Data Science Portofolio

AVOCADO PRICE FORECASTING

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About the Avocado Price Dataset

The dataset represents weekly 2018 retail scan data for National retail volume (units) and price. Retail scan data comes directly from retailers' cash registers based on actual retail sales of Hass avocados. Starting in 2013, the table below reflects an expanded, multi-outlet retail data set. Multi-outlet reporting includes an aggregation of the following channels: grocery, mass, club, drug, dollar and military. The Average Price (of avocados) in the table reflects a per unit (per avocado) cost, even when multiple units (avocados) are sold in bags. The Product Lookup codes (PLU's) in the table are only for Hass avocados. Other varieties of avocados (e.g. greenskins) are not included in this table.

Data Attributes

Date :The date of the observation
AveragePrice : the average price of a single avocado
Total Volume : Total number of avocados sold
4046 : Total number of avocados with PLU 4046 sold
4225 : Total number of avocados with PLU 4225 sold
4770 : Total number of avocados with PLU 4770 sold
Total Bags : Total number of bags
Small Bags : Total number of small bags
Large Bags : Total number of large bags
XLarge Bags : Extra Large Bags
type : conventional or organic
year : year of the date
region : the city or region of the observation

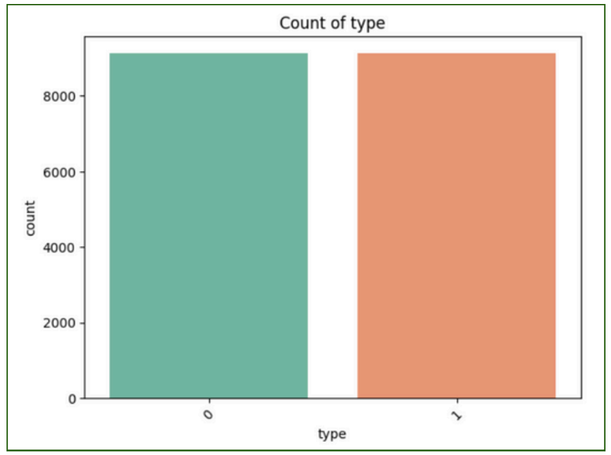
Data Information

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 18249 entries, 0 to 18248
Data columns (total 13 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   Date          18249 non-null  object
 1   AveragePrice  18249 non-null  float64
 2   Total Volume  18249 non-null  float64
 3   4046          18249 non-null  float64
 4   4225          18249 non-null  float64
 5   4770          18249 non-null  float64
 6   Total Bags    18249 non-null  float64
 7   Small Bags    18249 non-null  float64
 8   Large Bags    18249 non-null  float64
 9   XLarge Bags   18249 non-null  float64
 10  type          18249 non-null  object
 11  year          18249 non-null  int64
 12  region        18249 non-null  object
dtypes: float64(9), int64(1), object(3)
memory usage: 1.8+ MB
```

Top 5 rows of Data

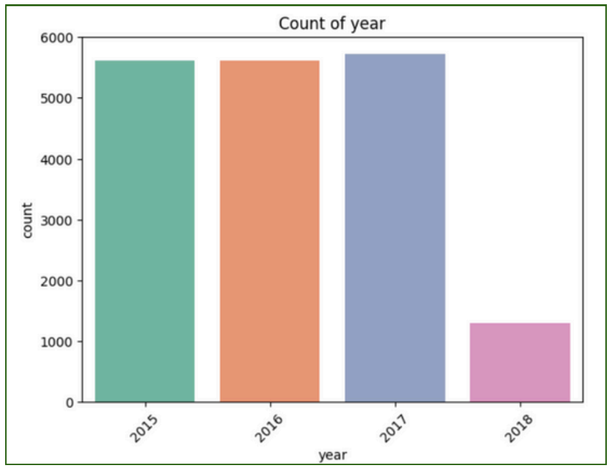
	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	2015-12-27	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.00	conventional	2015	Albany
1	2015-12-20	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.00	conventional	2015	Albany
2	2015-12-13	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.00	conventional	2015	Albany
3	2015-12-06	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.00	conventional	2015	Albany
4	2015-11-29	1.28	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.00	conventional	2015	Albany

Data Visualization



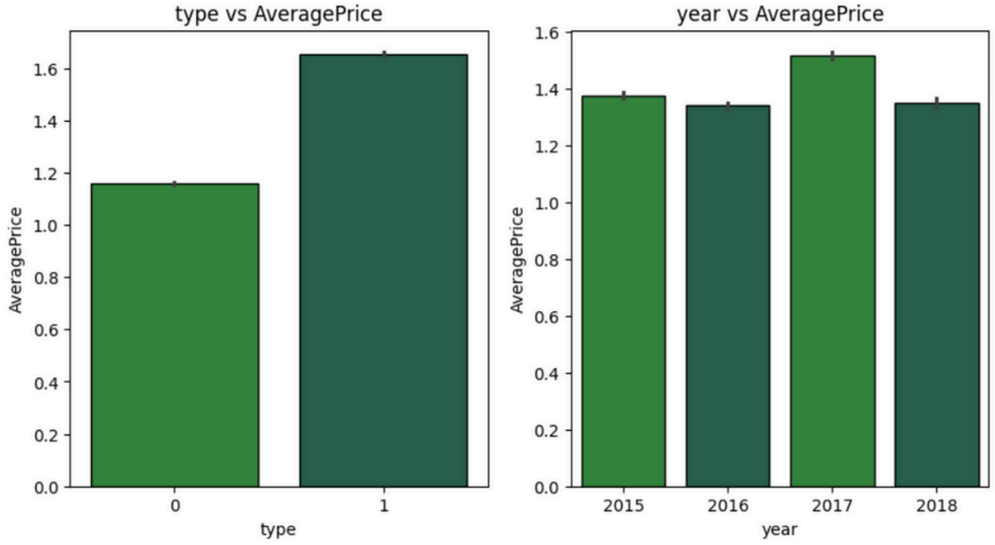
Type Distribution

- Conventional and Organic avocados are present in almost equal numbers.



Yearly Data Distribution

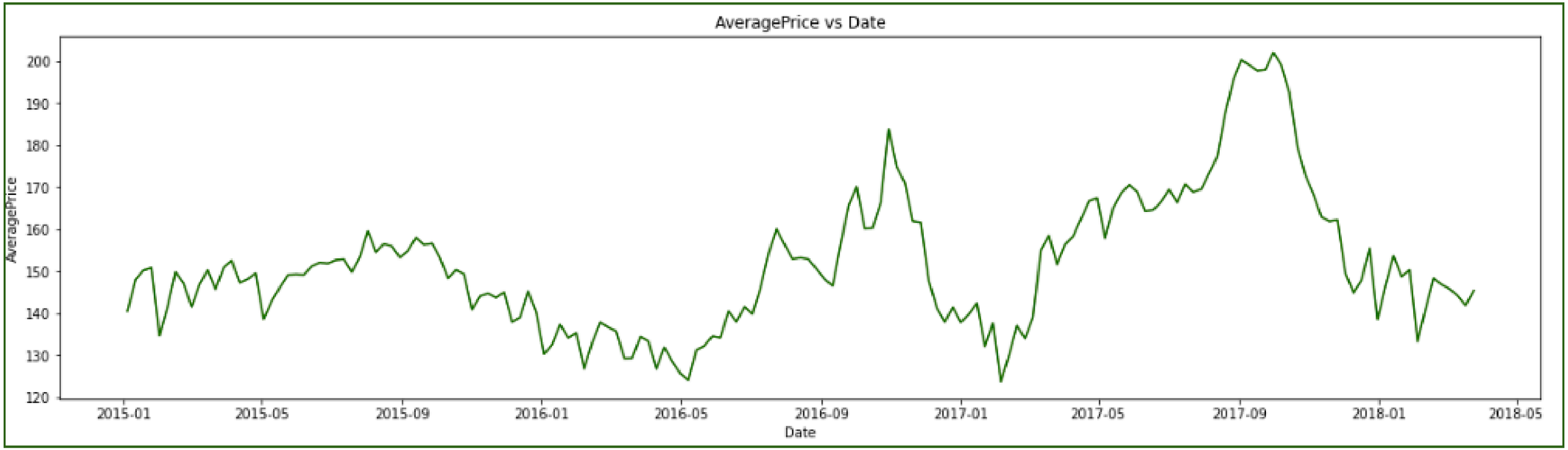
- Data points are consistent for the years 2015, 2016, and 2017.
- There is a sharp drop in 2018, likely due to limited or missing data.



Average Price Analysis of Avocados

- By Type
  - Conventional (0) avocados have a lower average price compared to Organic (1) avocados.
- By Year
  - The average price remains relatively stable during 2015, 2016, and 2018.
  - A significant price increase is observed in 2017.

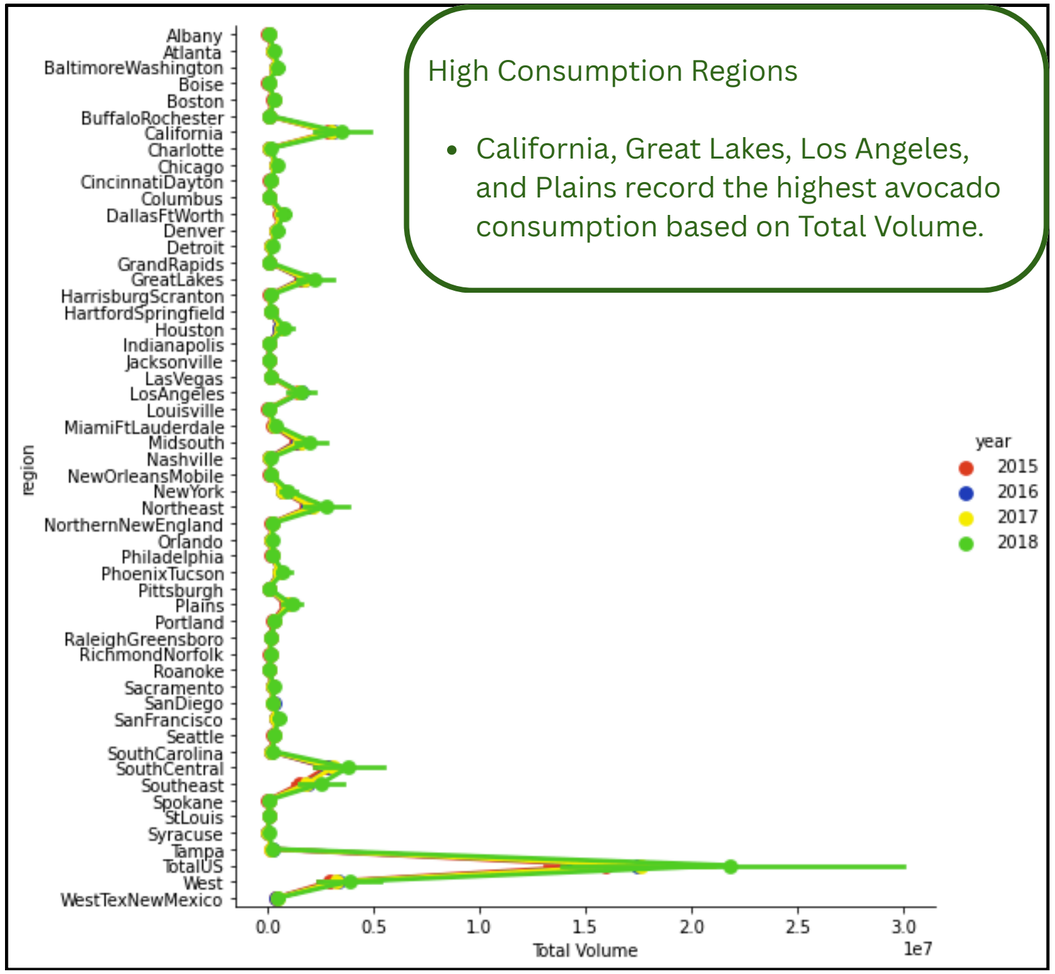
Data Visualization



Average Price Trend Over Time

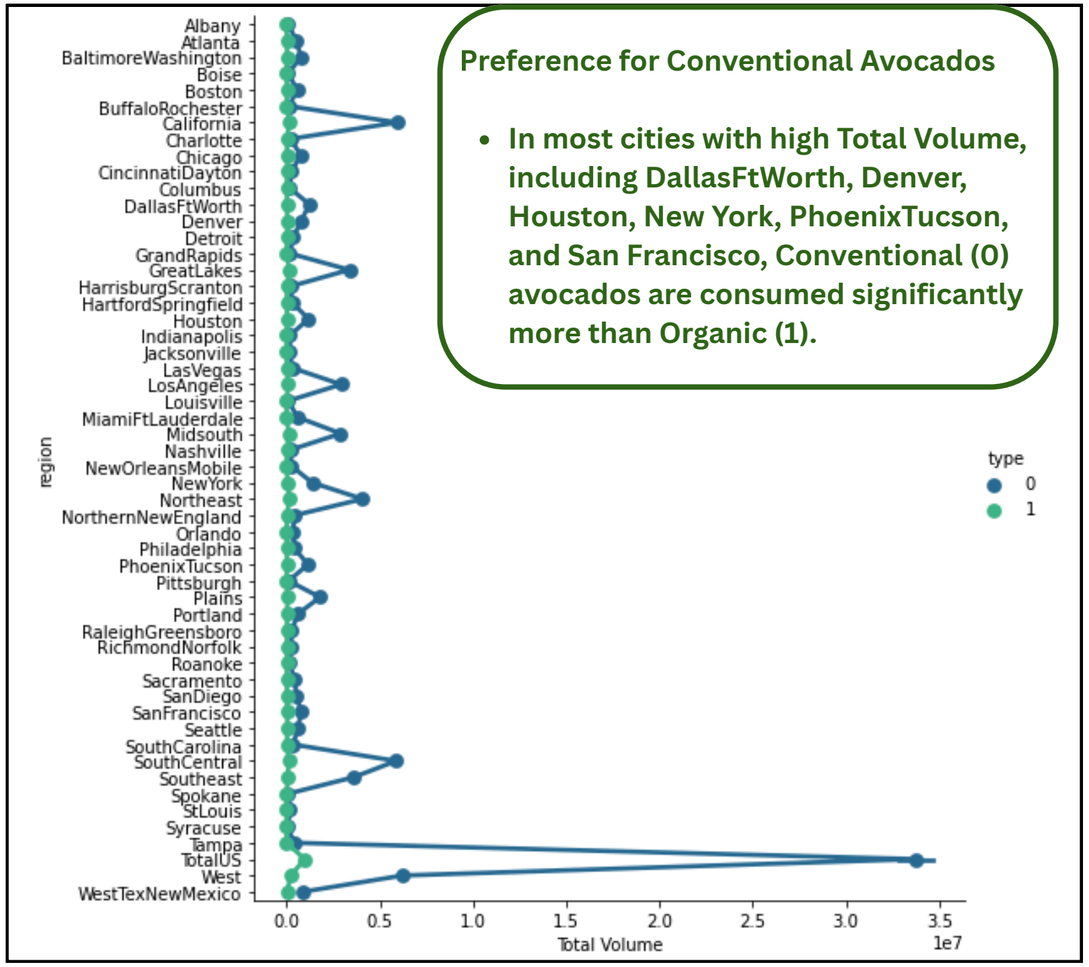
- **A positive upward trend is observed in Average Price over time.**
- **Three repetitive peaks appear at consistent intervals.**
- **Average Price drops around December / January.**
- **Highest prices are recorded during the months September to November.**

Data Visualization



High Consumption Regions

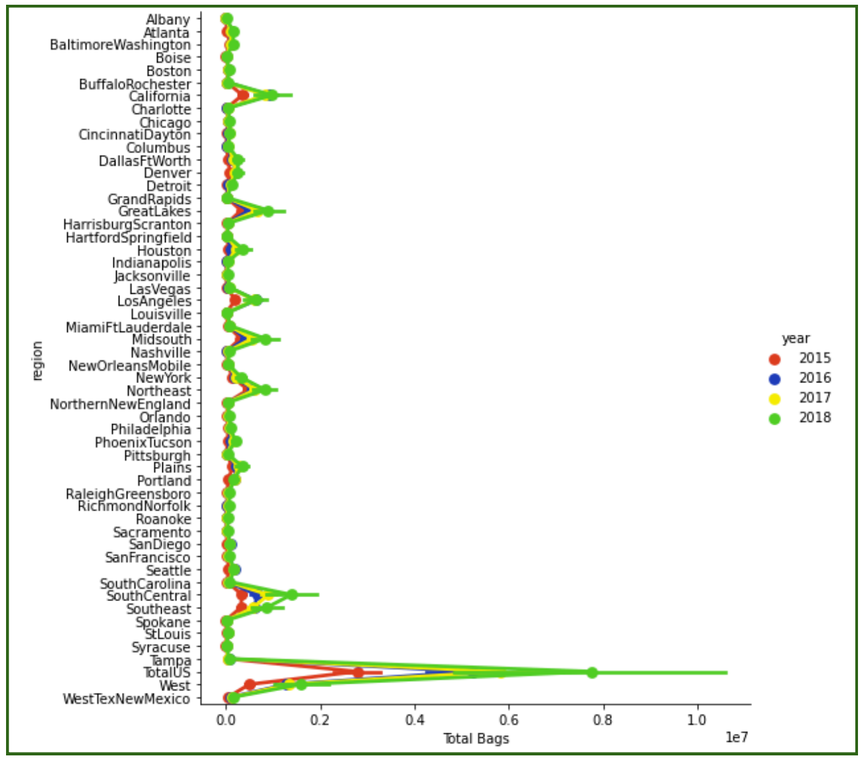
- California, Great Lakes, Los Angeles, and Plains record the highest avocado consumption based on Total Volume.

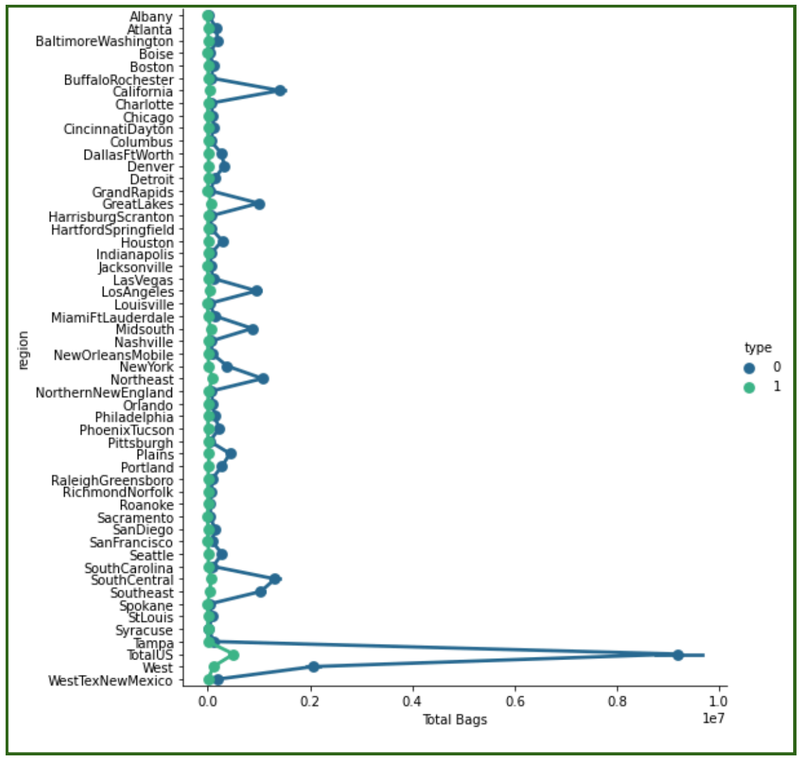


Preference for Conventional Avocados

- **In most cities with high Total Volume, including DallasFtWorth, Denver, Houston, New York, PhoenixTucson, and San Francisco, Conventional (0) avocados are consumed significantly more than Organic (1).**

Data Visualization

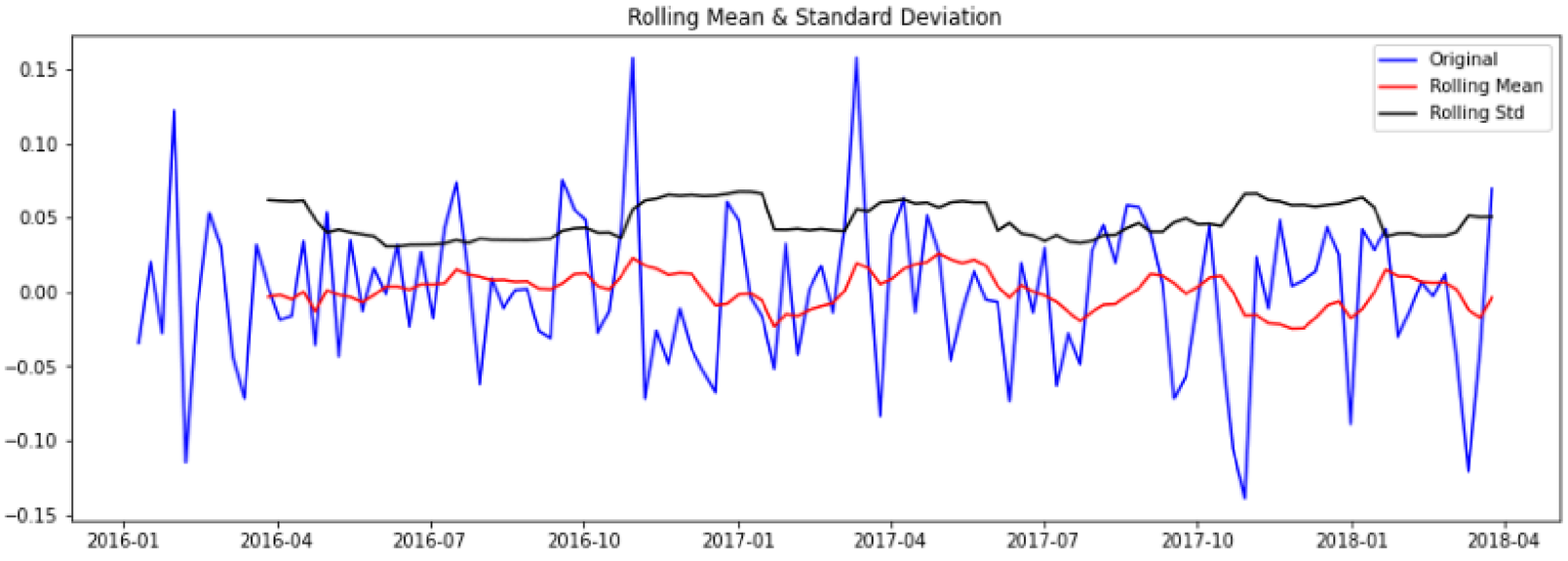




Correlation Between Bags & Total Volume

Bag usage shows a strong positive correlation with Total Volume, as evidenced by TotalUS data. There is a clear and consistent increase in bag usage in direct proportion to the rise in avocado demand, indicating a cause-and-effect relationship.

Augmented Dickey-Fuller Test



Objective

To check whether the time series is stationary or not using the Augmented Dickey-Fuller (ADF) Test.

Results of Dickey-Fuller Test:

Test Statistic	-4.60
p-value	0.00
#Lags Used	11.00
Number of Observations Used	104.00
Critical Value (1%)	-3.49
Critical Value (5%)	-2.89
Critical Value (10%)	-2.58
dtype: float64	

Interpretation:

- Since p-value < 0.05 and Test Statistic < Critical Values → Reject H0 → Data is stationary

Conclusion:

- The dataset is stationary at a 99% confidence level, making it suitable for SARIMA modeling.

SARIMA Overview: What & Why

What is SARIMA?

SARIMA (Seasonal Auto-Regressive Integrated Moving Average) is an extension of ARIMA that captures seasonality in time series data.

Model order:

(p, d, q) × (P, D, Q, M)

- (p, d, q): same as ARIMA parameters
- (P, D, Q): seasonal components
- M: seasonal period (here 52 weeks → 1 year)

Why SARIMA?

SARIMA is used to forecast weekly avocado prices by capturing both trend and seasonality patterns.

SARIMA Model Configuration

Model Setup

- Model: SARIMAX(1, 1, 2) × (0, 1, 0, 52)
- Dependent Variable: Log_AveragePrice
- Sample Period: Jan 2015 – Mar 2018
- Observations: 169

Model Fit Quality

- AIC: -361.85 → Low → Good fit
- BIC: -350.83 → Supports model efficiency
- HQIC: -357.37

Conclusion

- Model has a good overall fit based on AIC/BIC.
- Significant AR(1) and MA(1) terms indicate strong temporal dependence.
- Residuals show slight non-normality but acceptable for forecasting.
- SARIMA is suitable for weekly avocado price forecasting.

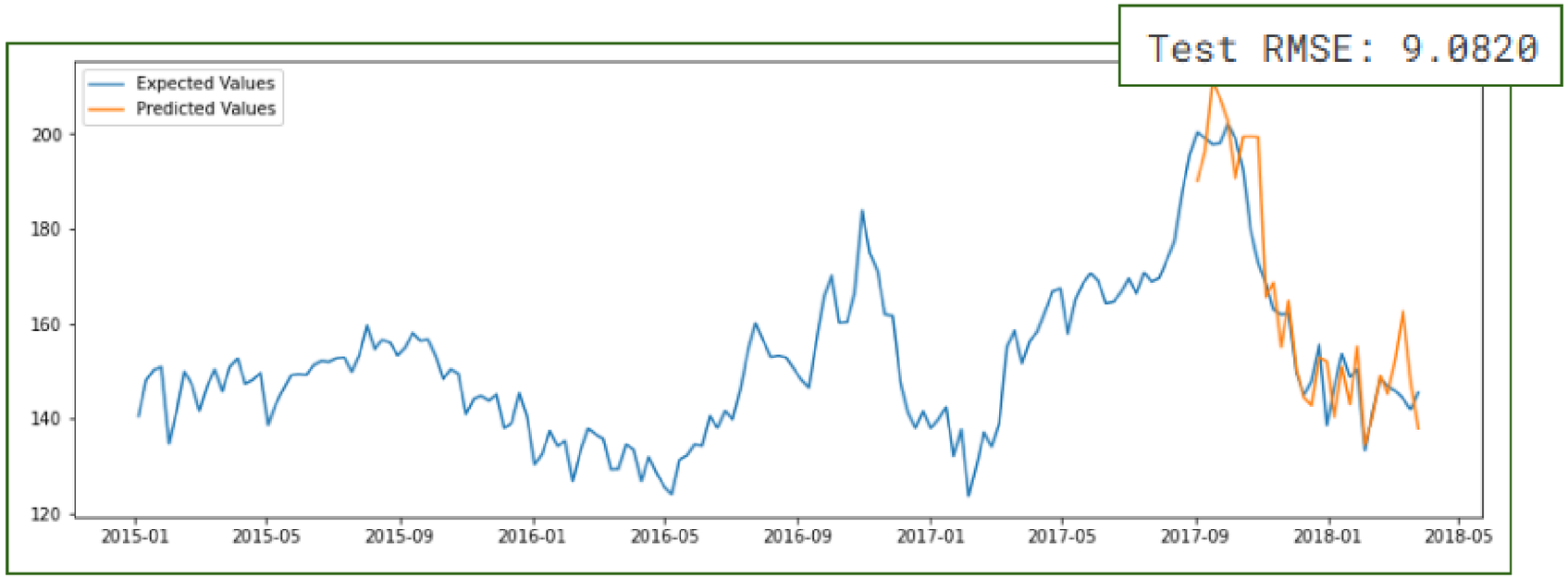
SARIMAX Results

Dep. Variable:	Log_AveragePrice	No. Observations:	169
Model:	SARIMAX(1, 1, 2)x(0, 1, [], 52)	Log Likelihood	184.923
Date:	Mon, 12 Sep 2022	AIC	-361.845
Time:	14:14:49	BIC	-350.831
Sample:	01-04-2015	HQIC	-357.374
	- 03-25-2018		
Covariance Type:	opg		

	coef	std err	z	P>|z|	[0.025	0.975]
ar.L1	0.7727	0.169	4.566	0.000	0.441	1.104
ma.L1	-0.7458	0.184	-4.047	0.000	-1.107	-0.385
ma.L2	-0.1546	0.109	-1.416	0.157	-0.369	0.059
sigma2	0.0024	0.000	9.163	0.000	0.002	0.003

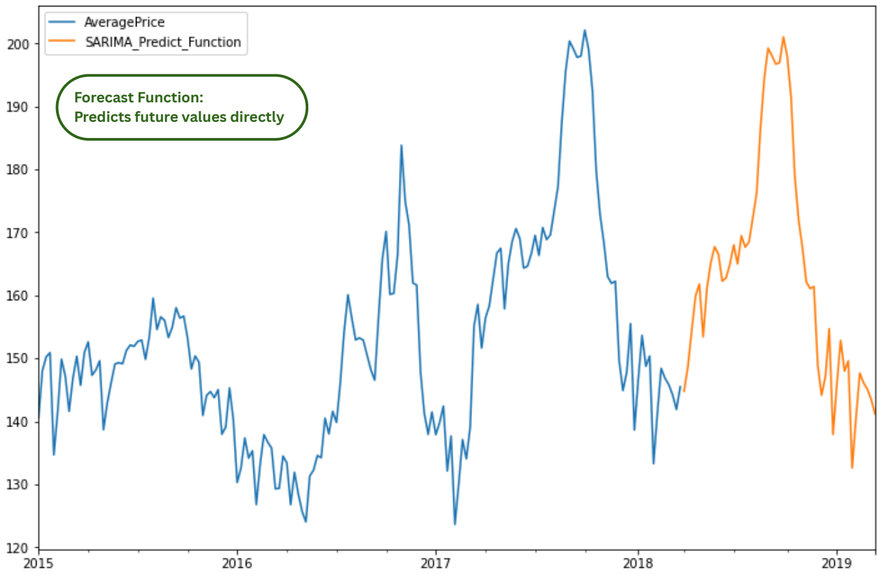
Ljung-Box (Q):	77.68	Jarque-Bera (JB):	7.83
Prob(Q):	0.00	Prob(JB):	0.02
Heteroskedasticity (H):	1.16	Skew:	0.10
Prob(H) (two-sided):	0.64	Kurtosis:	4.26

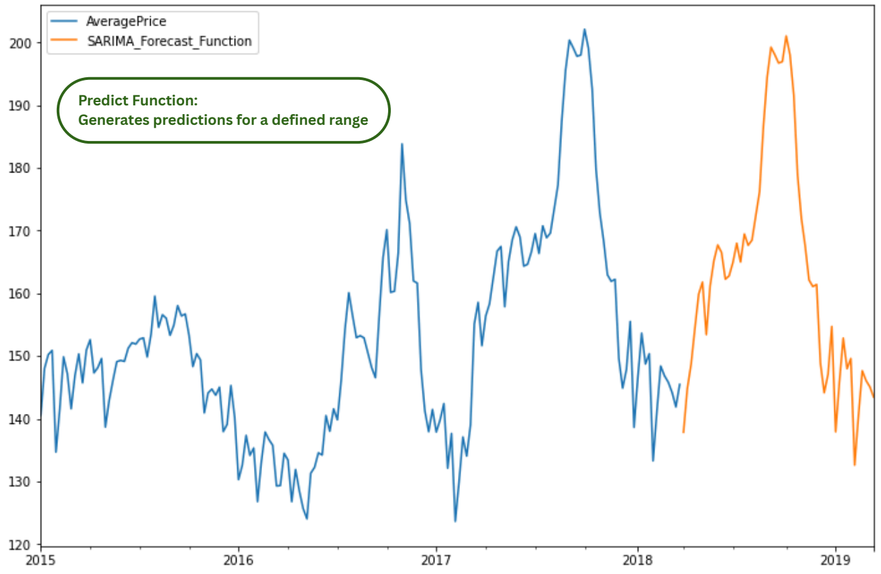
In-Sample Forecasting Results



The SARIMA model was applied using a rolling forecast on the last 30 data points to evaluate its predictive performance. The results show that the predicted values closely follow the actual values, indicating a good model fit. Although slight overfitting is observed in certain peaks and drops, the overall accuracy remains acceptable, with a test RMSE of 9.082. These findings confirm that the model performs well on historical data and is reliable enough to proceed with out-of-sample forecasting.

Out-Sample Forecasting Results





The results obtained from both methods are almost identical, with only minor differences in decimal values. This indicates that the model produces consistent and reliable predictions.
Moreover, the model successfully captures the seasonal patterns present in the data and shows a slight upward trend in the projected period. These findings confirm that the SARIMA model is highly suitable for generating short- to medium-term forecasts of avocado prices, providing a solid foundation for future decision-making.

Key Insights & Conclusion SARIMA Forecasting

Key Insight

- SARIMA model effectively models weekly avocado prices.
- Seasonality is well captured after applying seasonal differencing.
- High accuracy demonstrated by low RMSE and consistent forecasts.
- Forecast Function and Predict Function produce almost identical results.
- Suitable for short- to medium-term forecasting.

Conclusion

- The dataset is well-suited for learning time series analysis and exploring various forecasting techniques.
- Through this project, we gained insights into stationarity, data transformations, and seasonal modeling.
- The SARIMA model provides reliable projections of future avocado prices, making it valuable for business decision-making.

thank you