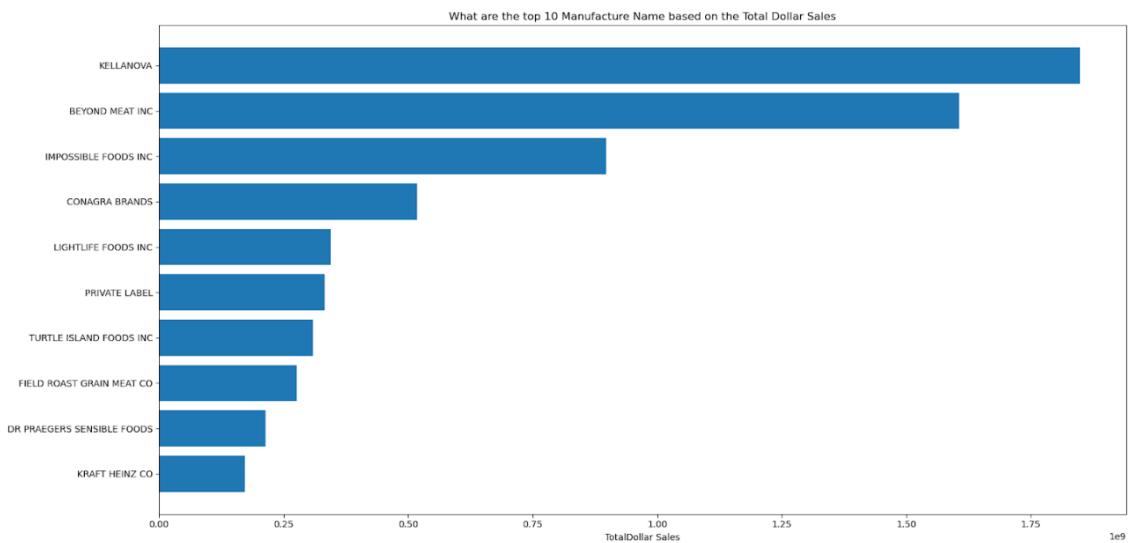


Fig 5. Top 10 manufacturers' names based on their total Dollar sales over four years from 2020 to 2024.

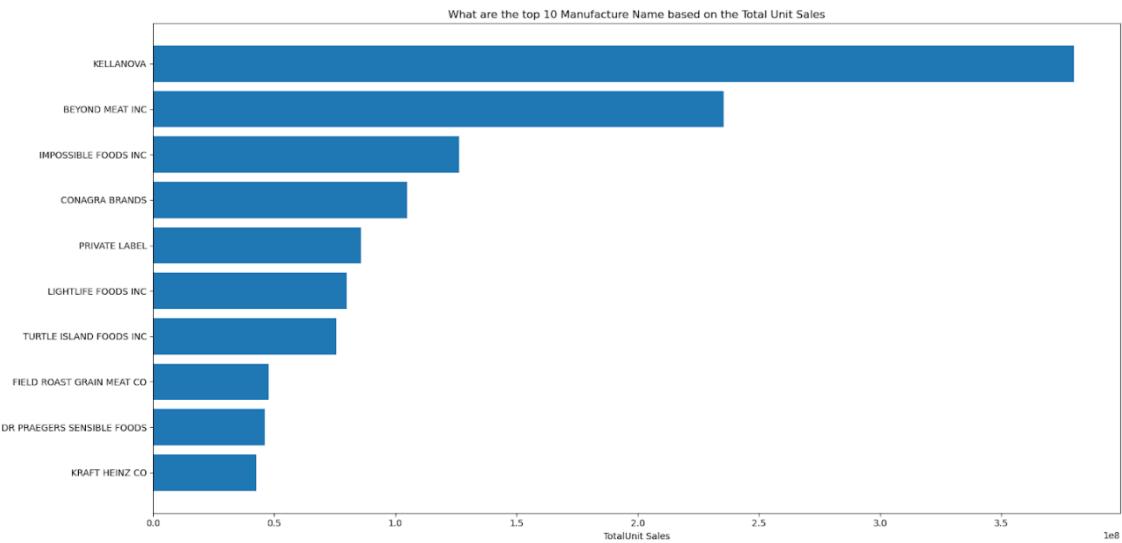


Fig 6. Top 10 manufacturers' names based on their total unit sales over four years from 2020 to 2024.

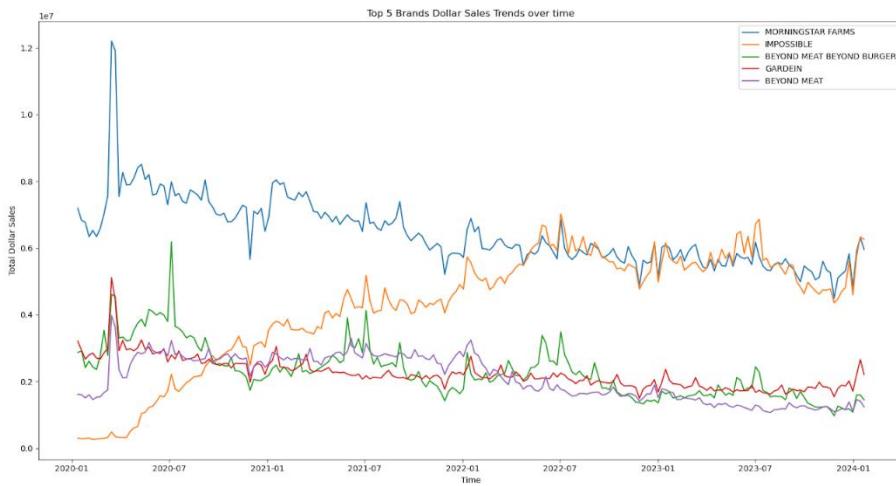
Insight: The MORNINGSTAR FARMS brand is the first brand based on all three metrics. The brand IMPOSSIBLE is the second one for all three metrics. The brand GARDEIN is the third one based on the total unit and volume sales, but for the dollar sales, the BEYOND MEAT BEYOND BURGER stands in third place.

The KELLANOVA manufacture is the first based on all three metrics. The manufacturer BEYOND MEAT is the second one for all three metrics. IMPOSSIBLE FOODS INC is the third one. CONAGRA stands fourth in this ranking.

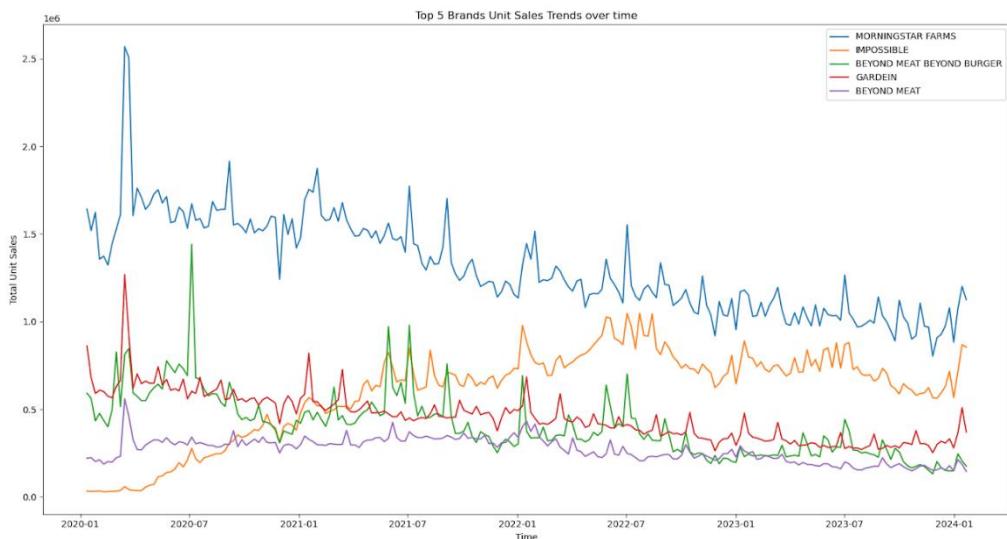
A.3 Weekly Sales Trends

Analysis of sales trends highlighting increasing and decreasing trends.

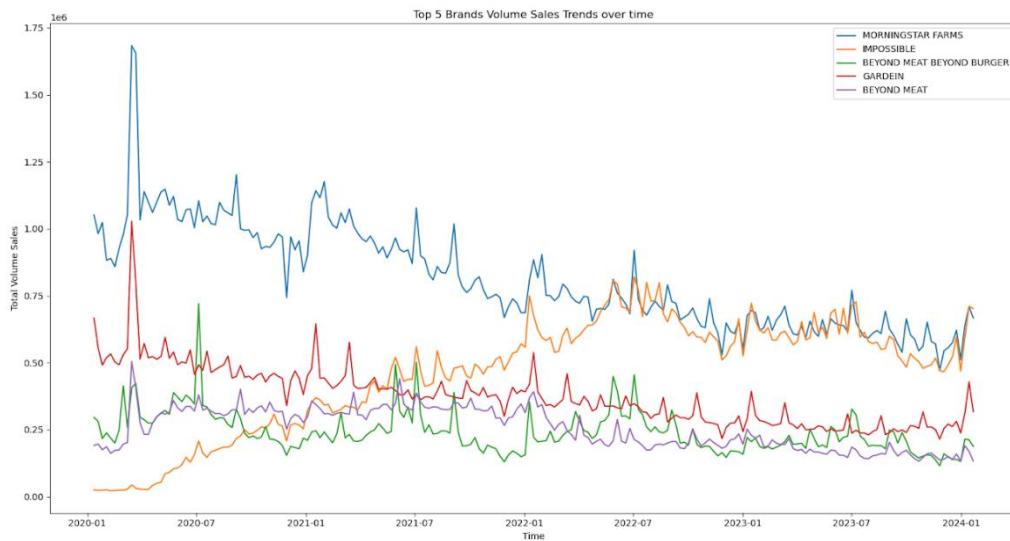
A.3.1 Weekly metric trend increasing or decreasing for the top 5 brands



The chart above shows that except for the brand IMPOSSIBLE, which has an increasing dollar sales trend, all other brands have a decreasing trend over four years.

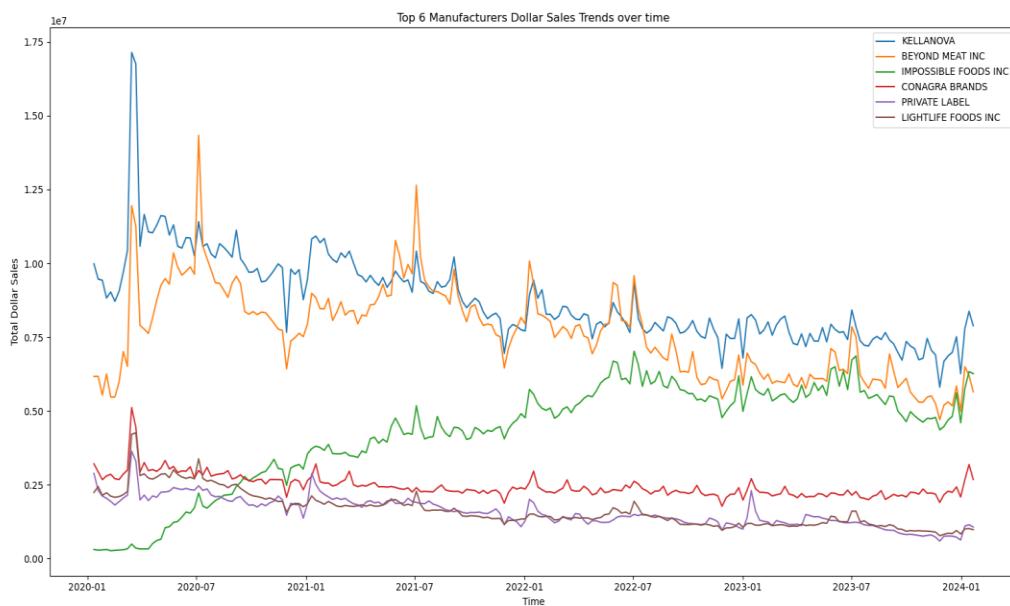


The chart above shows that except for the brand IMPOSSIBLE, which has an increasing unit sales trend from 2020 to the middle of 2022, all other brands have a decreasing trend over four years. The unit sales trend for IMPOSSIBLE is steady from July 2022 to January 2024.

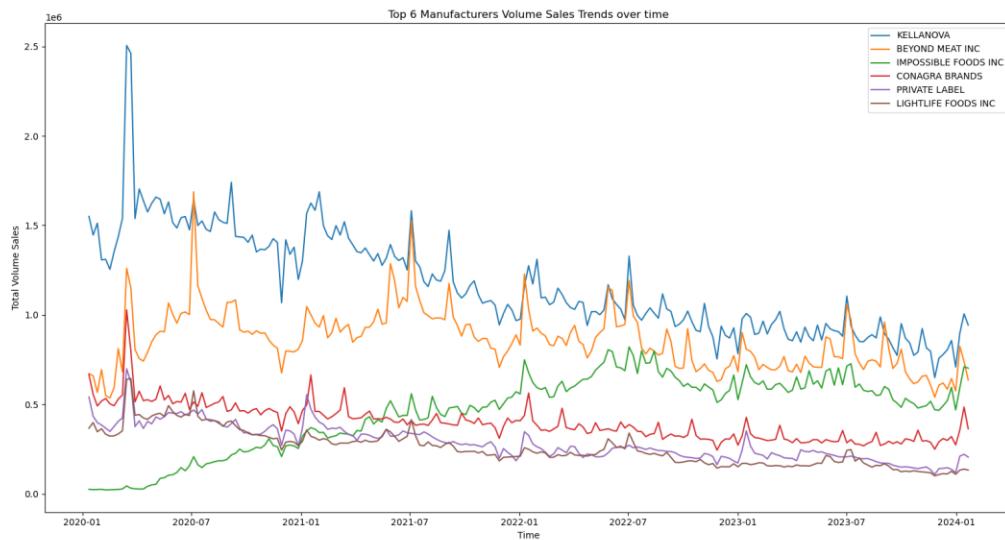
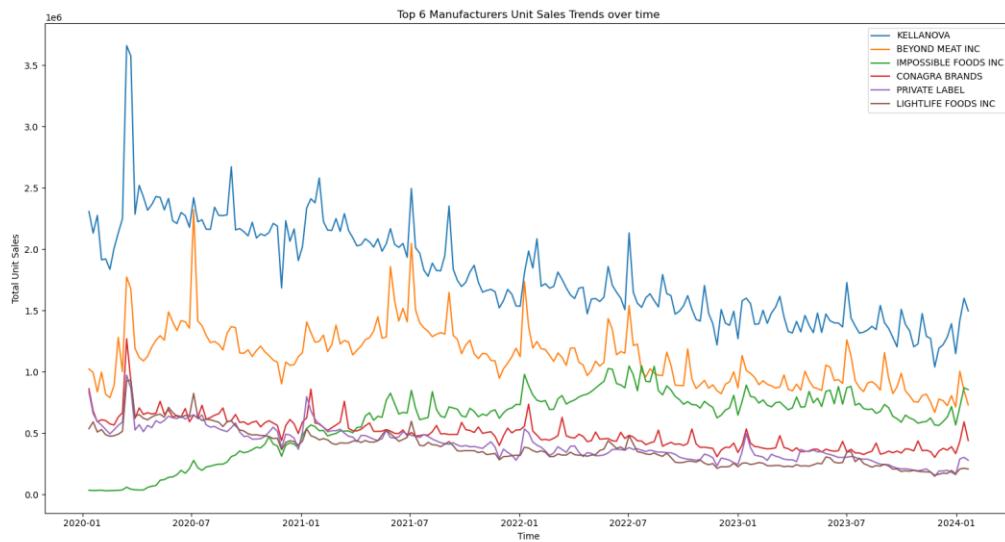


The chart above shows that the weekly trend for volume sales for the top five brands is very similar to the trends for their unit sales.

A.3.2 Weekly metric trend for the top 6 manufacturers



As we can see, the Average Weekly Dollar Sales trends for the top six manufacturers are decreasing except for IMPOSSIBLE FOOD INC. This is true for Average Weekly Volume Sales and Unit Sales.

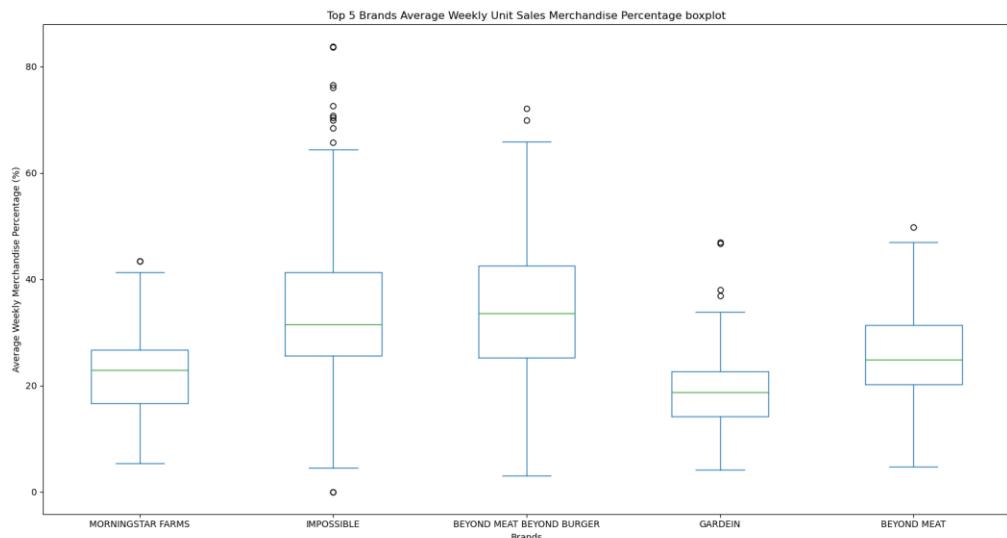
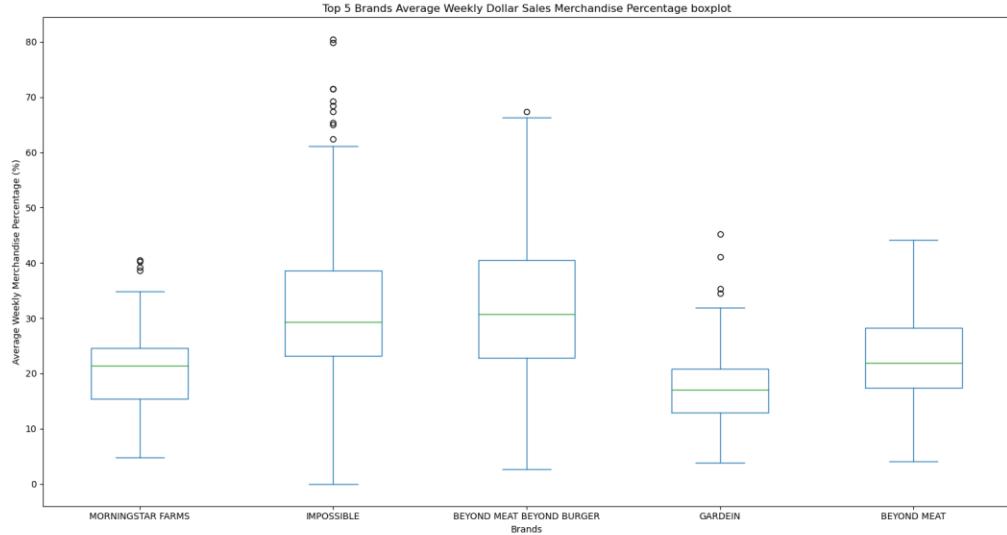


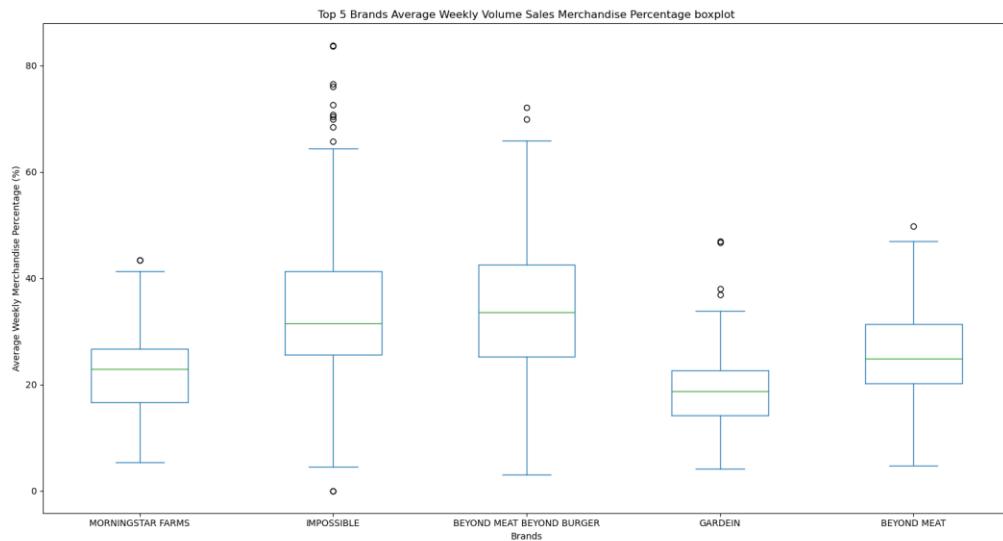
A.4 Merchandise Sales Analysis

A.4.1 Average weekly merchandise percentage for the top 5 brands

In this section, we calculate the ratio of merchandise sales out of all sales. We calculate this ratio weekly for each brand and manufacturer. In the charts below, we plot the boxplot of this ratio over 4 years. As we can see, the brands BEYOND MEAT, BEYOND BURGER, and IMPOSSIBLE have the highest median weekly merchandise ratio. This ratio could be a good representative of differences in sales trends among different brands or manufacturers.

We have the same difference in ratio for all Dollar Sales, Volume Sales, and Unit Sales.



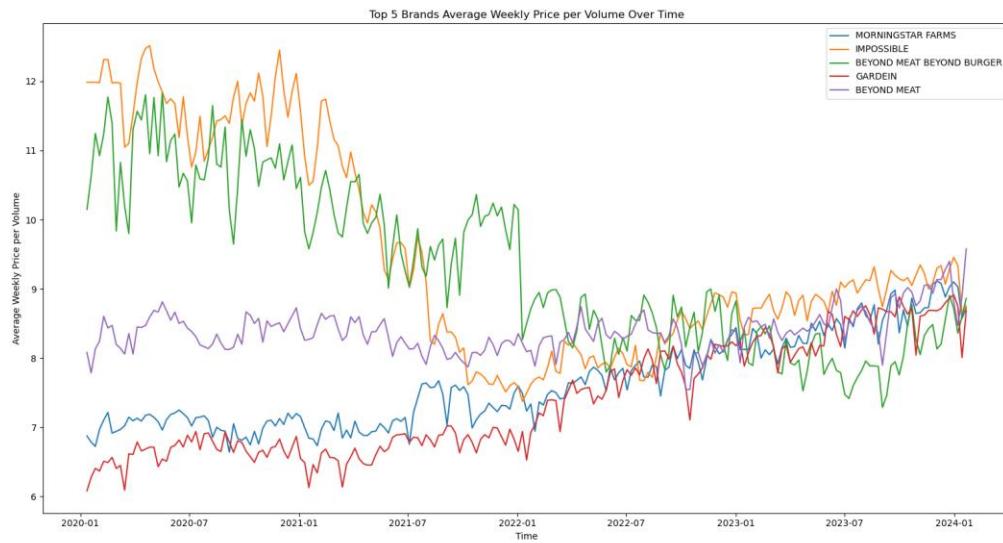


A.5 Price Trends Analysis

A.5.1 Average weekly price per volume trend for the top 5 brands

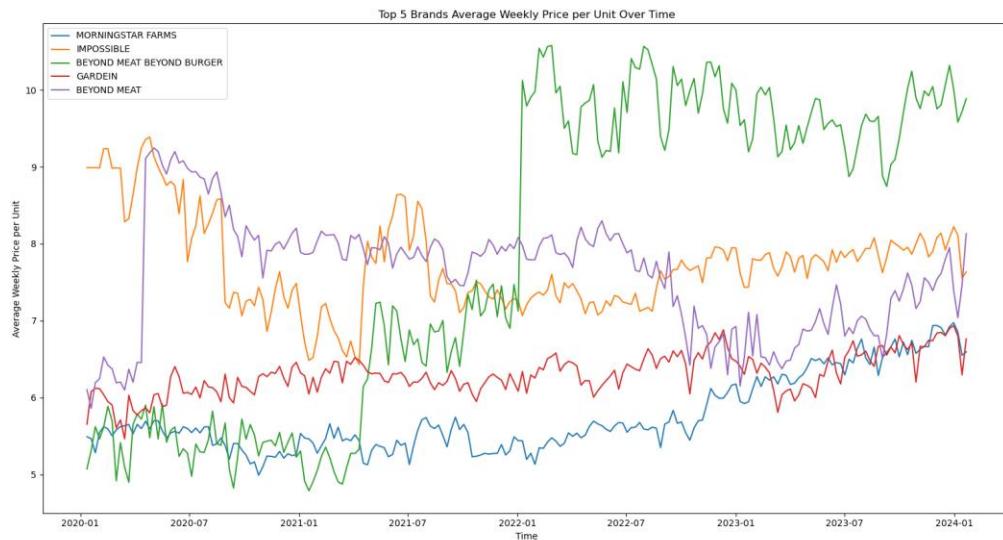
We have the price per volume(16 ounces) for each product. By plotting the trend of price per volume for each brand and manufacturer, we can check two things. The price trend during the period and price comparison for them. The chart below shows that in 2020 and 2021, the average price per volume was around \$11.5 for the IMPOSSIBLE brand. After that, the BEYOND MEAT BEYOND BURGER was around \$11. After, we had BEYOND MEAT, MORNINGSTARS, and GARDEIN with \$8, \$7, and \$6.5 average prices per volume, respectively.

These differences in average price are because of differences in product type. The first two brands were the main producer of BURGER which was more expensive than other products. We can check this with the charts representing different product shares for each brand.



A 5.2 Average weekly price per unit trend for the top 5 brands

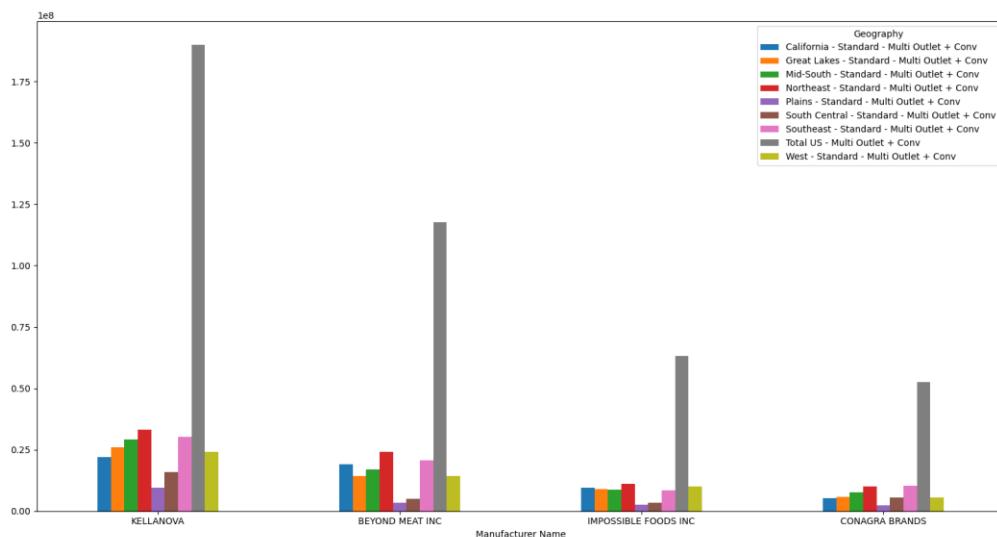
In this section, we plot the price trend from a different perspective. In the chart below, we have the average weekly price per unit for each brand. Some products have a higher volume for each unit, and vice versa. This is the average amount of money that the customer must pay to buy one unit of a product from each brand. Now, we can see that the order is changed. The IMPOSSIBLE and BEYOND MEAT have the highest average price per unit. Oppositely, the GARDEIN and BEYOND MEAT BEYOND BURGER have the lowest average price per unit.



A.6 Geographical Sales Comparison

Total unit sales for the top 4 manufacturers in different geography

The chart below shows two different information. First, we can see that the differences in unit sales for different manufacturers are approximately the same in different geographical locations. Some small changes exist, but the overall trend and pattern are the same. Second, it shows that people in the Northeast, Mid-South, California, and Great Lakes are more likely to buy meat alternative products than people from the South and plain areas.

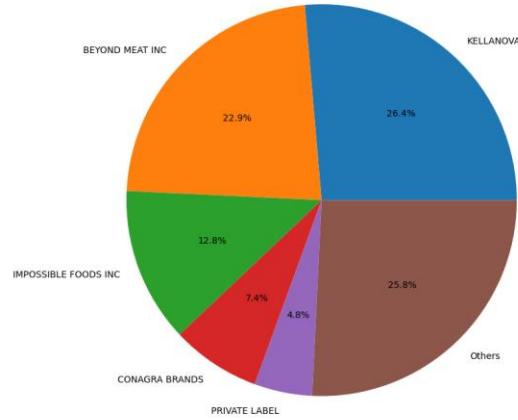


A.7 Market Share Analysis

A.7.1 Top 5 Manufacturers Market Share

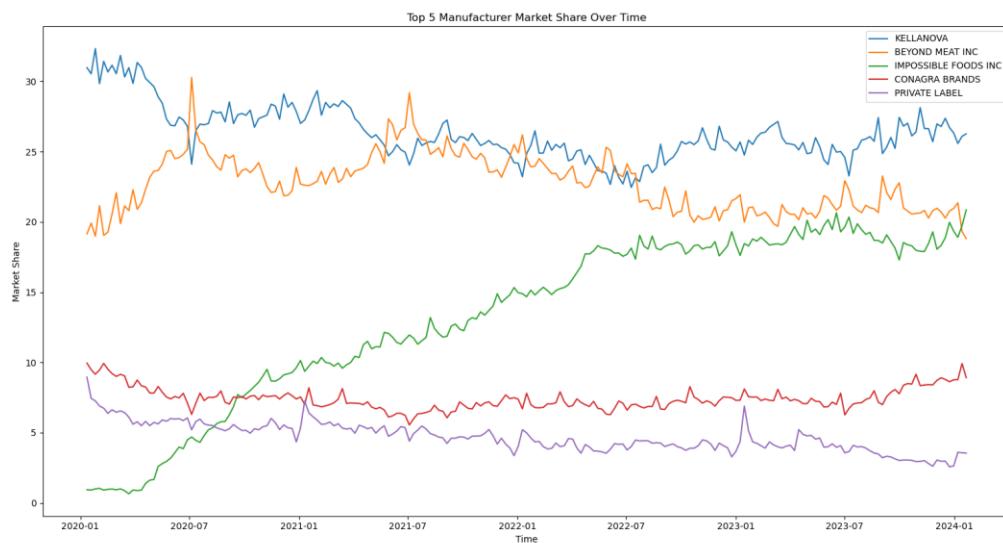
In this section, we calculate the market share for all the manufacturers and then show the top 5 and put all other manufacturers as others. By market share, we mean Total Manufacturer Sales divided by Total Sales.

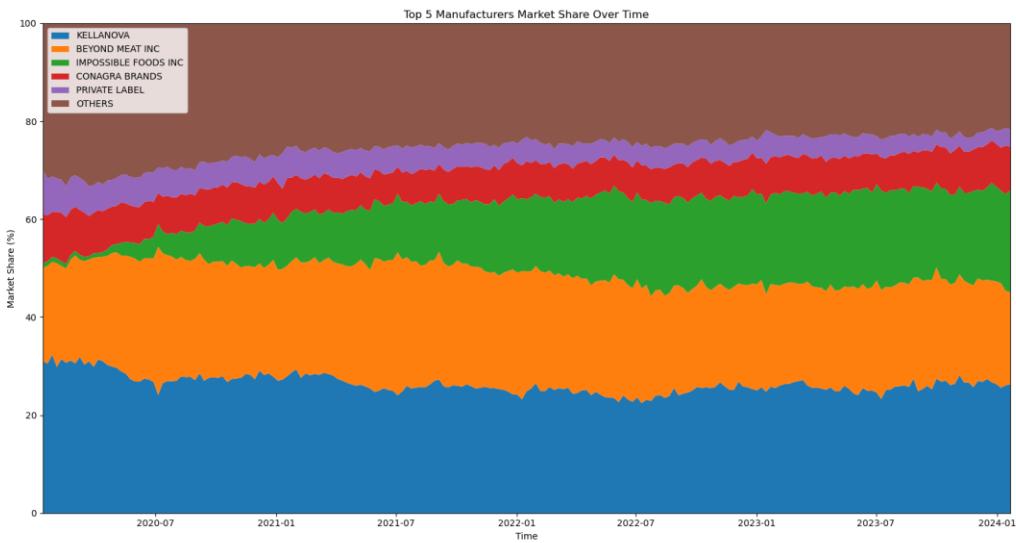
As we can see, around 75% of the market is covered by the top 5 manufacturers. They are the main player in this industry.



A.7.2 Top 5 Manufacturers' Market Share over time

In this section, we check the weekly market share trend for the top manufacturers. As we can see, except for IMPOSSIBLE FOODS INC, all other manufacturers had a steady trend for weekly market share ratio over time. The IMPOSSIBLE FOODS INC had an increasing trend. In the second chart, we can see this change more clearly. All manufacturers had a constant market share ratio with a very small fluctuation. However, the market share ratio for IMPOSSIBLE FOODS INC has been growing and stands in third place for weekly market share in 2024.



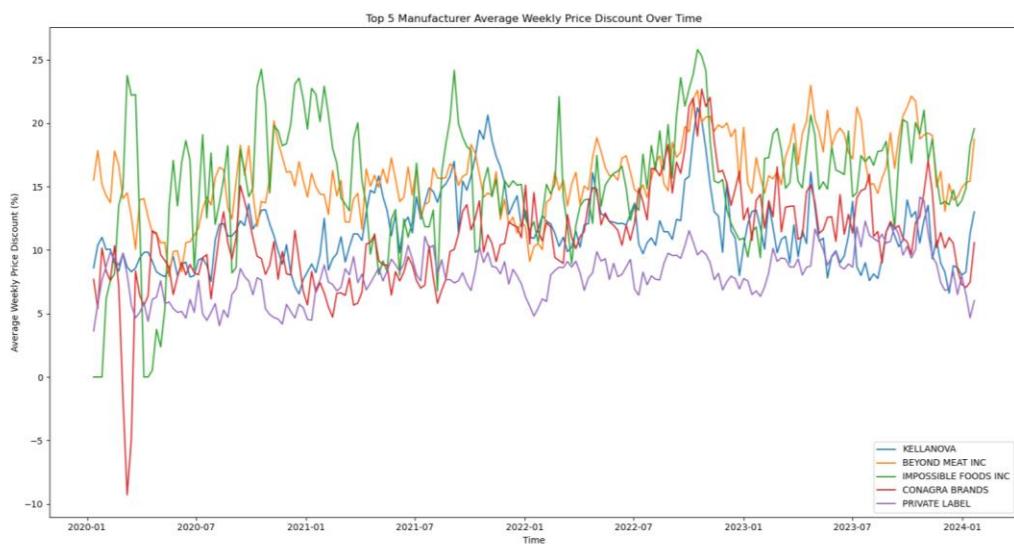
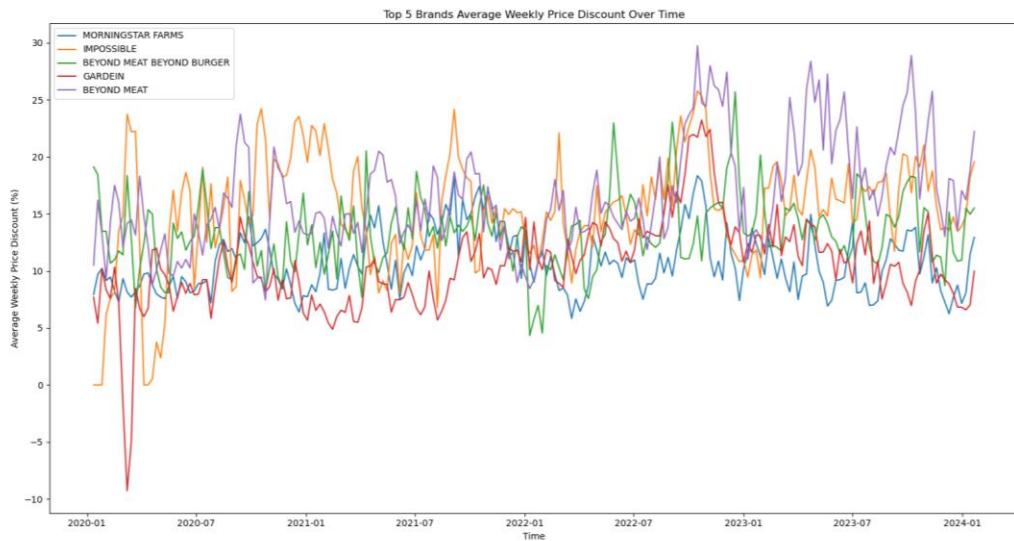


A.8 Price Discount and Sales Relationship

A.8.1 Average price discount of the top 5 brands and manufacturers over time

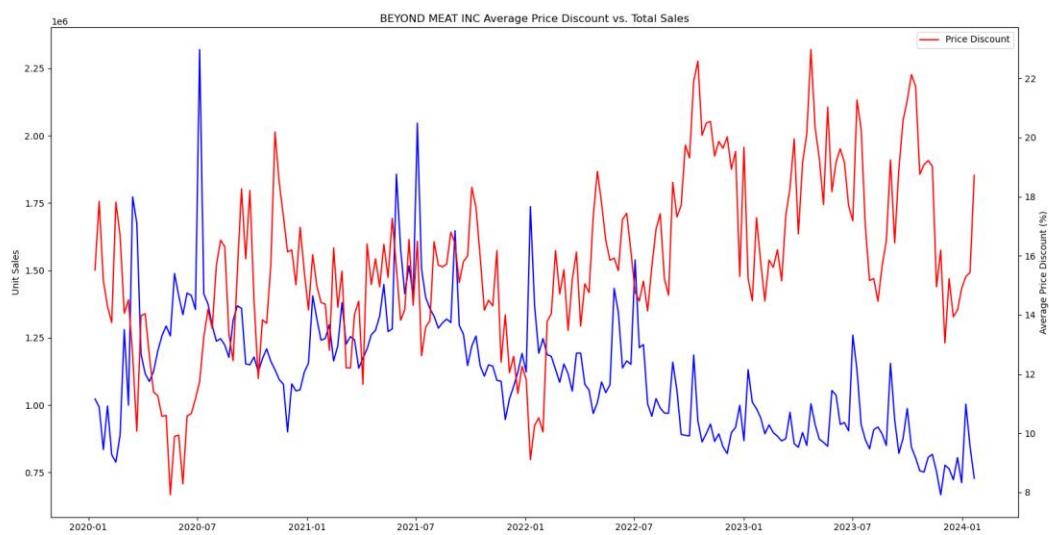
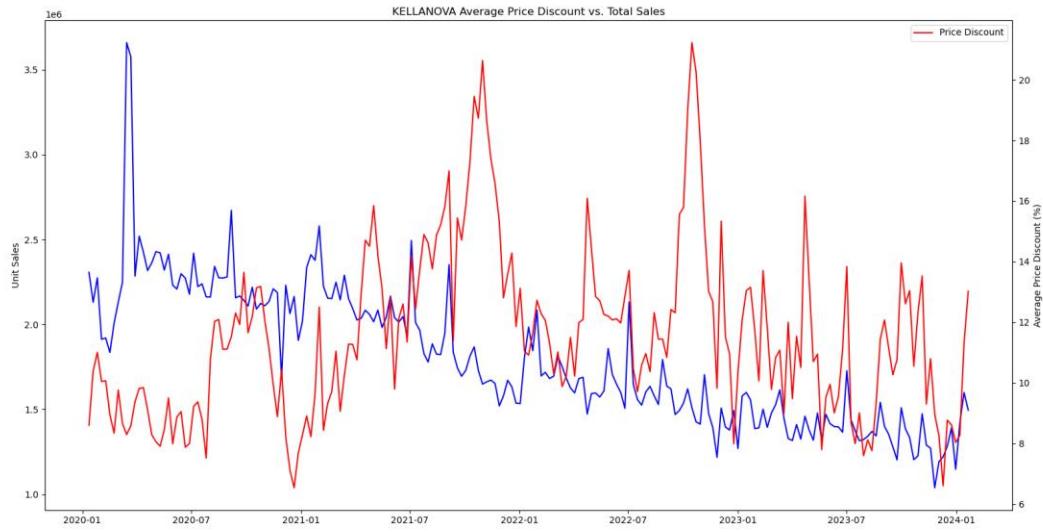
The sales of merchandise have different types. One of them is price reduction. We considered this type of discount and checked the brands and manufacturers' average weekly discount rates over time.

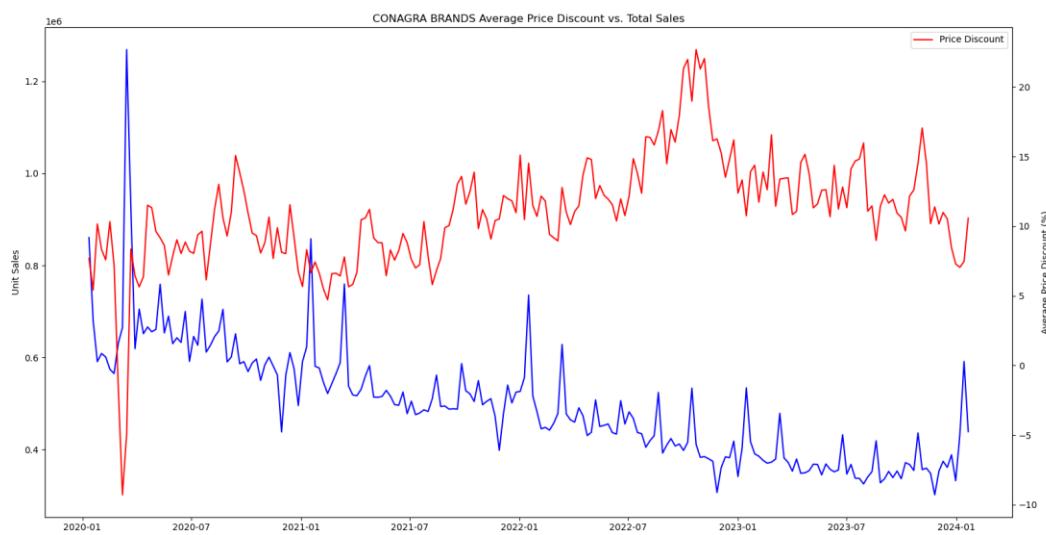
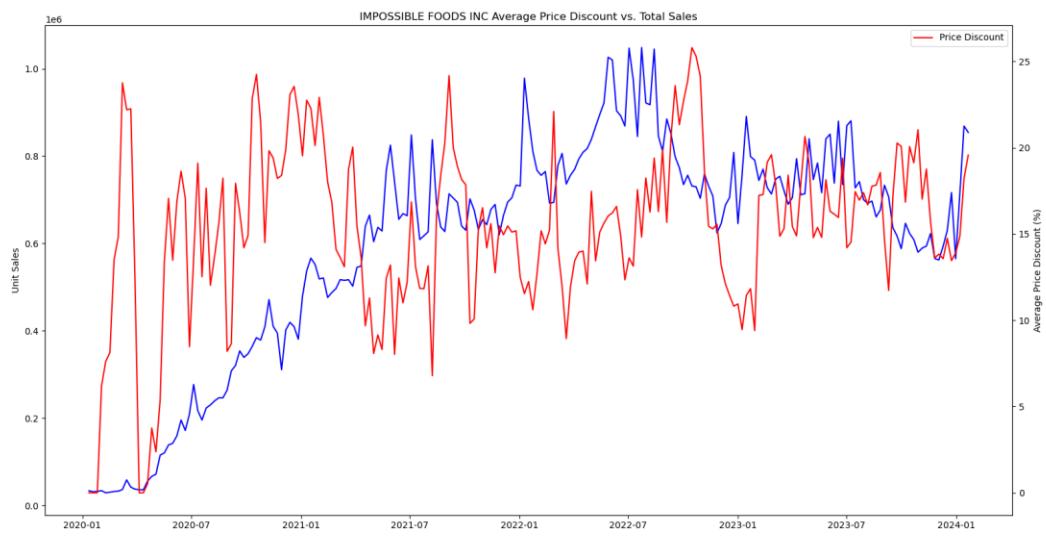
The patterns show the discount with the same mean and variance over time. In fact, we cannot find any increasing or decreasing pattern for discount rate. However, there are some small differences between the discount rate mean and variances among different brands/manufacturers. This information is important but cannot say many things about the sales. We need to add more information to the chart to make it more readable regarding the sales.

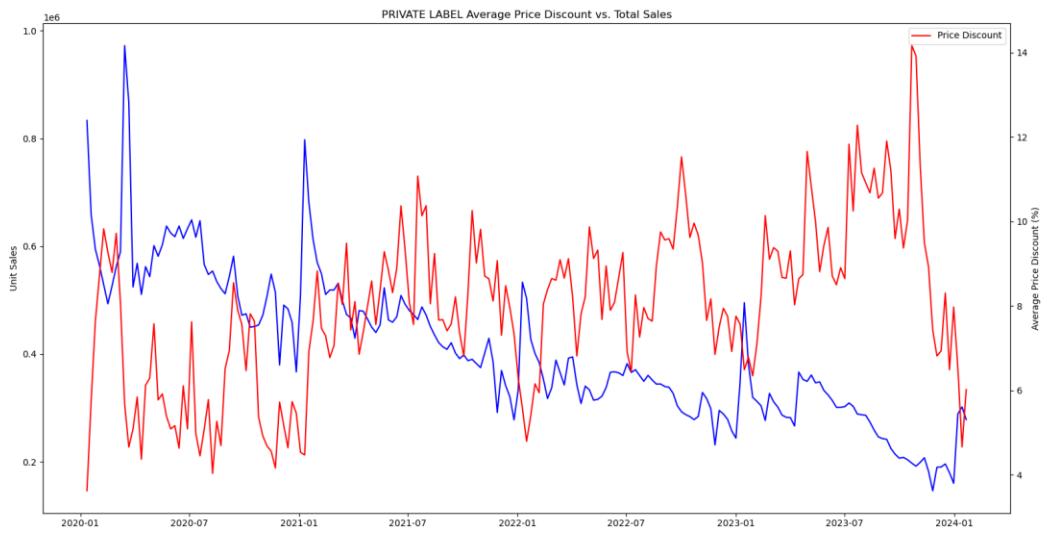


A.8.2 Relationship between Average Price Discount and Total Unit Sales for the top 5 Manufacturers

In this section, we analyzed the impact of price discounts on sales. The charts below show the trend of price discounts and manufacturers' weekly unit sales together. The trend for unit sales is pretty decreasing for all top manufacturers. Still, the trend for price discounts fluctuates over time, sometimes increasing or decreasing, and some other times steady.







Based on the charts above, some other reasons pull the total unit sales for manufacturers down, and the price discount cannot resist in front of them very well. In some short-term periods, the price discounts have changed the unit sales pattern, but in general, the unit sales are decreasing regardless of the price discount percentage.

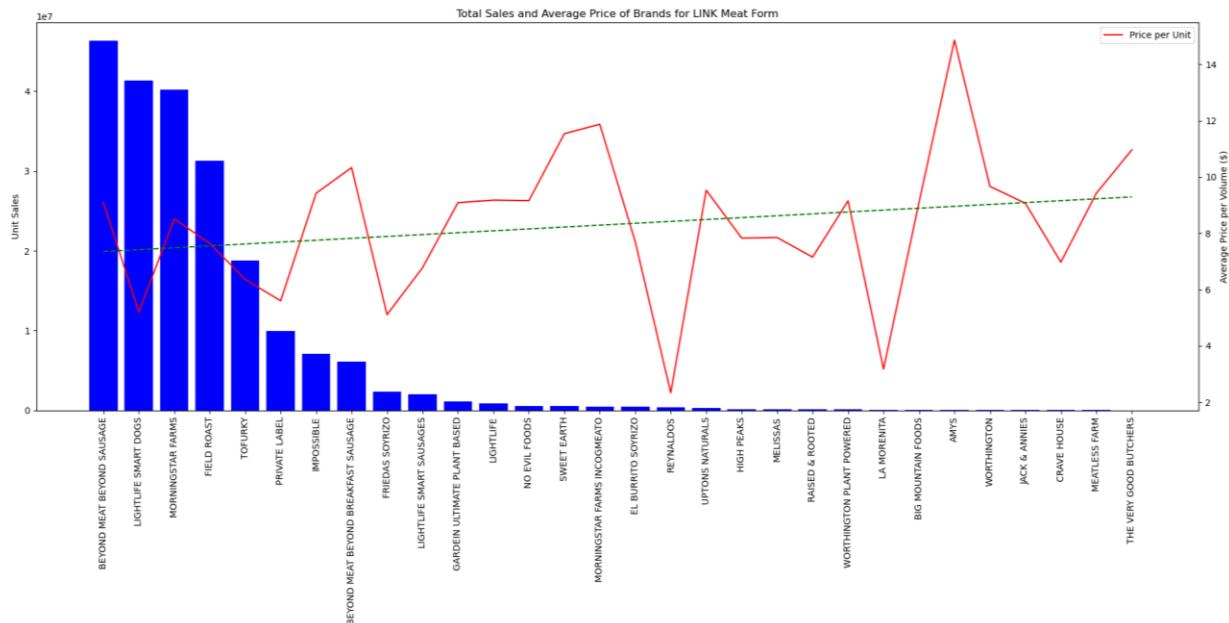
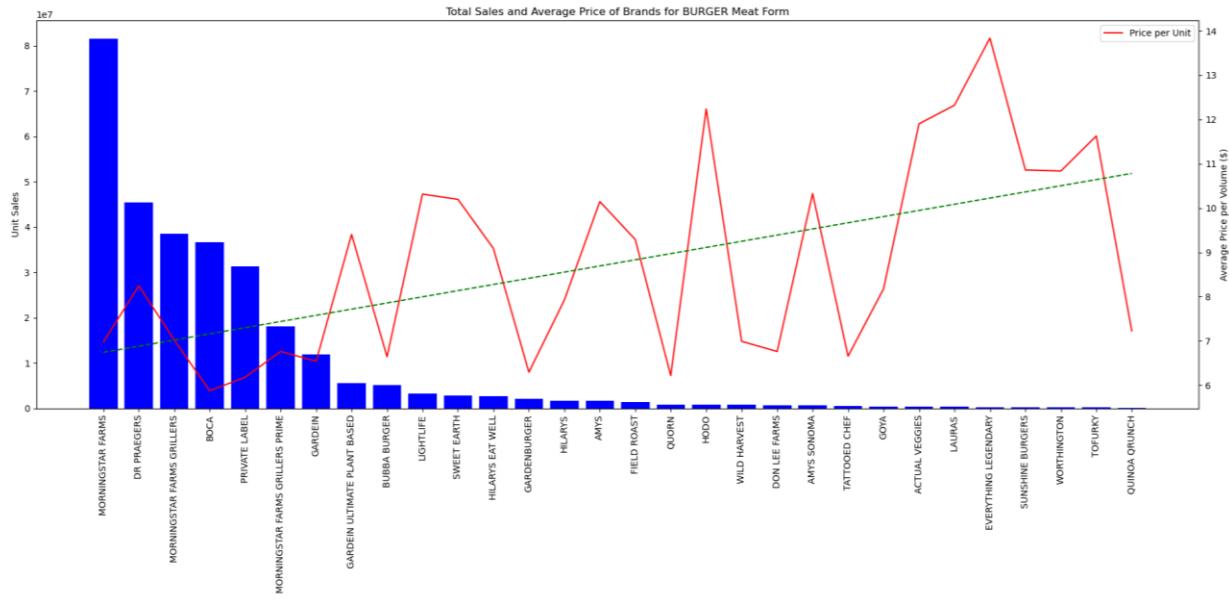
A.9 Price Gap and Sales Correlation

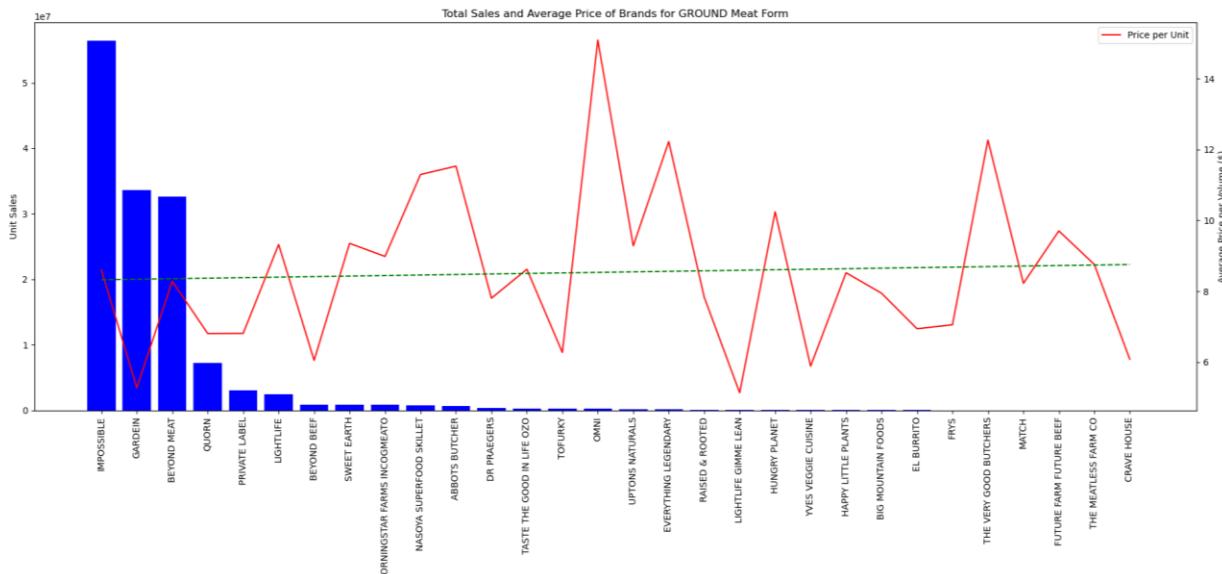
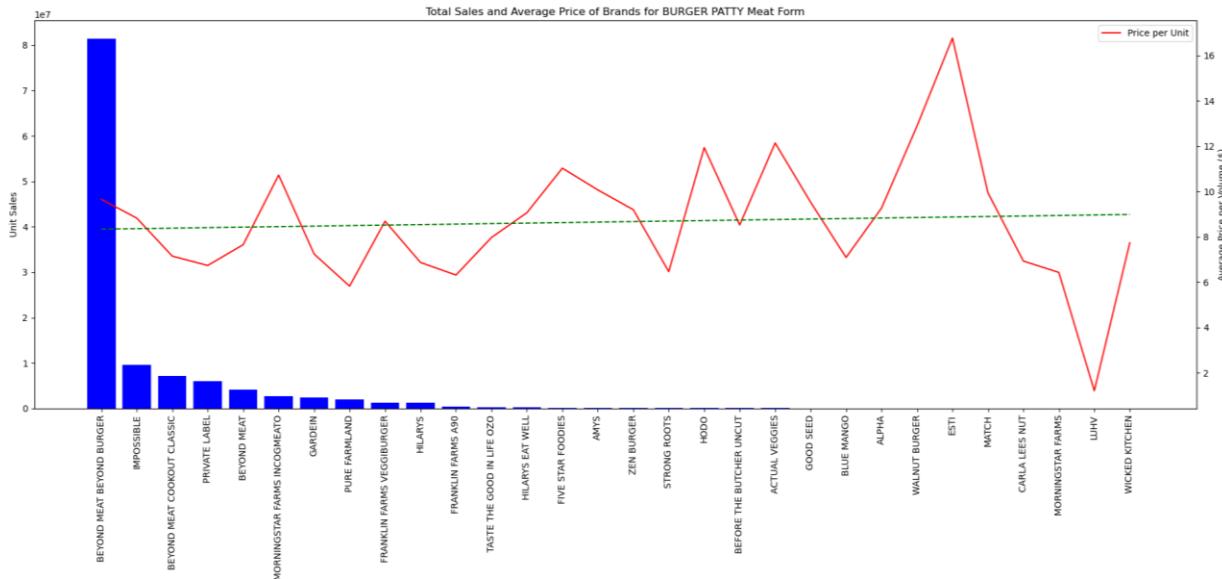
In this section, I just extract the eight meat forms out of 56 unique forms. These eight forms consist of around 75% of all the sales. Therefore, I checked these eight forms to assess the price gap and sales. These forms are listed below:

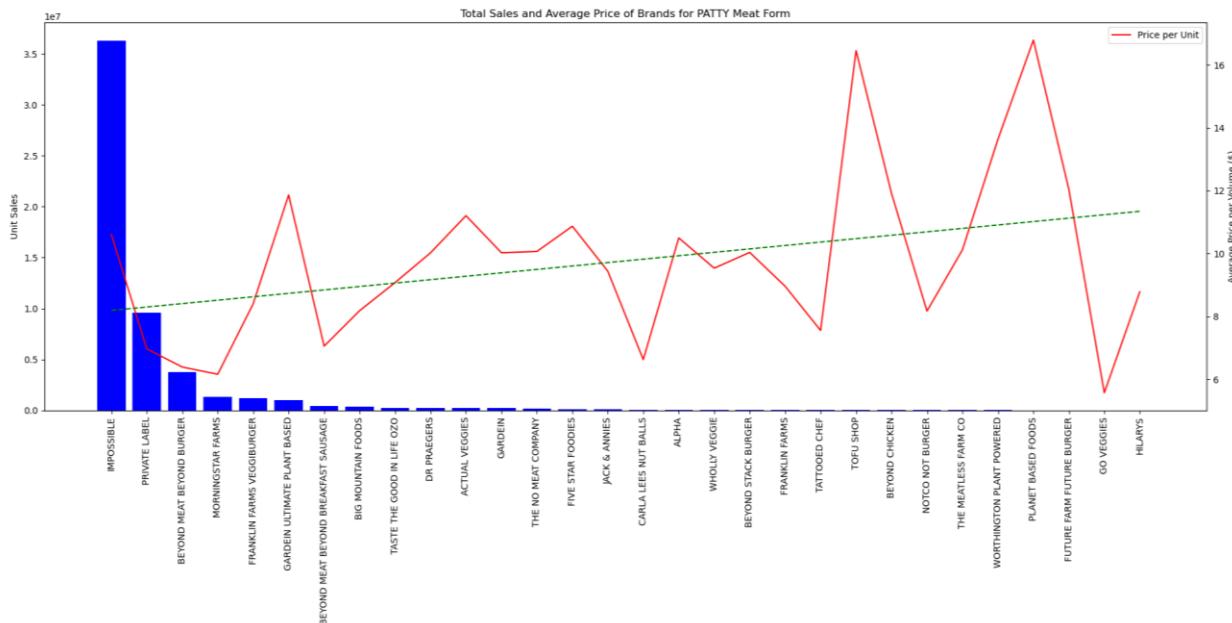
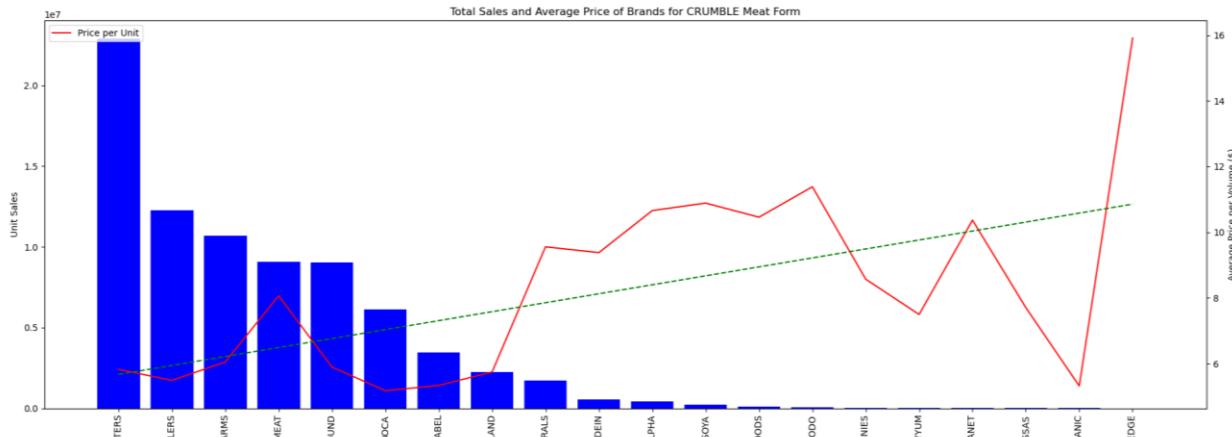
- BURGER
- LINK
- BURGER PATTY
- CRUMBLE
- GROUND
- PATTY
- MEATBALL
- SLICED

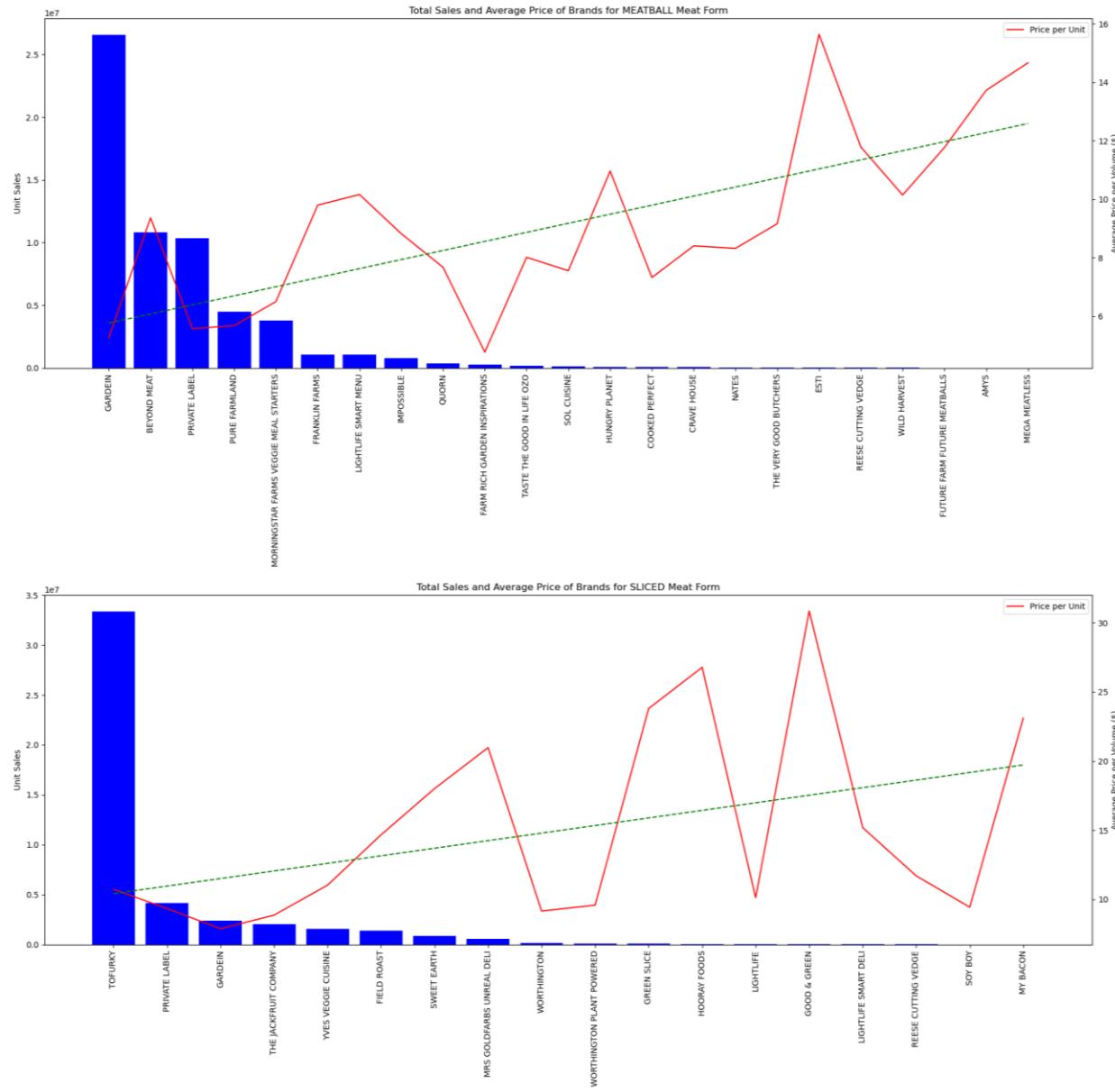
The charts below show the total unit sales for each brand and their average price. The pattern shows that increasing the average price leads to decreasing unit sales. According to this finding, the product average price is a good predictor of unit sales.

The difference between the average prices for different product types is not constant. In some cases, the average prices vary widely; in others, this difference is negligible.





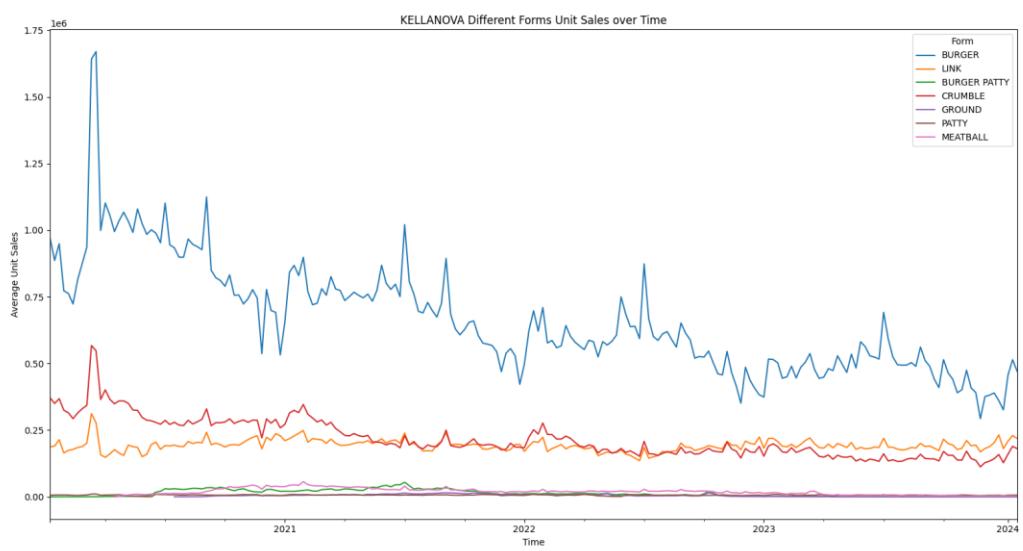
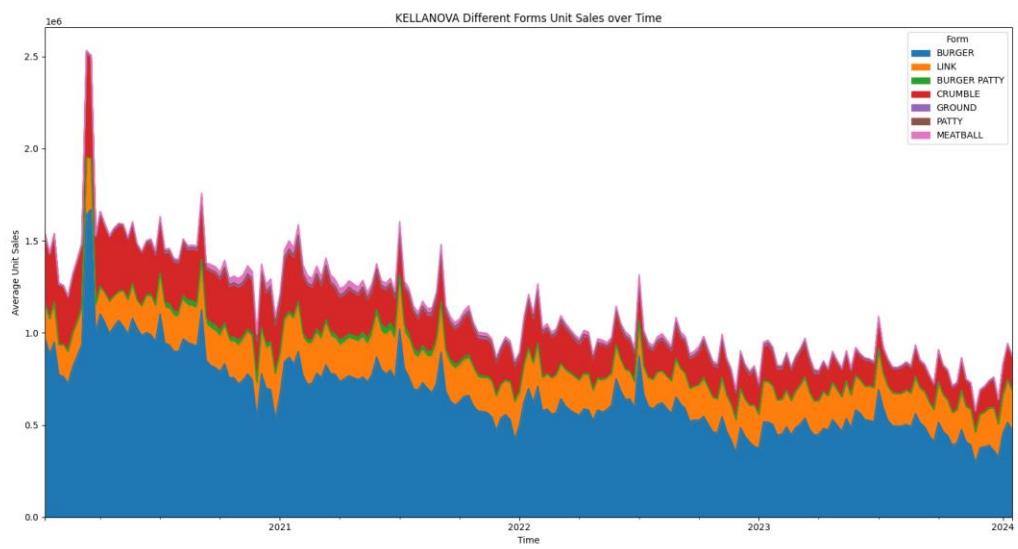


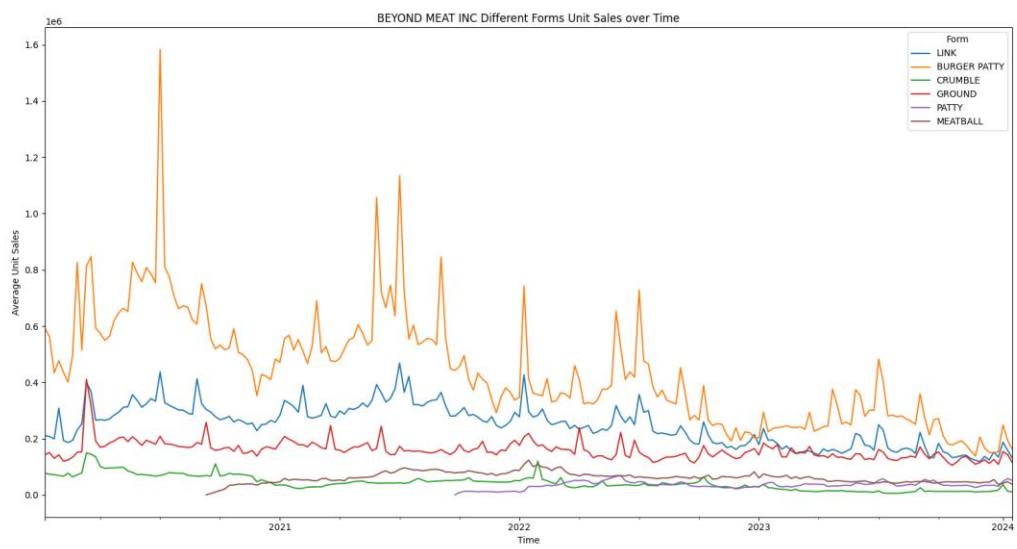
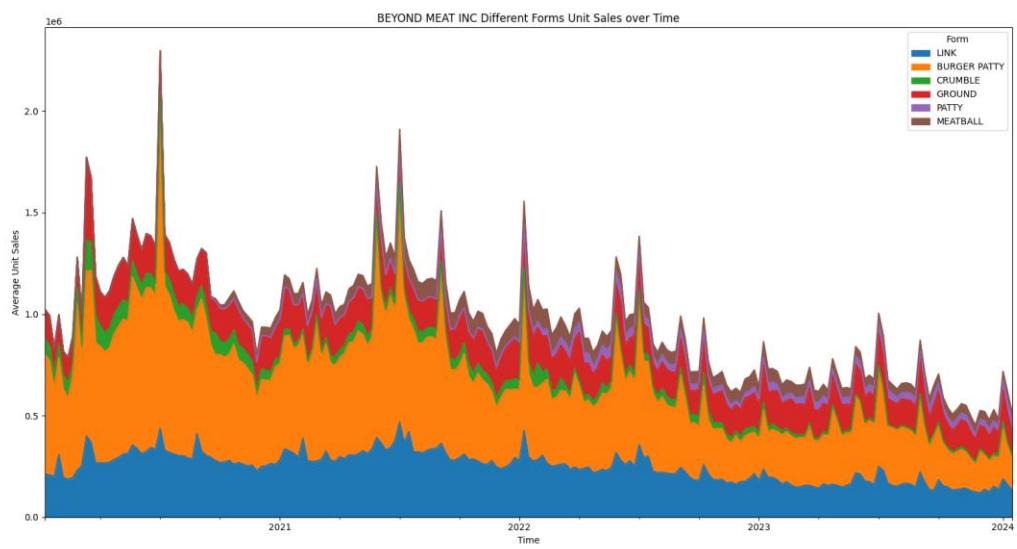


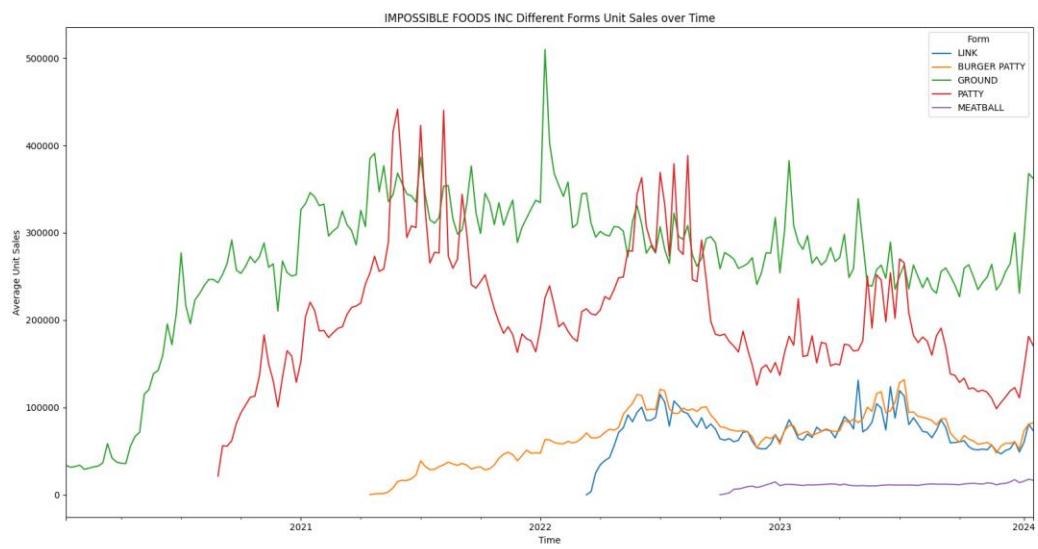
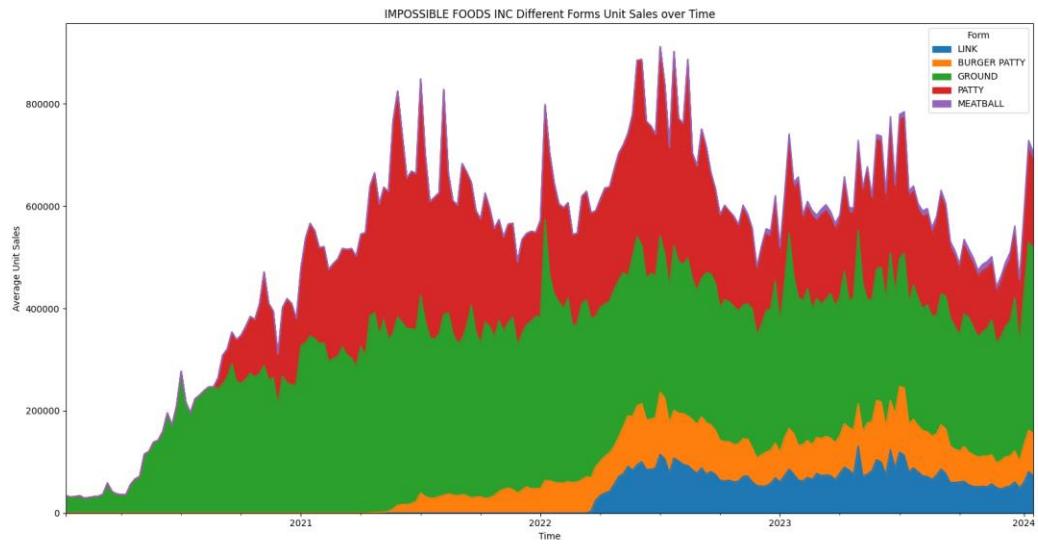
A.10 Product Form Sales Trends

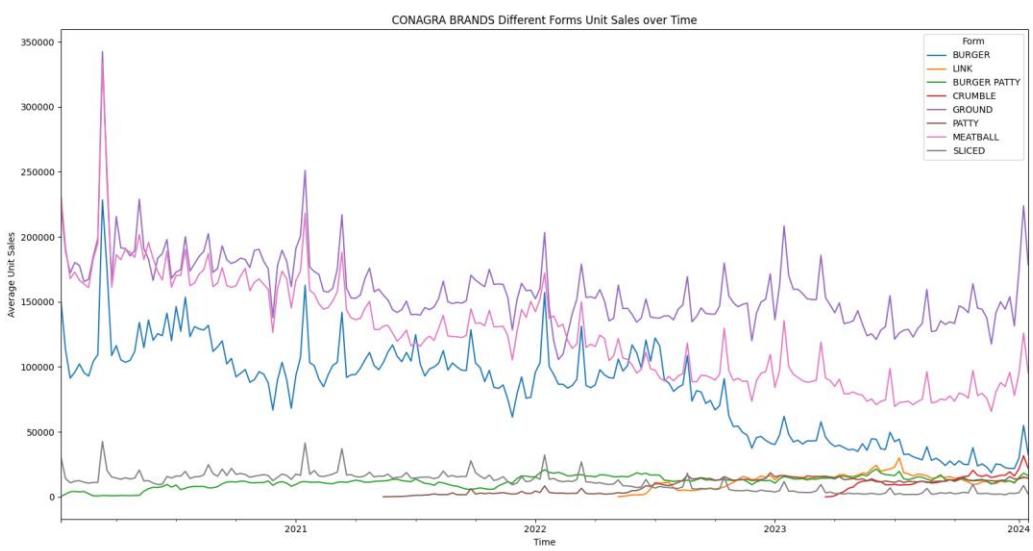
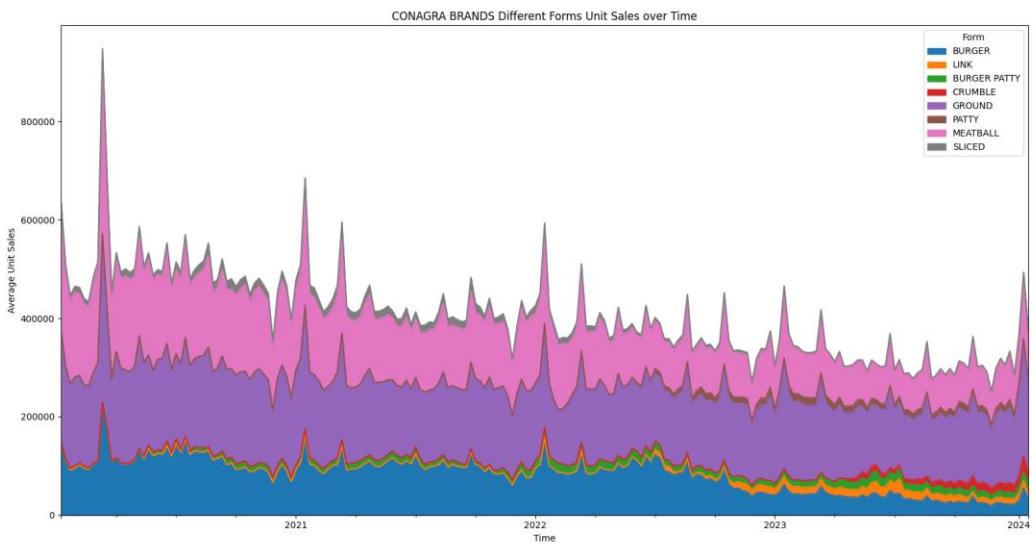
A.10.1 Manufacturers' Unit Sales Trends for Different Substitute Meat Forms

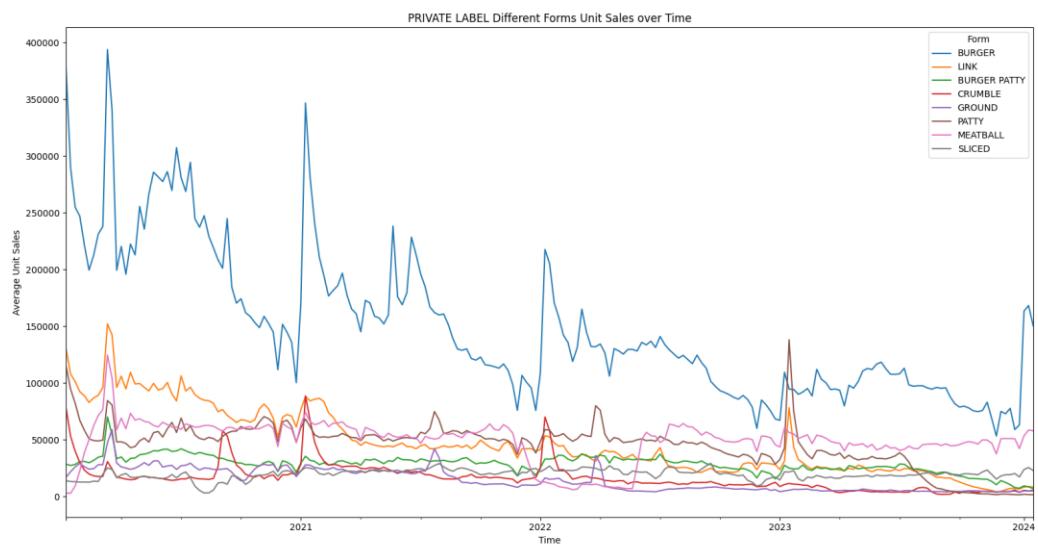
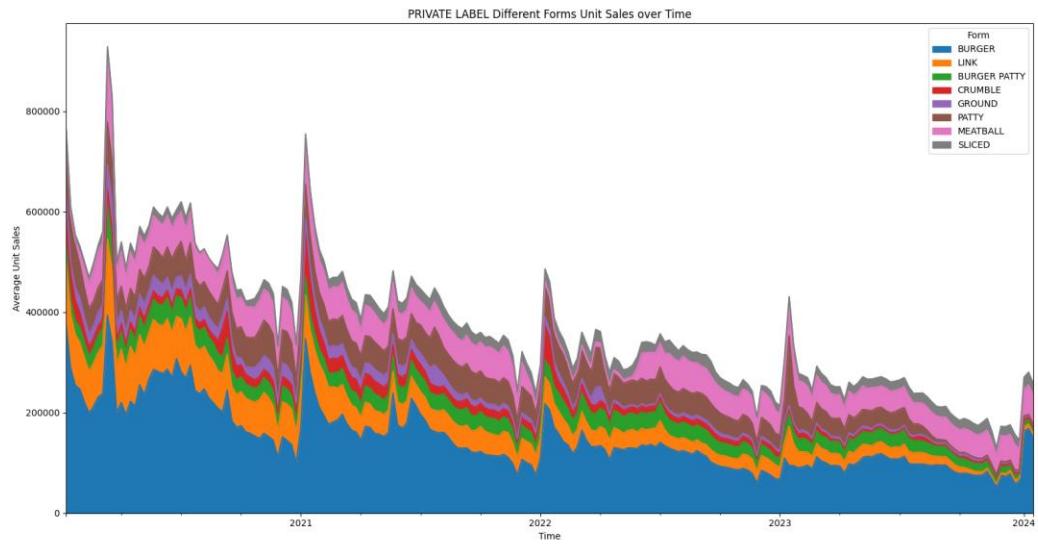
The next question is the trend of weekly unit sales of specific product types for each manufacturer. For example, what is the trend of BURGER sales for KELLANOVA? In the charts below, we plotted the stack area chart to show the total unit sales for the manufacturer and the share of each product type. We also plotted the line chart to show the trend of each product type separately.



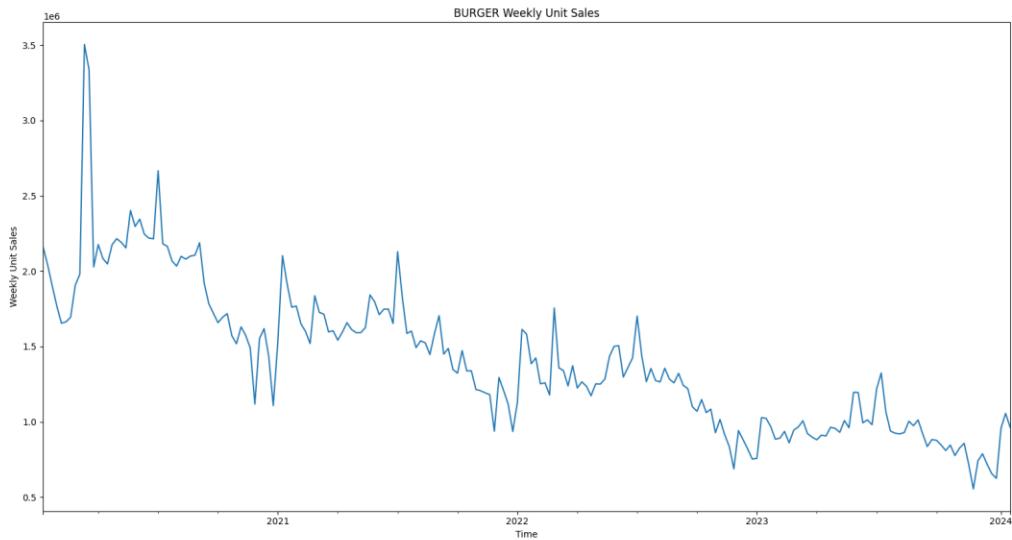








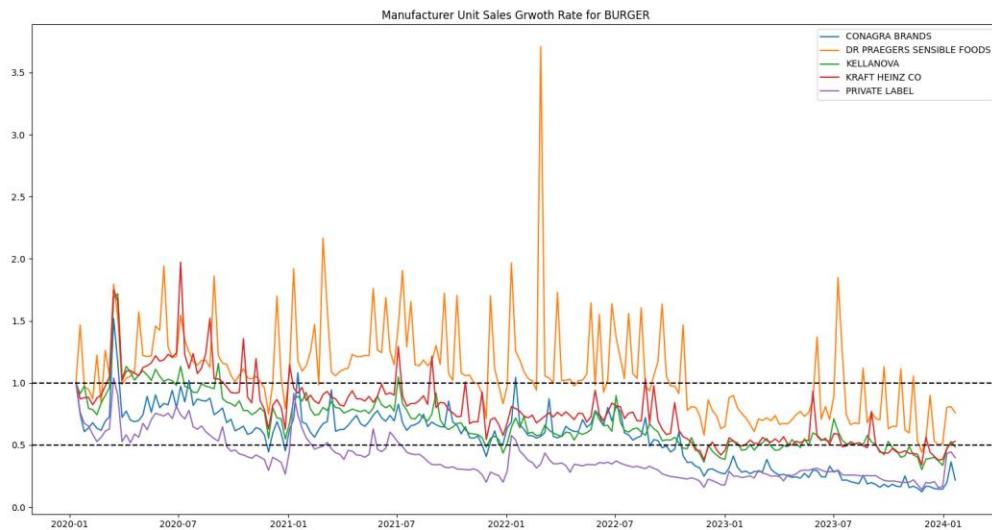
A.10.2 Unit Sales for BURGER throughout these four years

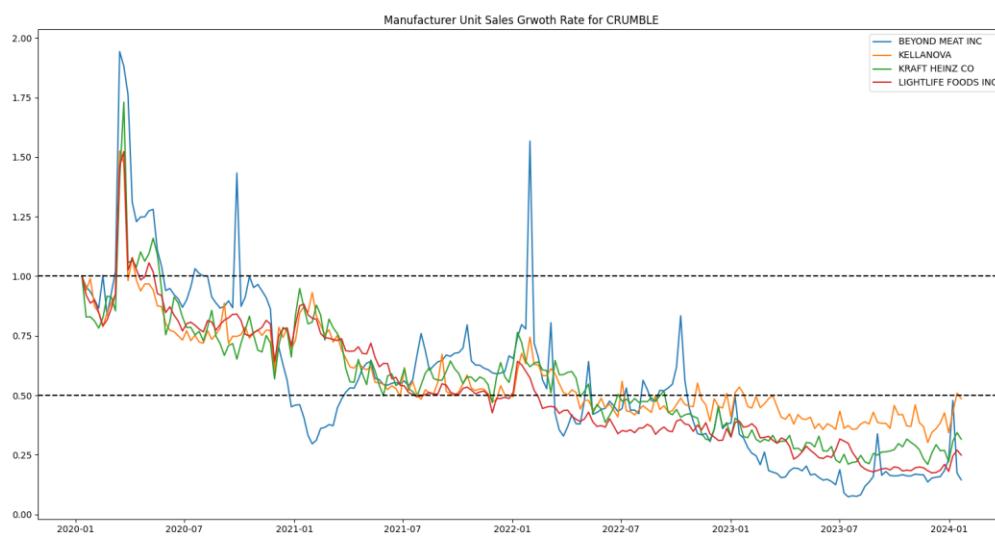
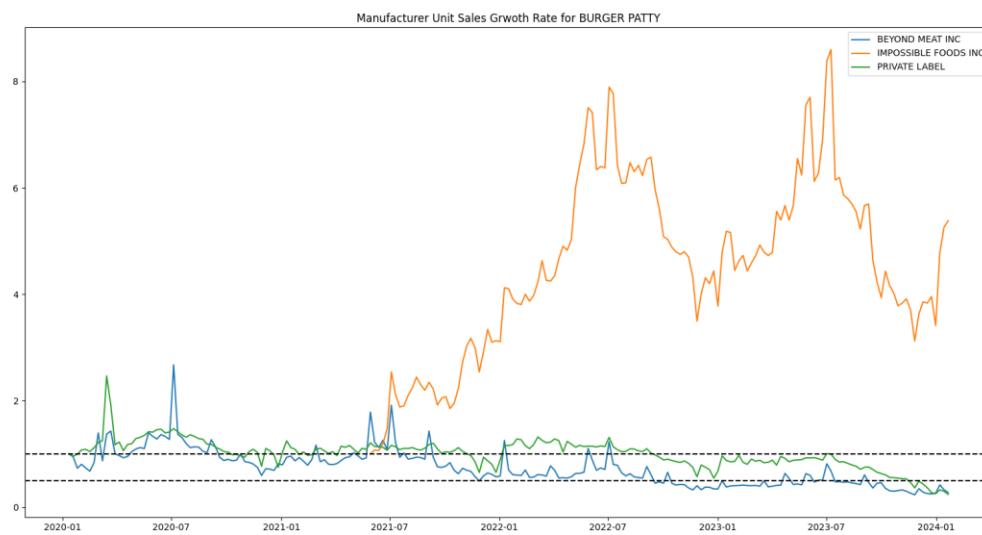


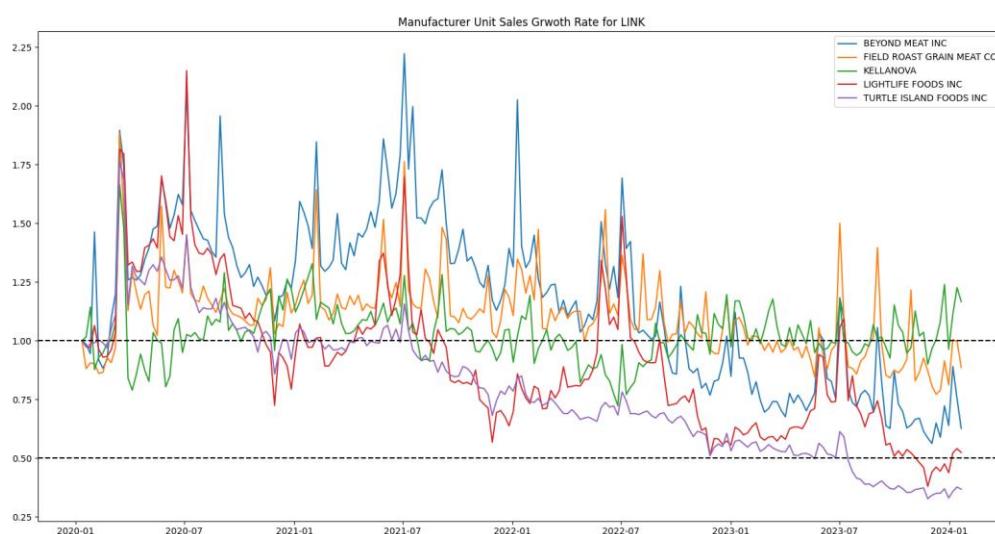
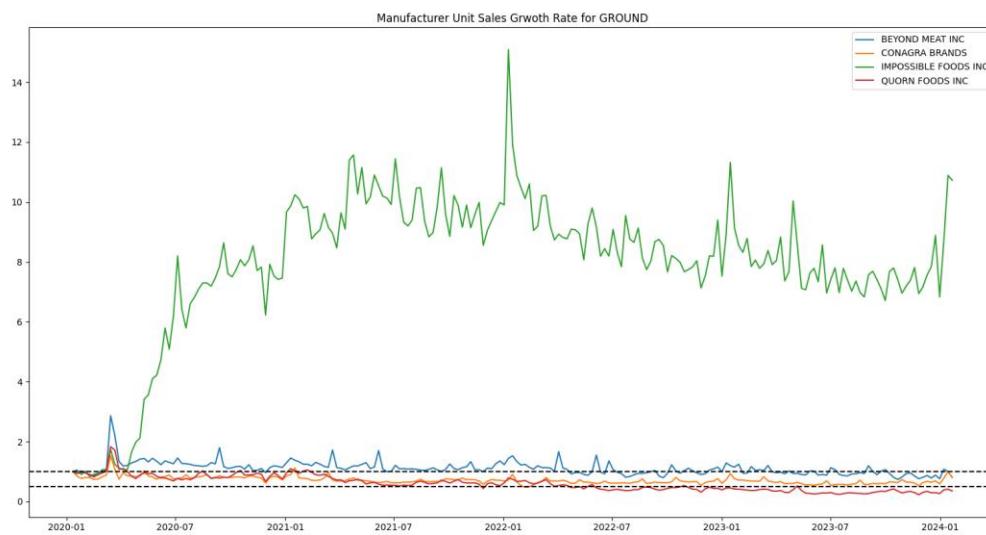
As we can see, the trend of BURGER unit sales is decreasing. Next, I want to check if all the manufacturers that produce the BURGER have experienced this decreasing trend.

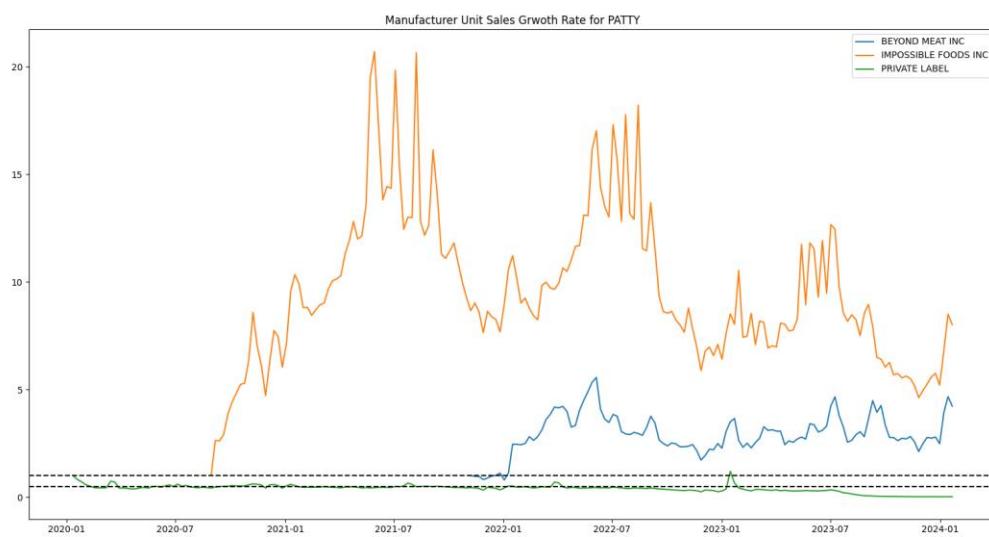
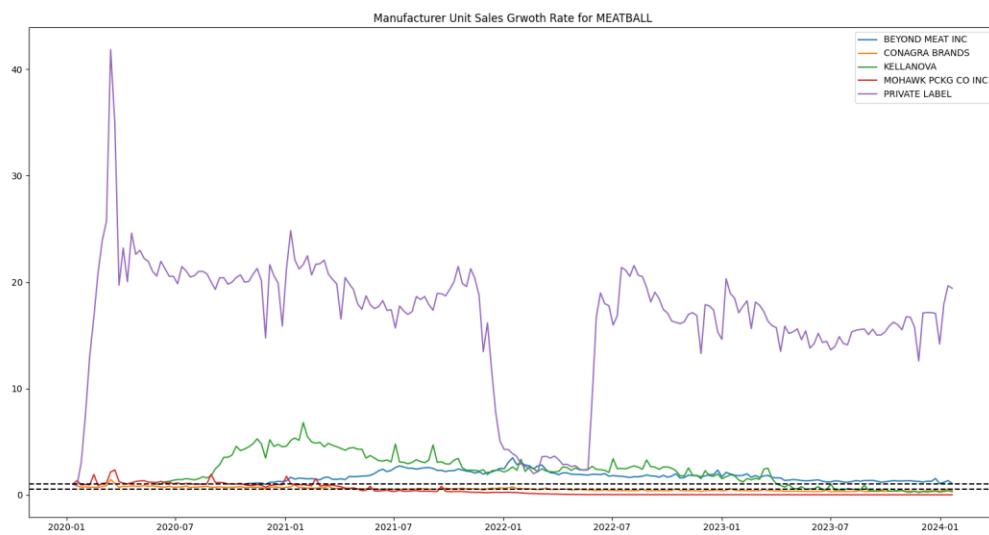
A.10.3 The Manufacturers' Unit Sales Growth Rate for Different Product Forms

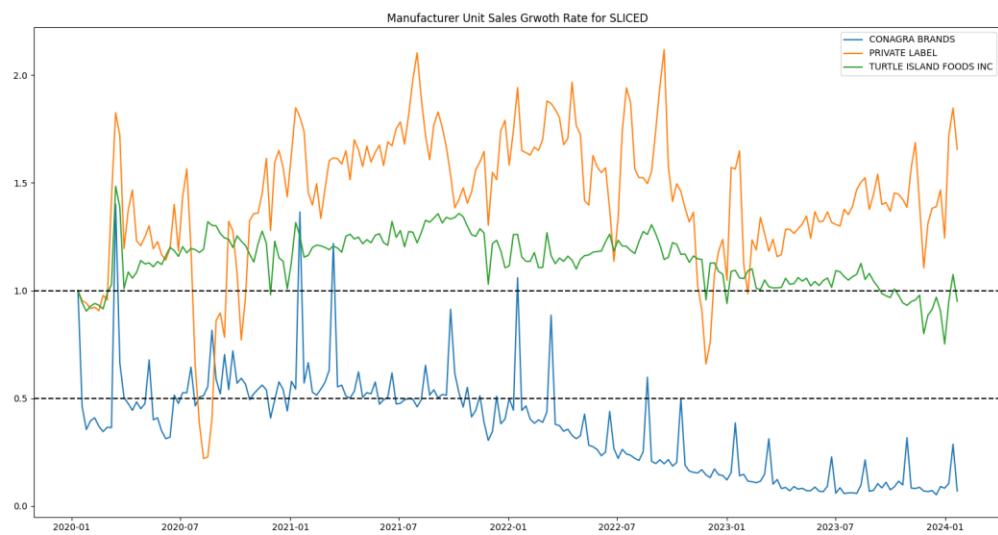
Here, we analyze the manufacturer if their market share is greater than 5% for the specific product form.





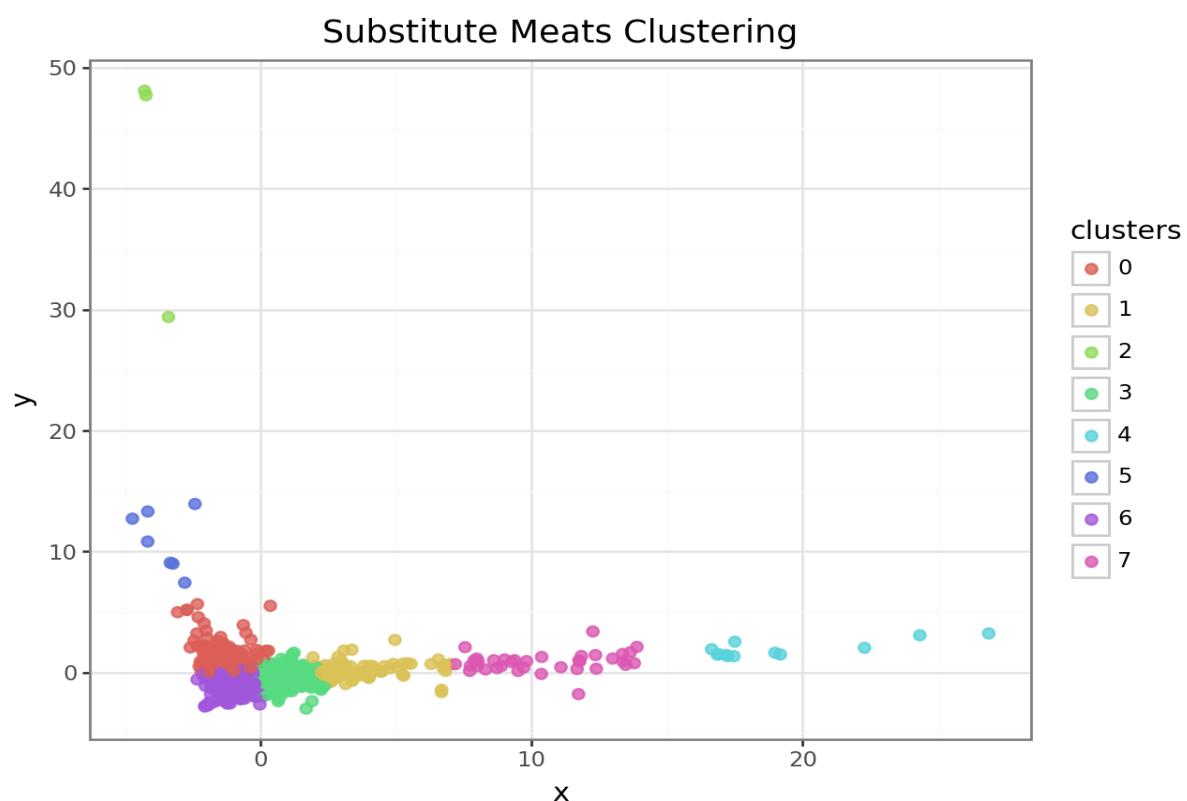






A.11 Clustering Analysis

Cluster products and their attributes:



I clustered the product data into 8 clusters. In the table below, we have a description of each cluster.

Cluster	Package	Product Type	Form	Flavor / Scent	Type Of Meat Substitute	Type Of Substitute	Brand Name	Manufacturer Name	Median Weekly Unit Sales
0	CARDBOARD BOX CARTON CARDBOARD SLEEVE & VACUUM PACKED PLASTIC WRAP IN BOX	VEGETABLE MEAT SUBSTITUTE TOFU SUBSTITUTE SEITAN	FUN NUGGETS ULTRA THIN SLICE BAD BUN	3 GRAIN SPICY SICHUAN GINGER SCALLION	ROAST BEEF ITALIAN DELI MEAT CORNED BEEF	PLANT BASED SWEET POTATOES GRAIN PUMPKIN SEED	DODONI MRS GOLDFARBS UNREAL DELI REESE CUTTING VEDGE	EUROFRESH FOODS INC GOOD2GO VEGGIE DODONI'S AGRICULTURAL DAIRY IND	100
1	RESEALABLE STAND UP BAG PLASTIC WRAPPED VACUUM PACKED IN SLEEVE	PLANT BASED CHICKEN SUBSTITUTE POULTRY SUBSTITUTE FISH SUBSTITUTE	CHUB DELI SLICED POPCORN	MEXICAN CHIPOTLE SWEET & SOUR PARMESAN GARLIC	PASTRAMI FRANKFURTER CHICKEN AND PORK	GRAINS AND FRUITS MADE FROM PLANTS GRAINS AND VEGETABLES	CACIQUE	CACIQUE FOODS LLC IMPOSSIBLE FOODS INC BEYOND MEAT INC	2860
2	PAPER WRAPPED BOX BAG IN BOX	TEMPEH SUBSTITUTE	NOT STATED ON PACKAGE BLOCK BALL	CHICK PEAS & SUNFLOWER SEED RASPBERRY HABANERO BARBECUE SMOKED SALT & PEPPER STEAK	TEMPEH ANDOUILLE SAUSAGE PROSCIUTTO	PEANUTS AND HEMP PLANT PROTEIN ADZUKI BEAN	SMILING HARA HEMPEH SAN DIEGO ABBOITS BUTCHER	SMILING HARA TEMPEH SAN DIEGO TEMPEH LLC AB FOODS LLC	35
3	INDIVIDUAL POUCH IN RESEALABLE PLASTIC BAG PLASTIC BAG IN BOX RESEALABLE PLASTIC PEG BAG	BURGER FALAFEL POULTRY SUBSTITUTE	BREAKFAST SAUSAGE ROLL FINGER DIPPER	ZESTY RANCH BEER ELYSIAN BEER	ANDOUILLE SAUSAGE BRAT PORK SAUSAGE	PLANT BASED WITH VEGGIES SEEDS AND GRAINS VEGGIE WITH BLACK BEANS GREEN AND RED PEPPERS MEAT FREE	BEYOND STACK BURGER TYSON EL BURRITO SOYRIZO	TYSON FOODS INC NESTLE USA INC FRIEDAS INC	710
4	VACUUM PACKED RESEALABLE PLASTIC BAG PLASTIC CONTAINER IN SLEEVE	PLANT BASED SUBSTITUTE MEAT SUBSTITUTE POULTRY SUBSTITUTE	BREAKFAST SAUSAGE PATTY WING GROUND	ORIGINAL SAUSAGE HOT DOG VEGETABLE CHICKEN	PORK VALUE NOT AVAILABLE BEEF	MADE FROM PLANTS VEGGIE PLANT BASED	LIGHTLIFE SMART DOGS BEYOND MEAT BEYOND BURGER MORNINGSTAR FARMS	KELLOGG'S BEYOND MEAT INC IMPOSSIBLE FOODS INC	20700
5	VACUUM PACKAGED PLASTIC PEG BAG & WINDOW RESEALABLE PLASTIC WRAP TRAY	TEMPEH SUBSTITUTE FISH SUBSTITUTE TOFU	B&B SLICED PIECE	LUPINI BEAN SMOKED HICKORY SMOKED	PROSCIUTTO CAPRICCI CHICKEN SAFOMA	PLANT BASED WITH LUPINI BEANS GOOD & GREEN HOUSE FOODS GO UMAMI	CURRENT FOODS SALMON GOOD & GREEN HOUSE FOODS GO UMAMI	MAESTRO D'ITALIA INC SUBWAY FOODS INC HOUSE FOODS AMERICA CORP	50
6	BAG IN BOX PLASTIC TUB CARTON	SOY SOY SUBSTITUTE CHICKEN SUBSTITUTE	CUT SLIDER GIZZARD	MILD ITALIAN GREEK MOUSSAKA PEPPADEW PIQUANTE PEPPER	MEATLOAF LONGANIZA MEATBALL	ADZUKI BEAN RED LENTILS CHICKPEAS AND CARROTS MIXED VEGGIES WHOLE GRAINS SOY AND PEPPERS	ZOGLOS VEGANISTIC CHOICE EARTHS BEST NOTCO NOTO BURGER	AB FOODS LLC PAT LAFRIDA MEAT PURVEYORS OLD FASHIONED KITCH	100
7	RESEALABLE PLASTIC PEG BAG PLASTIC WRAPPED IN CARDBOARD SLEEVE RESEALABLE PLASTIC BAG	TEMPEH MEAT SUBSTITUTE PLANT BASED SUBSTITUTE	ROPE BREAKFAST SAUSAGE PATTY TIP	HOT & SPICY SAUSAGE HOT ITALIAN MANDARIN ORANGE	PORK SAUSAGE PORK MEATBALL	MADE FROM PLANTS VEGGIE PLANT PROTEIN	BEYOND MEAT BEYOND SAUSAGE LIGHTLIFE SMART DOGS BEYOND STEAK	REYNALDOS MEXICAN FOOD CO IMPOSSIBLE FOODS INC BEYOND MEAT INC	9480

We also checked the ACV Weighted Distribution in the clustering. Describing the interpretation is based on the charts:

