Analyzing Amazon’s Revenue: Exploring Forecasting Models

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Introduction:

Amazon Inc. has grown significantly since its humble beginnings, evolving from a money-losing venture at its IPO in 1997 to a trillion-dollar giant by 2020. As investors and stakeholders seek insights into the sustainability of Amazon's growth, forecasting its revenue accurately becomes crucial. This report delves into various forecasting models to accurately predict Amazon's revenue for the fiscal year 2021.

Objective:

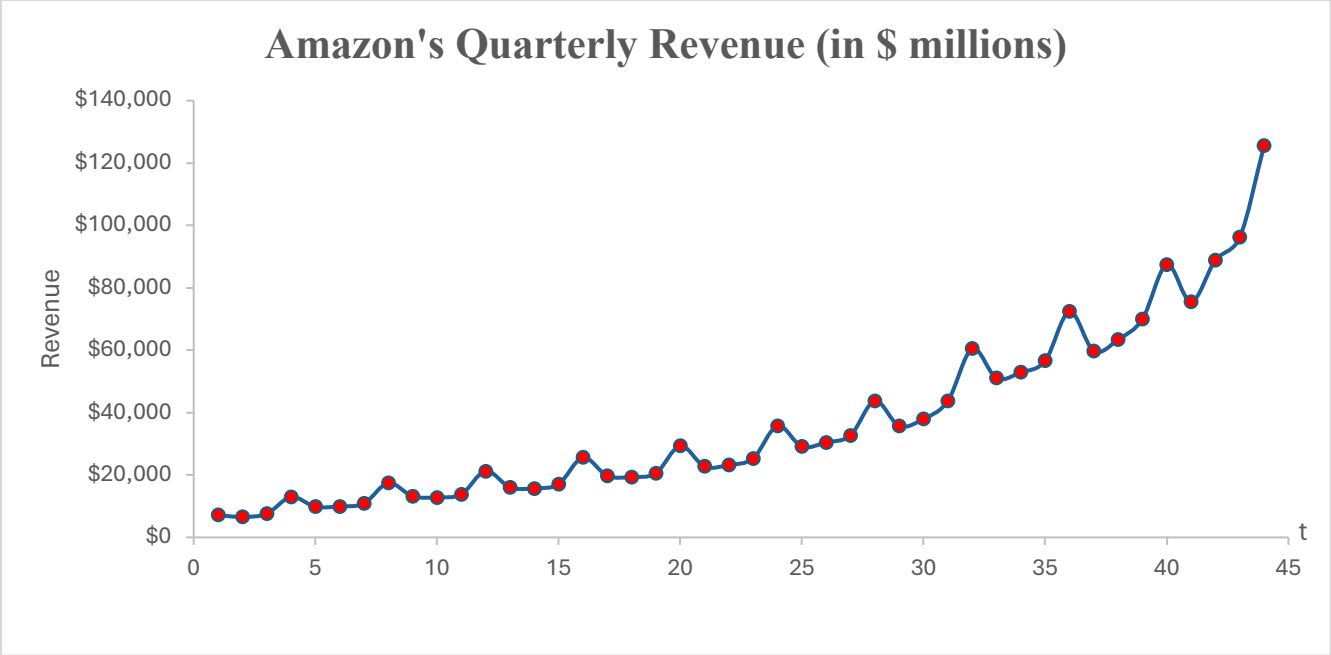
We aim to analyze historical revenue data from 2010 to 2020 and identify the most suitable forecasting model. By employing trend regression models with seasonal dummy variables and the Holt-Winters Exponential smoothing method, we seek to uncover the intrinsic patterns and seasonal fluctuations within Amazon’s revenue stream.

Data Description:

The dataset comprises quarterly revenue figures for Amazon Inc. from 2010 to 2020, with the fiscal year concluding at the end of December. Each row includes the year, quarter, and corresponding revenue in millions of dollars. This dataset serves as the foundation for analyzing and forecasting Amazon's revenue trends, facilitating the exploration of various forecasting models and providing insights into its financial performance.

Key Insights:

A scatterplot of Amazon’s quarterly revenue for the fiscal years 2010 through 2020 highlights some essential characteristics. Firstly, a persistent upward movement indicates sustained growth over the observation period, with notable improvement in the later years. Secondly, a seasonal pattern repeats itself year after year. For each year, revenue is the highest in the fourth quarter (October - December), a holiday season, compared to other quarters. Further, the COVID-19 pandemic significantly impacted Amazon's revenue dynamics, particularly in 2020. The pandemic-induced lockdowns and social distancing measures led to a surge in online shopping, resulting in substantial revenue growth in the second and third quarters. This underscores the need for a forecasting model capable of capturing both the long-term growth trend and the recurring seasonal effects. Continued monitoring of revenue trends remains crucial for stakeholders to assess Amazon's performance and make informed decisions in navigating the dynamic business landscape.



Methodology:

We employ cross-validation to find the preferred model for trend with seasonality, dividing the data into a training set (2010 – 2018) and a validation set (2019 – 2020). Various trend regression models, including linear, exponential, quadratic, and cubic, with seasonal dummy variables and the Holt-Winters exponential smoothing model, are explored on the training set to identify the optimal forecasting approach.

Trend Regression Models

The trend variable t is labeled from 1 to 44, denoting the quarterly period between 2010 and 2020. In addition to t and t^2, we also compute three seasonal dummy variables, d1, d2, and d3, representing the first three quarters, using the fourth quarter as a reference.

The estimated trend models with the training set, where y denotes revenue, are:

Linear: $\hat{y}t = 6964.2569 - 8429.9830\ d1 - 9386.5813\ d2 - 8641.4017\ d3 + 1423.3760\ t$

Exponential: $\hat{y}t = \exp(9.1904 - 0.2997\ d1 - 0.3555\ d2 - 0.3210\ d3 + 0.0572\ t + 0.0682^2/2)$

Quadratic: $\hat{y}t = 17874.3634 - 8429.9830\ d1 - 9293.0661\ d2 - 8547.8865\ d3 - 306.6551\ t + 46.7576\ t^2$

Cubic: $\hat{y}t = 12003.6869 - 7659.3081\ d1 - 8781.2635\ d2 - 8289.0143\ d3 + 1345.6115\ t - 63.1690\ t^2 + 1.9807\ t^3$

The models estimated above are applied to the validation set to generate revenue forecasts and subsequently used to calculate forecast errors.

Holt-Winters Exponential Smoothing Model

Initial seasonal, level, and trend values are calculated, with seasonal factors adjusted based on the previous year's data for the same period. These initial values act as starting points for the iterative forecasting

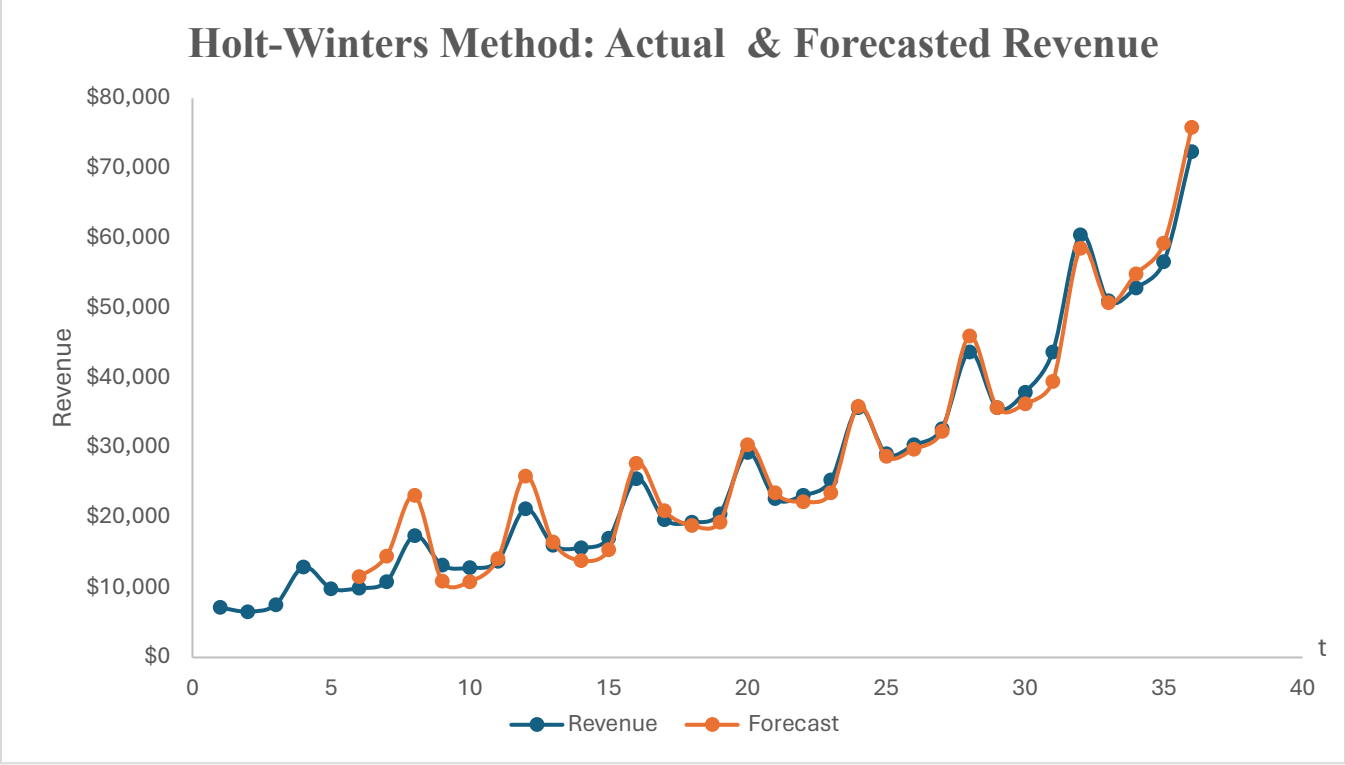
process. Subsequently, seasonal factors are determined based on previous periods, adjusting for the seasonal variation in the data. As the analysis progresses, the level and trend values are updated iteratively, considering the current data point and its relationship with seasonal factors. Finally, forecasts are generated based on the calculated level, trend, and seasonal factors.

We fine-tuned the alpha, beta, and gamma parameters to optimize the forecasting model using optimization techniques such as Solver in Excel. We aimed to minimize the Root Mean Squared Error (RMSE) between actual and forecasted values. Table 1 presents the user-supplied and solver-generated smoothing parameters and the resulting RMSE.

Table 1: Smoothing Parameters

Parameter	User - supplied	Solver - generated
Alpa (α)	0.25	0.5364
Beta (β)	0.15	0.6450
Gamma (γ)	0.10	1.0000
RMSE	8059.96	2837.04

Solver-generated smoothing parameters are preferred as they result in lower RMSE. The scatterplot below showcases the comparison between actual and forecasted revenue generated through the Holt-Winters method. Notably, the forecasted revenues closely align with the actual revenues, indicating high accuracy in the forecasting process.



Model Evaluation and Results:

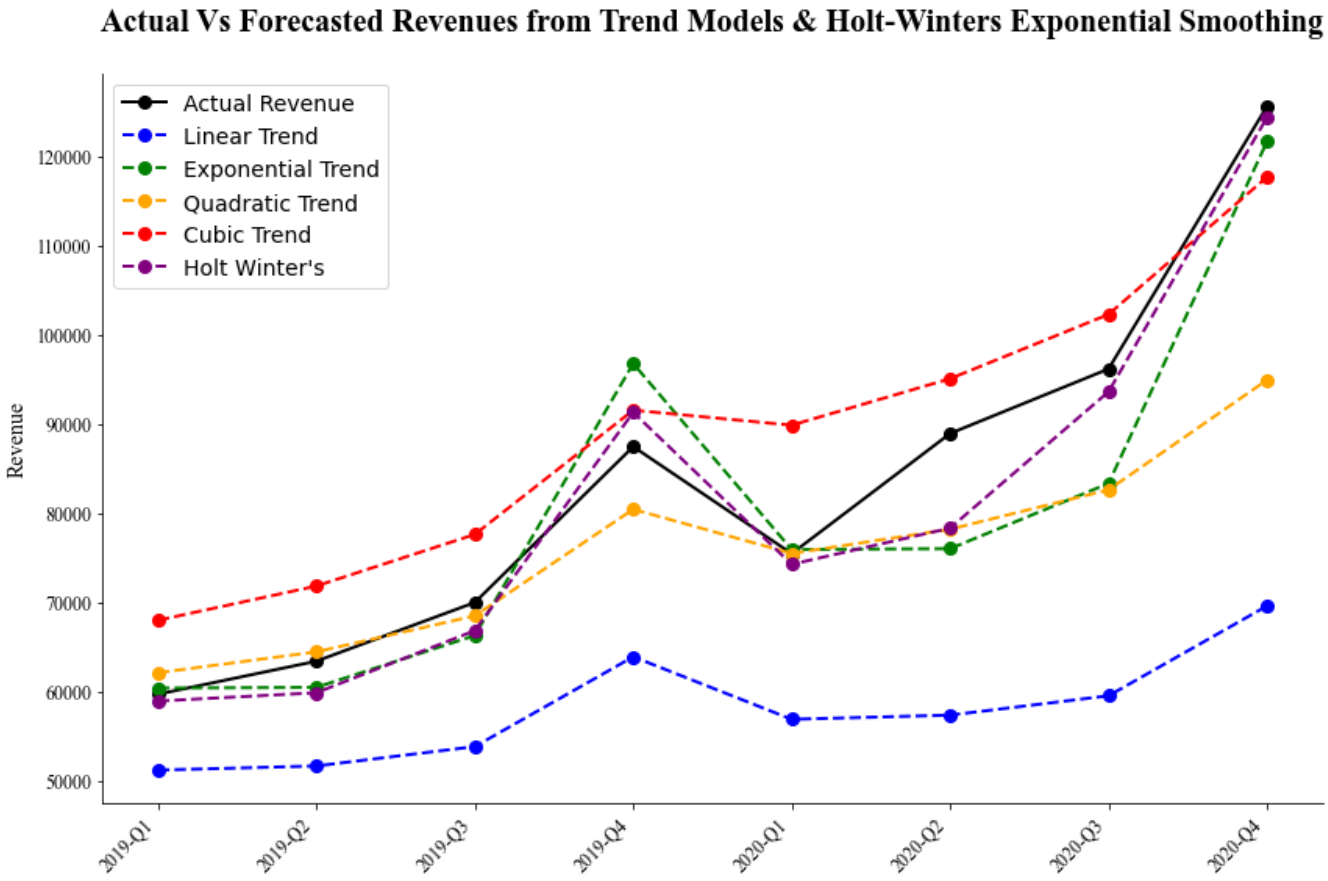
In Table 2, we present the performance measures of competing models. To determine the most appropriate forecasting model for Amazon's revenue, we use the forecast errors in the validation set to compute Mean Absolute Error (MAE), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE) calculated from the validation data.

Table 2: Performance Measures of Competing Models

Model	MAD	MAPE	MSE
Linear Trend	25,326.75	28.19%	854,667,894.30
Exponential Trend	5,846.02	6.66%	57,031,009.62
Quadratic Trend	8,364.20	8.31%	162,068,585.22
Cubic Trend	7,869.35	10.17%	69,852,317.84
Holt - Winters Exponential Smoothing	3,362.79	4.12%	19,959,617.35

After evaluating the performance of each model on the validation set, the Holt-Winters exponential smoothing model demonstrated the lowest MSE, MAD, and MAPE values, indicating superior forecasting accuracy compared to other models.

The scatterplot below compares the actual and forecasted revenues derived from the trend models and the Holt-Winters exponential smoothing model within the validation set. This comparison again confirms that Holt-Winters outperformed other models in accuracy, as its forecasted revenue closely matches the actual revenue. However, a slight discrepancy was noted in 2020 Q2, which may be attributed to the significant impact of the COVID-19 pandemic on Amazon's revenue dynamics. The pandemic-induced lockdowns and surge in online shopping likely influenced this deviation.



Forecast for Fiscal Year 2021:

Utilizing the Holt-Winters exponential smoothing model on the entire dataset from 2010 - 2020, we forecasted Amazon's revenue for the fiscal year 2021. The quarterly revenue forecasts for the fiscal year 2021 are $110,881.97, $125,190.00, $131,594.03, and $167,642.36 million, respectively.

Conclusion:

Our analysis confirms that the Holt-Winters exponential smoothing model provides the most accurate forecasts for Amazon's revenue, effectively capturing the complexities of its revenue patterns by incorporating both trend and seasonality. Its ability to deliver accurate forecasts makes it the preferred choice for investors seeking to navigate the dynamic e-commerce landscape. Its robustness and adaptability to changing market conditions empower investors to make well-informed decisions, capitalize on emerging opportunities, and effectively manage risks.

While Amazon has enjoyed remarkable growth and success, its future trajectory faces challenges from various fronts. Heightened competition in the e-commerce market, with established players and new entrants vying for market share, presents a significant consideration. Additionally, Amazon's reliance on

mid-to-high-end market positioning, notably in segments like cloud computing (Amazon Web Services), may pose limitations for expansion, particularly in emerging markets or lower-income demographics.

Moreover, relying on third-party sellers introduces complexities and uncertainties in Amazon's business model. While its Prime Video segment shows promise, it is still in the early stages of reaching a broad customer base compared to competitors like Netflix, Disney Plus, and Hulu, which boast established customer loyalty.

Additionally, Amazon's strategic shift towards enhanced AI-powered innovations, as evidenced by its initiatives in 2020, intensifies competition with tech giants like Apple, Microsoft, and Google for market share and potential growth.

Despite these challenges, Amazon's unwavering commitment to innovation, customer-centric approach, and diversified revenue streams position it favorably to navigate potential hurdles and sustain growth. However, achieving this requires careful strategic planning and adaptation to evolving market dynamics. By staying agile and responsive, Amazon can continue its trajectory of success in the ever-evolving landscape of global commerce.