Time Series Forecasting

project by:

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Summary

Goal

Forecast the next quarter of US Cocoa Bean Imports

Models

	Versions:		Tuned Models:
Triple Exponential Smoothing	Raw Data vs. Log Transformed	Multiplicative*	= 2
SARIMA	Raw Data vs. Log Transformed	Manual, Short vs. Full Grid Search	= 6
Prophet	Raw Data vs. Log Transformed	Grid Search*	= 2

** The "untuned" versions of these models (e.g., "additive") for TES shown on upcoming slides but excluded from final evaluation*

Results

Triple Exponential Smoothing model on raw data performed best with lowest MAE & (tied for) lowest MAPE:

Model	Log Data	Tuning	MAE	MAPE	MAE_H1	MAE_H2	MAE_H3	MAPE_H1	MAPE_H2	MAPE_H3
ExponentialSmoothing	N	Manual	9,559,131	27%	8,232,452	9,662,805	10,782,135	24%	29%	30%
ExponentialSmoothing	Y	Manual	10,529,673	29%	8,454,657	10,832,715	12,301,647	24%	30%	33%
Sarima	N	Short Grid Search	17,625,899	67%	11,563,515	18,363,968	22,950,214	40%	72%	88%
Sarima	N	Grid Search	9,843,491	33%	8,015,458	10,640,699	10,874,315	29%	37%	33%
Sarima	N	Manual	22,289,323	92%	16,481,080	23,139,193	27,247,696	72%	99%	105%
Sarima	Y	Short Grid Search	9,876,090	27%	8,183,549	9,969,859	11,474,863	22%	27%	31%
Sarima	Y	Grid Search	9,886,487	29%	7,851,162	10,110,756	11,697,541	23%	31%	32%
Sarima	Y	Manual	10,271,880	29%	8,358,623	10,539,407	11,917,611	24%	30%	33%
Prophet	N	Grid Search	11,510,718	46%	12,449,653	11,544,815	10,537,687	54%	47%	37%
Prophet	Y	Grid Search	11,333,605	44%	13,120,463	11,264,117	9,616,237	59%	44%	29%

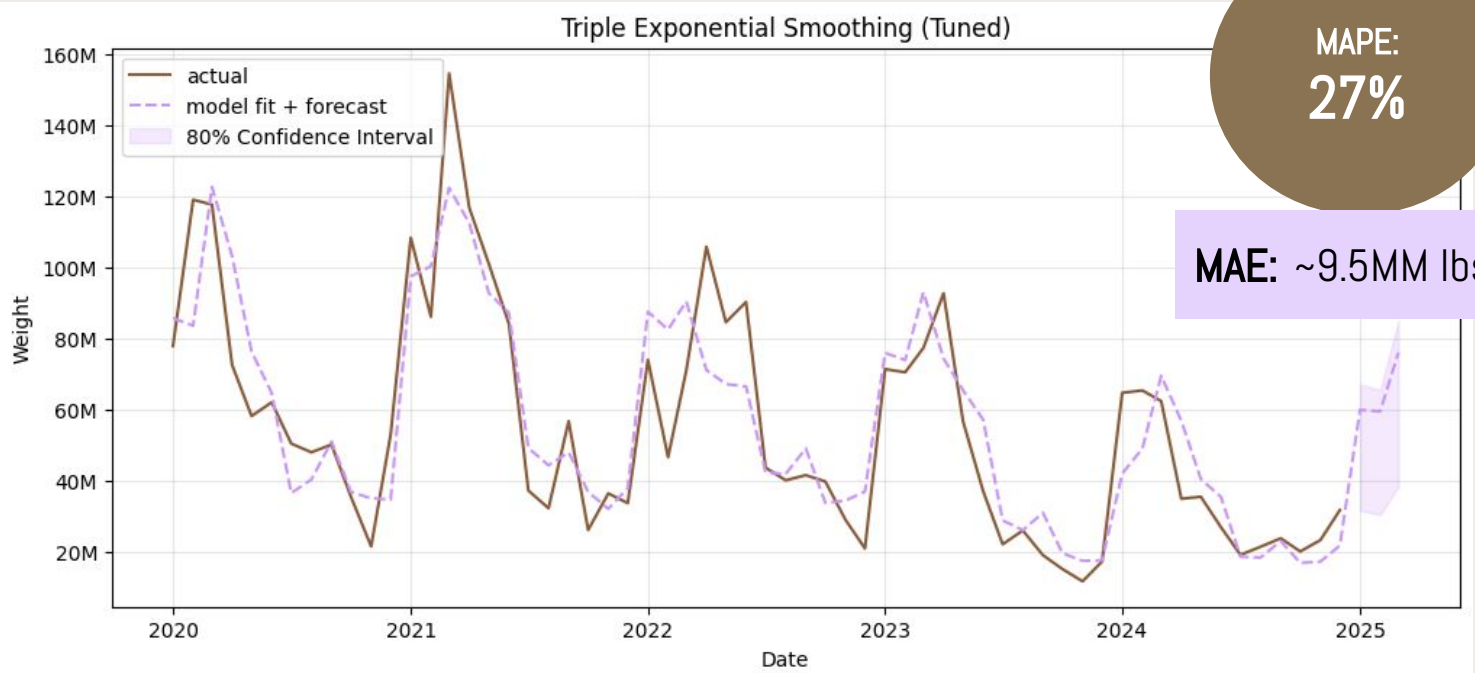
Results

Forecast

Date	Forecast	Lower_CI	Upper_CI
2025-01-01	59,915,879	31,650,287	67,112,957
2025-02-01	59,477,191	30,411,927	65,506,481
2025-03-01	75,993,848	38,341,516	84,996,332

Model

```
triple_tuned = ExponentialSmoothing(
  data['Weight'],
  trend="additive",
  damped_trend=True,
  seasonal="multiplicative",
  seasonal_periods=12
).fit(optimized=True)
```



MAPE: 27%

MAE: ~9.5MM lbs

MAPE Levels

- <20% = excellent
- **20-30% = good**
- <40% = acceptable for monthly forecasting

Good for seasonal / volatile, high volume, monthly data – a difficult combination to forecast.

It may benefit from additions/further fine-tuning.

Note, MAPE is higher than it would be with non-seasonal data where it can be lower (up to <5%)

notebook link:

Technical Setup

Data

Source: Census US imports of Cocoa Beans 2020-2024

Type: Structured

Observations: 60 (months)

Features: Month/Year

Target: Weight & Spend

Note, N is higher originally as the grain was by Country, but Country was not used in this forecast

Setup

Language: Python

Packages: prophet, seaborn, matplotlib, numpy, pandas

Compute: Python3 CPU in Google Colab

Evaluation Metrics

- Mean Absolute Error (MAE) & Mean Absolute Percentage Error (MAPE) on forecast