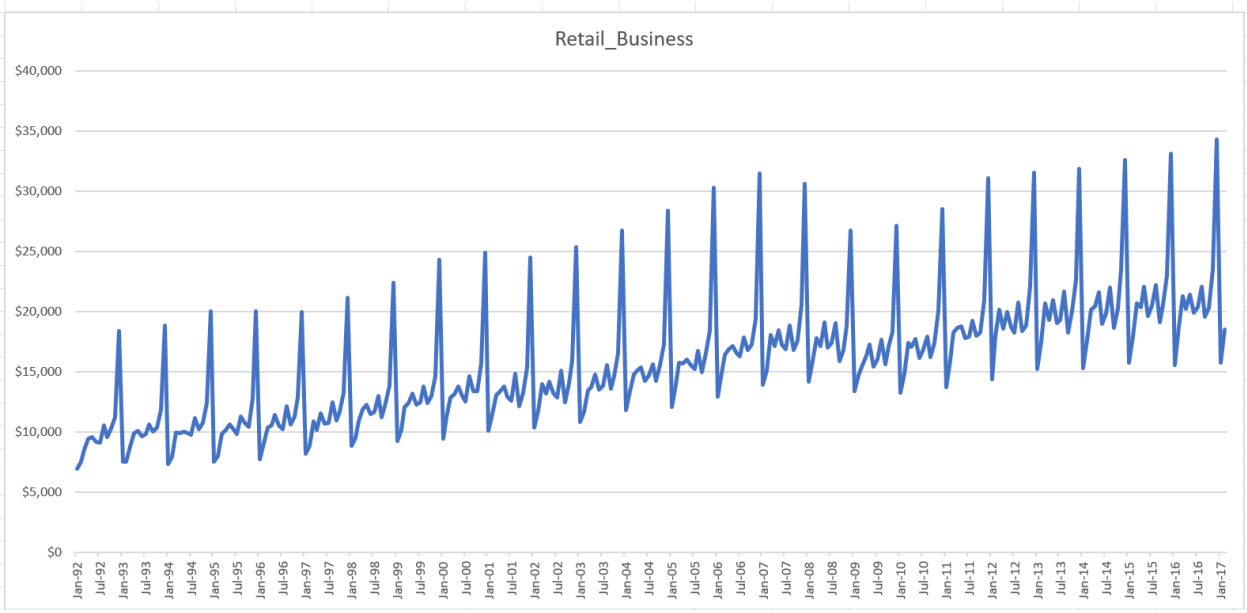
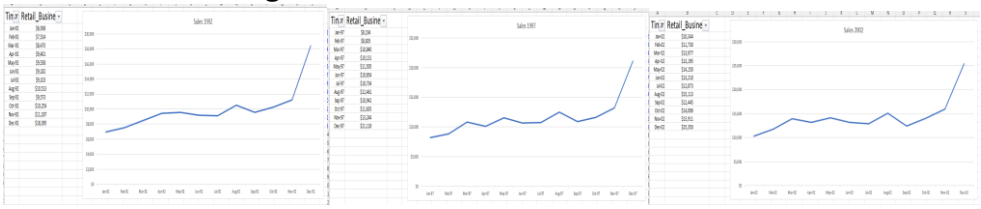
Ex 5.6 Time Series Analysis & Forecasting
Lisa Coombs
March 27, 2025

Answers 5.6

Time Series Questions



2A: Is there a certain characteristic to the pattern and trend?
This is a seasonality time series because there are regular fluctuations at periodic intervals. There is an uptick in sales each year from November to December. I looked at individual sales years: 1992, 1997 and 2007: Each year sales start increasing in September and continue through December.



2B: What advice might you give your client based on this time series? Why?
This data exhibits strong seasonality with annual peaks starting in September and going through to December. I would suggest making sure orders are placed for delivery in late August or early September, in time to stock the shelves for peak season sales starting in October.

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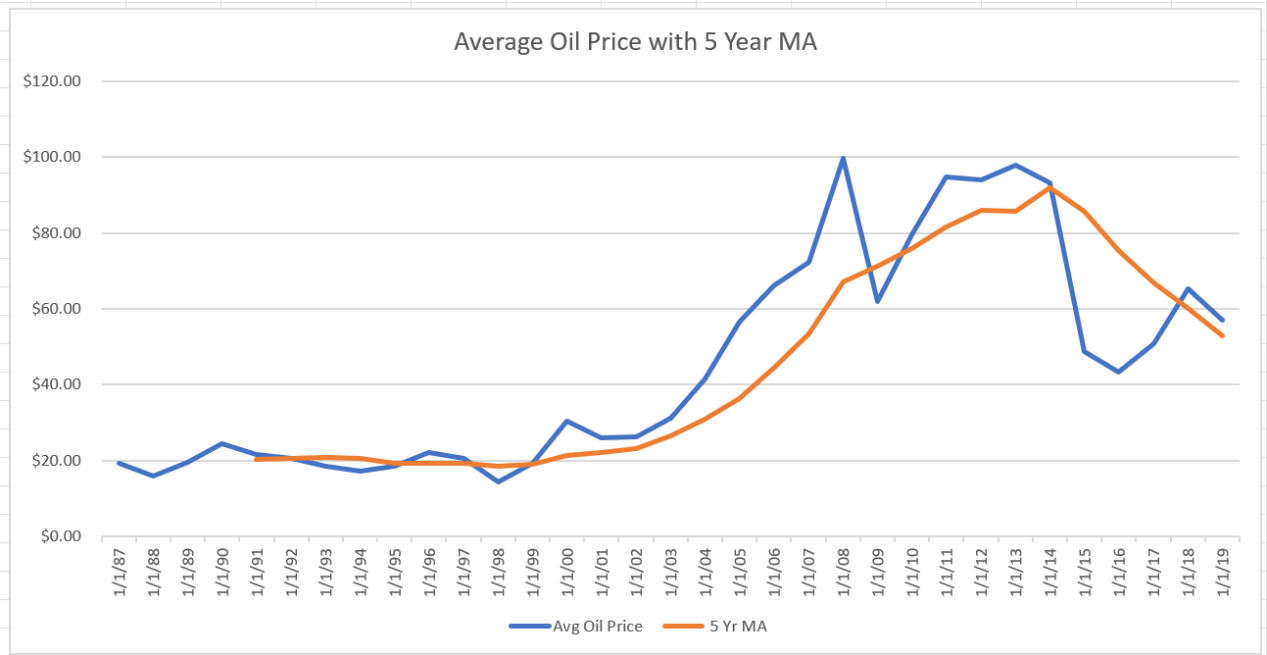
Simple Moving Average Questions



4A: Is there a certain characteristic to the pattern and trend? Make sure to provide a short explanation for your answer.
The average annual oil price (blue line) shows much more volatility than the 5-year moving average (orange line). From 1987 to 1999, oil pricing was stable; however, from 2000 until 2008, pricing increased sharply (up about $69/barrel). Then, from 2013 to 2019, it fell nearly $41 / barrel.

4B: Explain how the moving average affects oil price volatility and how it makes forecasting easier.
The 5-year moving average (orange line) smooths out short-term fluctuations and follows the general trend more gradually. This line looks like it has a smooth wave-like oscillation, a sinusoidal shape. It smooths out the price spikes and provides a clearer view of long-term trends.

5: Briefly explain why you might convert a non-stationary time series into a stationary time series before applying a forecasting model.
A stationary time series has statistical properties (mean & variance) that remain constant over time, making it easier to model and predict. If a time series is non-stationary, then trends and seasonality can introduce noise and instability (like the volatility in the Oil Pricing sheet) which can lead to inaccurate forecasts. Transforming the data (for example, using a simple moving average) helps to smooth out the data and capture meaningful patterns rather than temporary fluctuations.

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6A: Do some research on the ARIMA model and one other model not covered in this Exercise; Facebook Prophet is one example that's become popular in recent years.

MODEL	What it does	Main Advantage	Main Limitation
ARIMA	It's a statistical model used for time series forecasting – it predicts future values based on past data ARIMA does this by identifying patterns in a time series, such as trends and seasonal effects, and then creating a mathematical model to predict future data points	It's Effective for short-term forecasting when a time series has patterns but no strong seasonality (then it could be used with SARIMA – Seasonal Autoregression Integrated Moving Average)	It's not the best model for complex, highly volatile data or long-term forecasting. This is because it assumes patterns from the past will continue unchanged into the future
Gradient Boosting (GBM, XGBoost, LightGBM, CatBoost)	It's a machine learning technique that builds multiple weak models (like small decision trees) and then combines them to create a strong predictor. Each new model will fix the errors of the previous ones, thereby improving accuracy.	It's extremely accurate for structured or tabular data (like predicting sales, customer churn, or fraud detection)	It can be prone to overfitting, especially if not tuned properly, meaning it may perform well on training data but poorly on new, unseen data

6B: Imagine you have to explain these models to a colleague who's unfamiliar with them. Write two short paragraphs (1 for each model) without going into the technical details. Include links to the resources you found during research.

Article Title	Links	Online Resource
Understanding ARIMA Models: A Comprehensive Guide to Time Series Forecasting	https://medium.com/@data-overload/understanding-arima-models-a-comprehensive-guide-to-time-series-forecasting-dfc7207f2406	Medium
Intro to ARIMA Models	Introduction to ARIMA Models | DataScienceBase	GitHub
ARIMA for Time Series Forecasting: A Complete Guide	ARIMA for Time Series Forecasting: A Complete Guide | DataCamp	DataCamp

How Gradient Boosting can solve real world problems	XGBoost in Real-World Applications: How Gradient Boosting Can Solve Complex Problems	The Pi Guy Blog
How CatBoost Algorithm works	How CatBoost algorithm works |	GeeksforGeeks
Harnessing the Power of Gradient Boosting: Real-World Applications	Harnessing the Power of Gradient Boosting: Real-World Applications	The History of the World Blog

ARIMA + Weather Forecasting
ARIMA can help predict the weather by looking at past weather patterns. It analyzes things like temperature, rainfall, and air pressure over a time period and finds the trends or cycles. For example, if it rained every few days over the past month, the model could estimate when rain is likely to happen again.

Gradient Boosting + Natural Language Processing
Gradient Boosting is a machine learning technique that improves its predictions step by step by learning from mistakes. In Natural Language Processing (NLP), it helps analyze text data for things like sentiment analysis and customer feedback interpretation. Gradient boosting builds multiple small models (like decision trees), where each new model corrects the errors of the previous one, gradually improving accuracy. It is very effective at understanding complex language patterns, detecting sentiment in social media posts, categorizing customer reviews, and enhancing automated response systems.