

# Personal Expenditures in the United States

By

Maxwell Sag



## Table of Contents

<b>Executive Summary .....</b>	2
- Problem Statement .....	2
- Dataset .....	3
<b>Introduction .....</b>	3
<b>Analysis .....</b>	3
- United States Durable Goods .....	4
- United States Non-Durable Goods .....	6
- United States Services .....	8
- Durable Goods for Each State .....	10
- Non-Durable Goods for Each State .....	29
- Services for Each State .....	48
<b>Conclusion .....</b>	66
<b>Appendix .....</b>	69

## **Executive Summary**

The dataset being used in this project is personal expenditures in the United States broken down by state from 1997 to 2019. Personal expenditures are broken down into three different categories: Durable Goods, Non-Durable Goods, and Services. When visualizing the graphs of the data of the United States as a whole, it exhibits an upward trend, with a drop due to the economic recession of 2008. The data gives a glimpse of how the overall economy was performing from 1997 to 2019.

The forecasting models used were Regression with Linear Trend, Regression with Quadratic Trend, Advanced Exponential Smoothing model (Holt's Model), and an Autoregressive Integrated Moving Average model (ARIMA). Model evaluation was based on three accuracy measures: Mean Absolute Percentage Error (MAPE), Root Mean Squared Error (RMSE), and Theil's U statistic. MAPE is one of the most commonly used accuracy measures to forecast accuracy; it is the average of the percentage errors. RMSE is a measure of how far apart residuals are from one another; residuals are a measure of how far the regression line data points are. RMSE is commonly used in forecasting to verify results. Theil's U statistic compares forecasted results with the results of forecasting with minimal historic data. If the Theil's U statistic is less than 1, that means the forecasting model is better than guessing, if it's 1, that means the forecasting model is just about as good as guessing, and if it's more than 1, that means the model is even worse than guessing. The lower the accuracy measures, the better the forecast. Based on all these accuracy measures, the best forecasting model for this project was the Auto ARIMA model.

## Problem Statement

Analyze the personal expenditures of Durable Goods, Non-Durable Goods, and Services for each state to identify economic behavior for the next five years. Determine which states are on the verge of an economic decline and propose a solution to guarantee their economy goes towards an upward trajectory.

## Dataset

In order to be able to forecast, the data needs to be converted into a time series. To do so, the columns and rows of the dataset needed to be switched in order for the years, 1997 to 2019, to be in one column. The columns used were GeoName, Description, and Year.

## Introduction

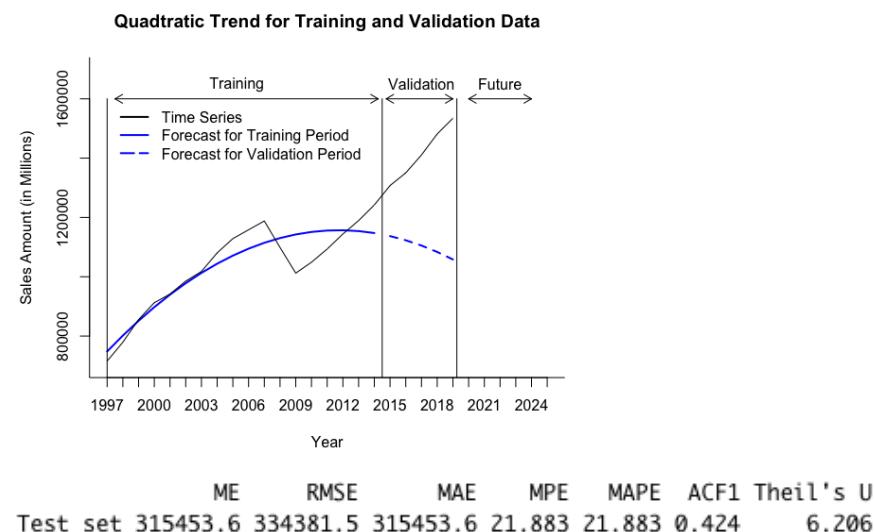
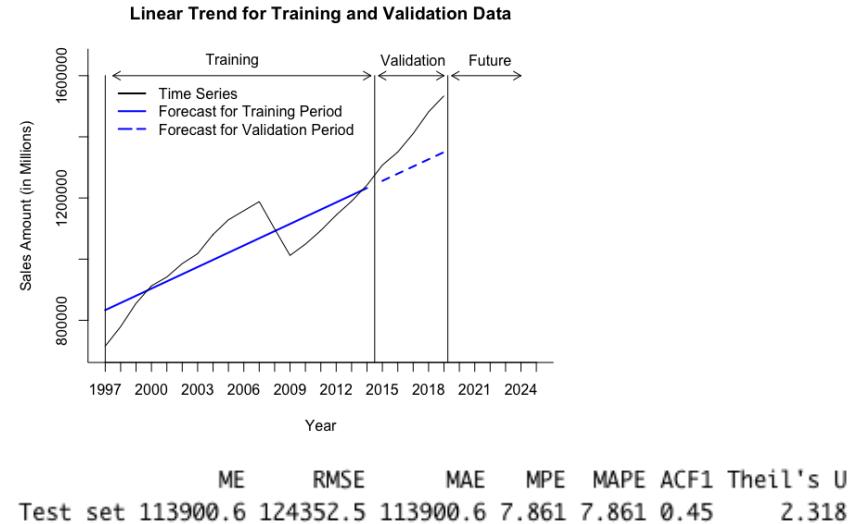
A vital facet of the United States is its economy; being the largest economy in the world. The economy is broken down into two categories: goods and services. If one of these categories begins to decline, the economic vitality of the United States goes into disarray. Economists must make sure the United States' economy stays on a linear path. One of the methods in making sure there is no decline is forecasting. Forecasting the economy provides an input on whether it will stay on the same trajectory over a period of time and what measures to take if it starts to decline.

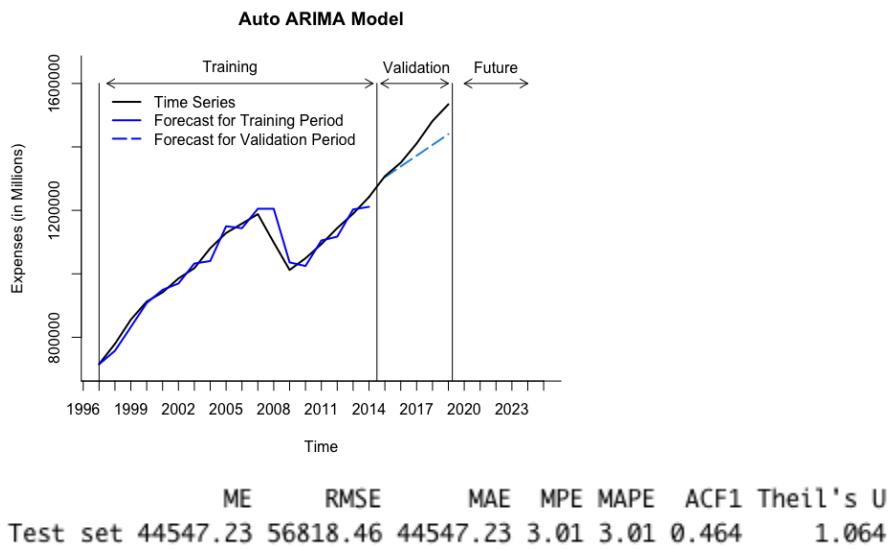
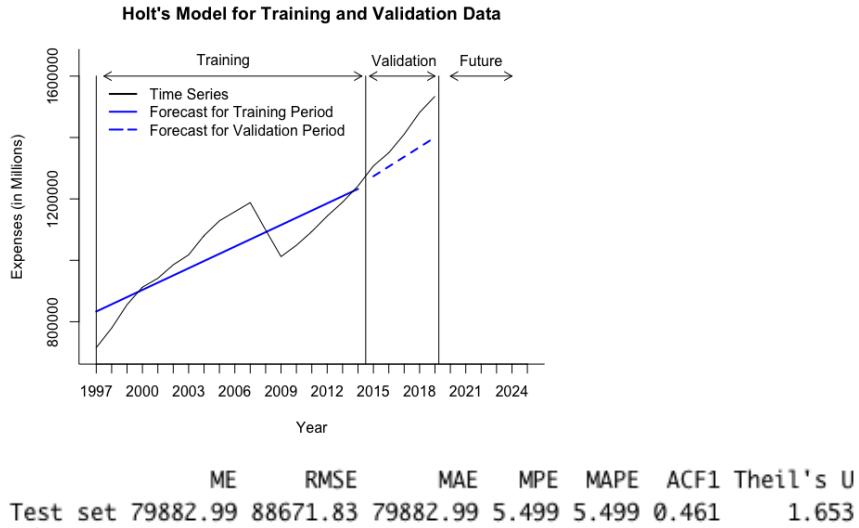
## Analysis

Before starting to analyze every state individually, the most accurate forecasting model needs to be chosen. Since every state is going to have a different trajectory in Goods, Non-Durable Goods, and Services, many different models could be of use for each state. In order to keep all of the forecasts relatively consistent, the same model will be used for each state. Using four different forecasting models (Regression with Linear Trend, Regression with Quadratic Trend,

Holt's Model, and Auto Arima Model) on the entirety of the United States' Personal Expenditure on Durable Goods, Non-Durable Goods, and Services, one will have the precise accuracy to be used on each of the 50 states and the District of Columbia.

### United States Durable Goods

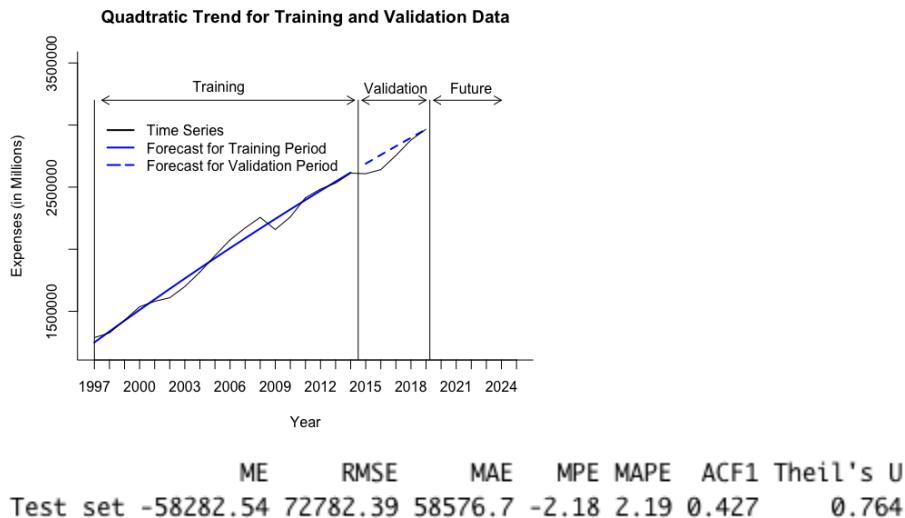
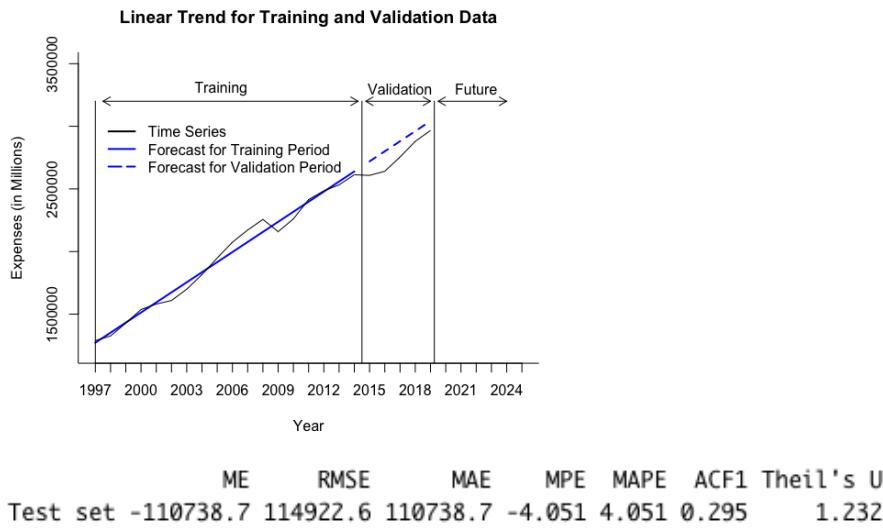


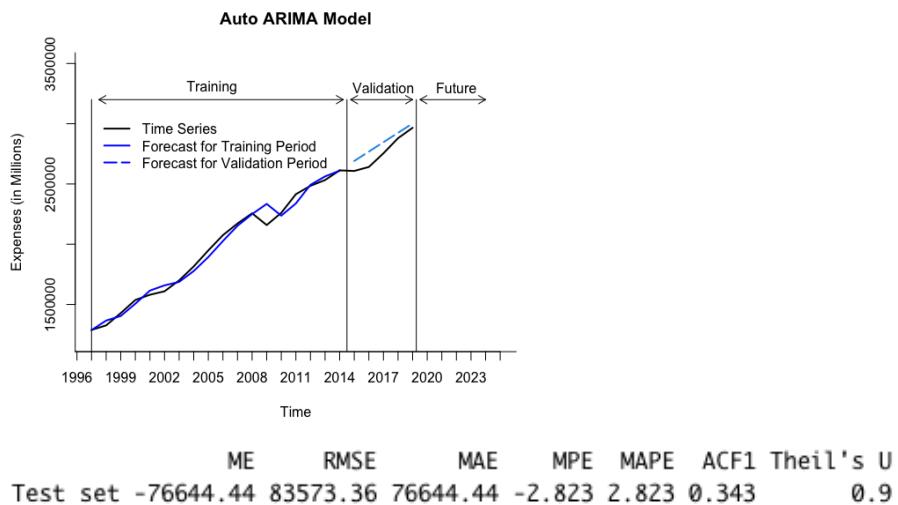
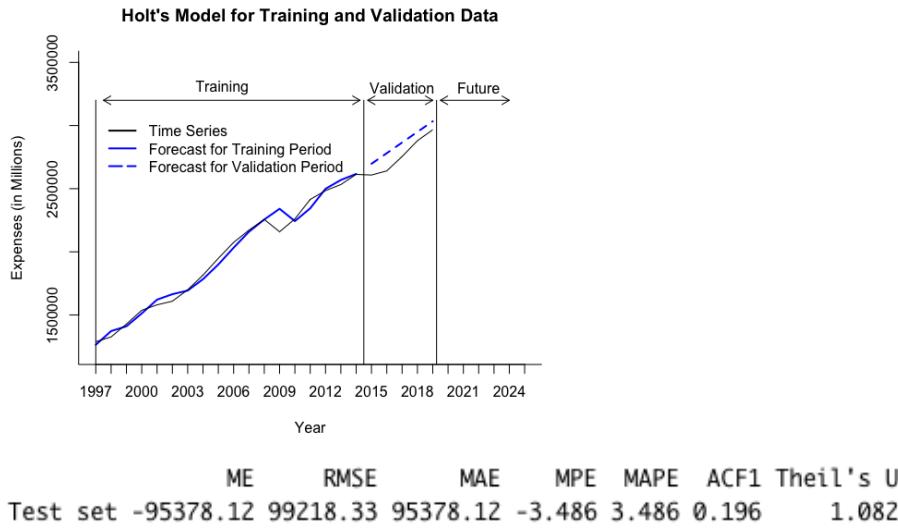


When reviewing all of these models by only looking at the graphs, the Auto ARIMA model appears to be the model to use. The forecast for the training period predicted the real data fairly accurately, but the forecast for the validation data fell short. Taking a look at the accuracy measures of each model, the Regression with Quadratic Trend has awful accuracy; a 21.88 MAPE, 334,381.5 RMSE, and 6.206 Theil's U statistic depict that this model cannot be used to accurately predict a forecast for this data. The Regression with Linear Trend has better numbers, RMSE of 124,252.2, MAPE of 7.861, and Theil's U statistic of 2.318, than the previous model,

but not good enough to predict an accurate forecast. Holt's Model has a better RMSE, MAPE, and Theil's U statistic than both the Linear and Quadratic Trend models, but the Auto ARIMA model trumps all three. The Auto ARIMA model has the lowest RMSE (56,818.46), MAPE (3.01), and Theil's U statistic (1.064) out of all four models, making it the most accurate model to use to forecast Durable Goods for each state.

### United States Non-Durable Goods

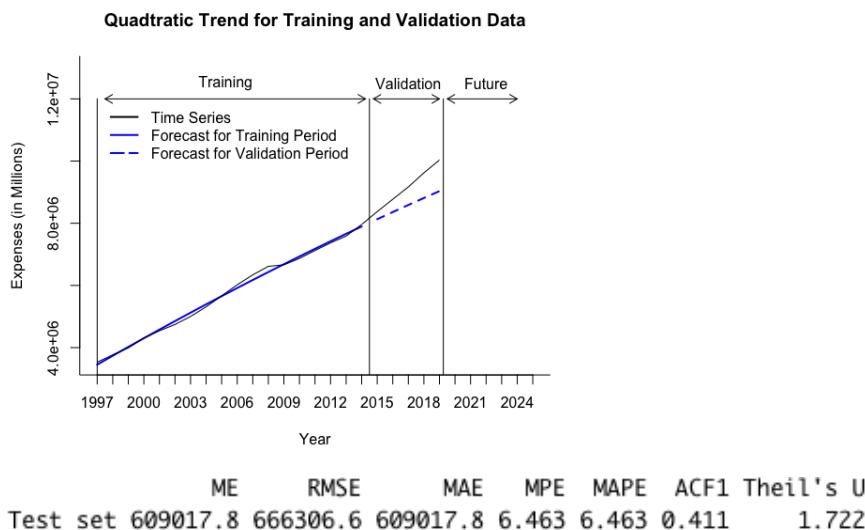
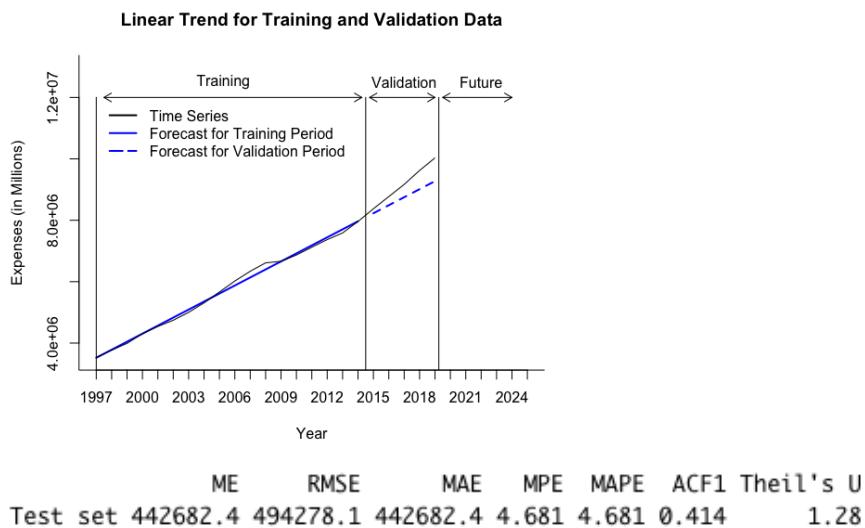


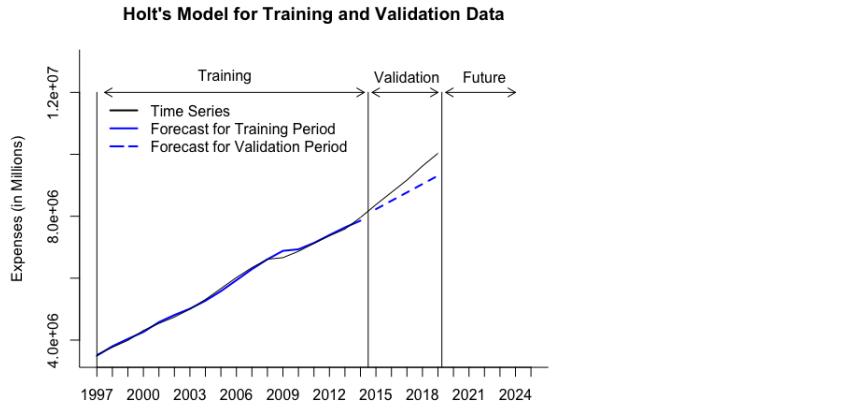


When comparing the graph of Durable Goods and Non-Durable Goods for the United States, the graph for Non-Durable Goods does not have a steep decline like the graph for Durable Goods has, it more or less stays on the path of linearity. What first comes to mind is either the Regression with Linear Trend model or the Regression with Quadratic Trend model would be the best model to accurately predict a forecast. The Regression with Linear Trend model did not live up to expectations, having a MAPE of 4.051, and an RMSE and Theil's U statistic well above all the other models. The Regression with Quadratic Trend model had the best accuracy measures with an RMSE of 72,782.39, MAPE of 2.19, and Theil's U statistic of 0.764 and therefore was

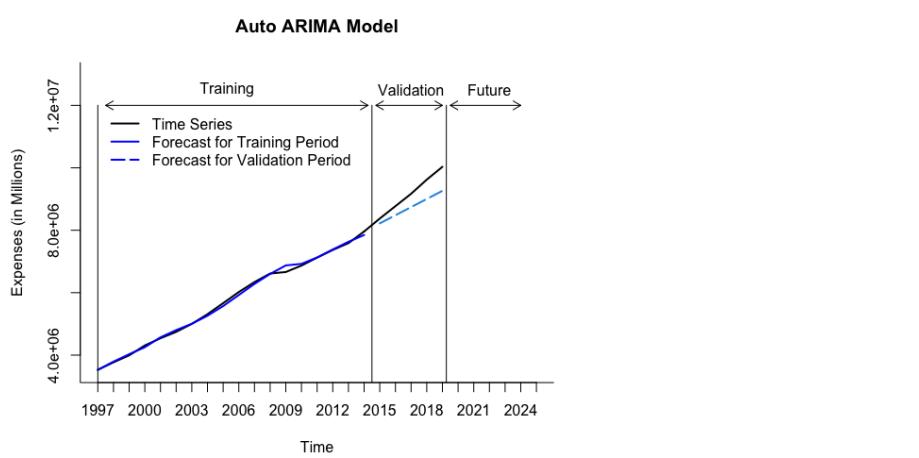
the most accurate model. But when knowing how extremely inaccurate this model forecasted for Durable Goods, data with a steep decline, and seeing how the Auto ARIMA model, RMSE of 76,644.4, MAPE of 2.823, and Theil's U statistic of 0.9, was almost just as good as the Regression with Quadratic Trend, the conclusion was to use the Auto ARIMA model to forecast each states' Non-Durable Goods.

### United States Services





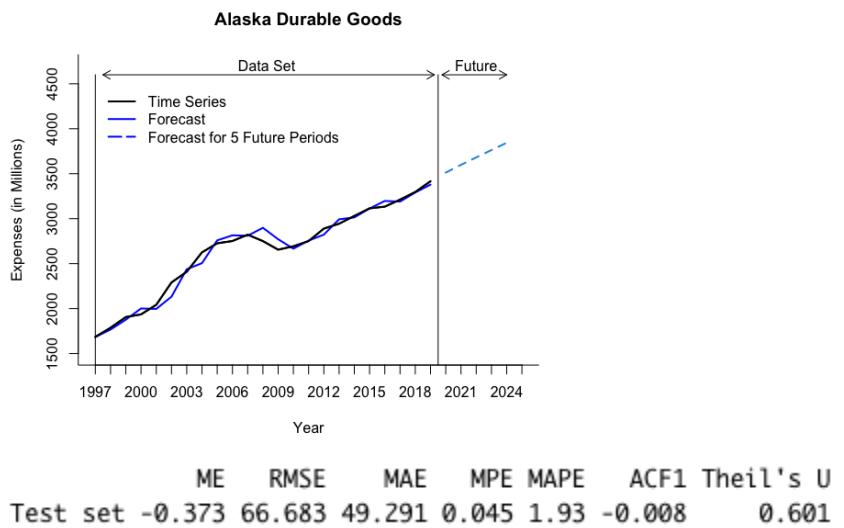
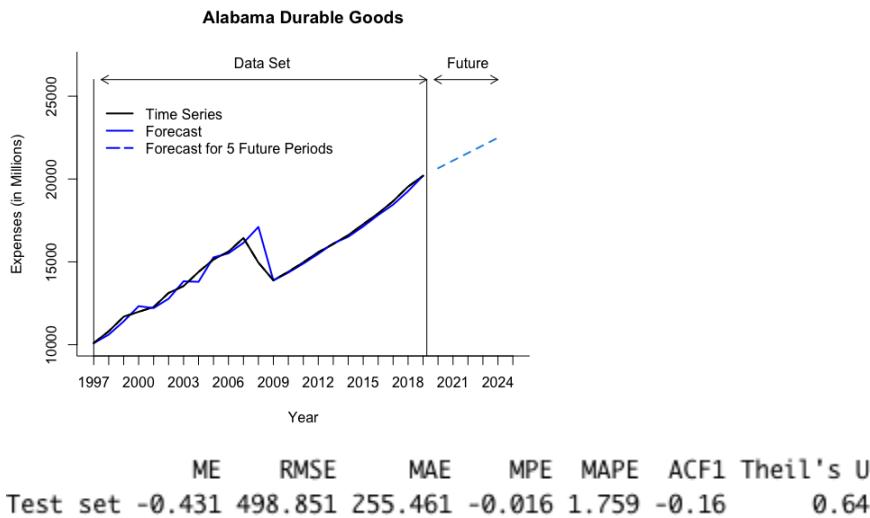
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 423806.6 471994 423806.6 4.484 4.484 0.414 1.222

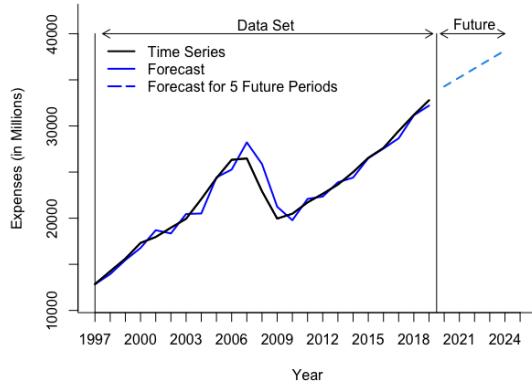


At first glance, the Time Series graph looks to be extremely linear. Essentially, many models can be used to depict an accurate forecast for Services. Surprisingly, the lowest MAPE was a whopping 4.48, the lowest Theil's U was 1.22, and the lowest RMSE was 471,994 (all Holt's Model). This was very surprising because with linear data, accurate forecasting tends to be more straightforward. With the RMSE score astonishingly high, there is only one conclusion as to why: overfitting. "Overfitting is a concept in data science, which occurs when a statistical model fits exactly against its training data. When this happens, the algorithm cannot perform accurately against unseen data" (IBM Cloud Education, 2021). The Regression with Linear Trend was not

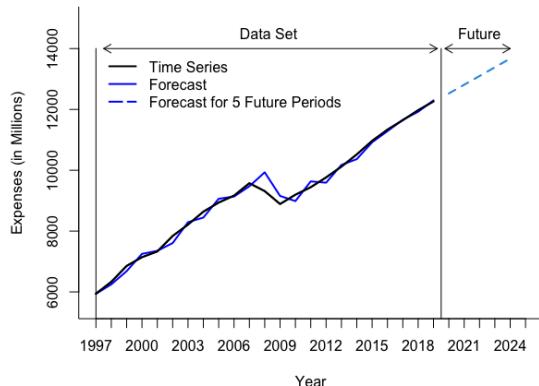
too far behind, with a MAPE of 4.68, Theil's U of 1.28, and RMSE of 494,278.1; the Auto ARIMA model was also close, with a MAPE of 4.78, Theil's U of 1.3, and RMSE of 503,290.1. After careful consideration and acknowledging the fact that the accuracy measures will be skewed due to overfitting, the Auto ARIMA model was chosen to forecast each states' expenditures on Services. Even though two forecasting models, Holt's Model and Regression with Linear Trend, have slightly better accuracy measures than the Auto ARIMA model, the accuracy measures were not that far behind and in order to keep the forecasts for Durable Goods, Non-Durable Goods, and Services consistent, the Auto ARIMA model will be used.

### Durable Goods for Each State

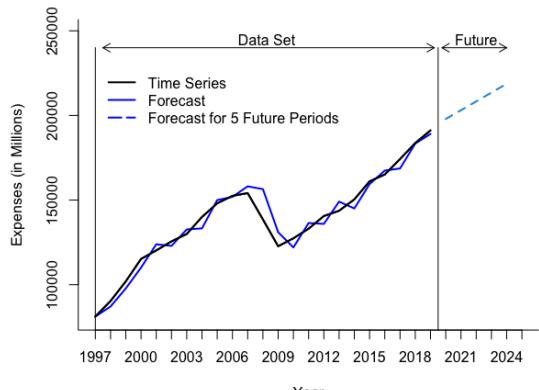


**Arizona Durable Goods**

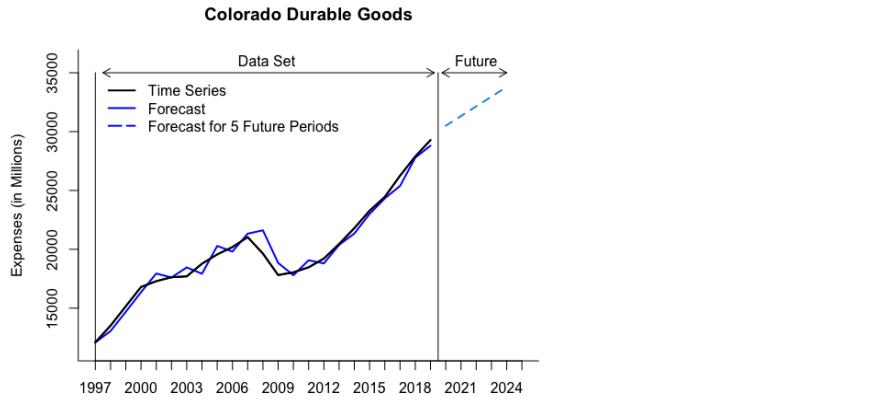
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set -22.91	948.912	666.637	-0.116	2.986	0.176	0.535

**Arkansas Durable Goods**

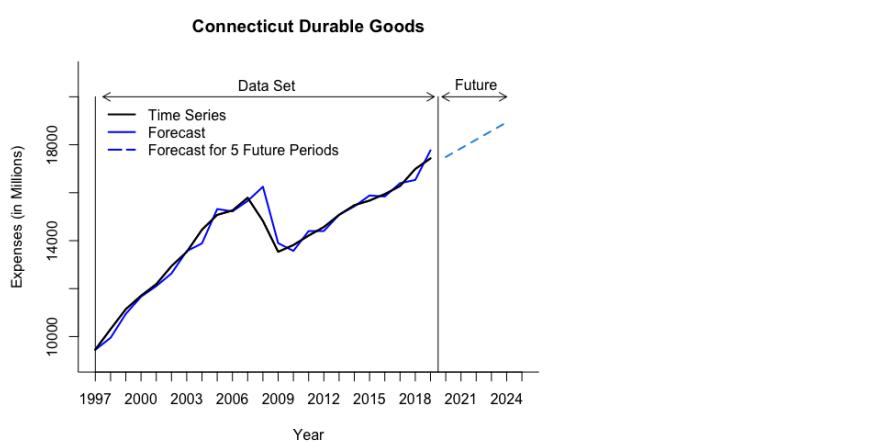
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set -0.402	183.138	130.888	0.024	1.48	-0.134	0.49

**California Durable Goods**

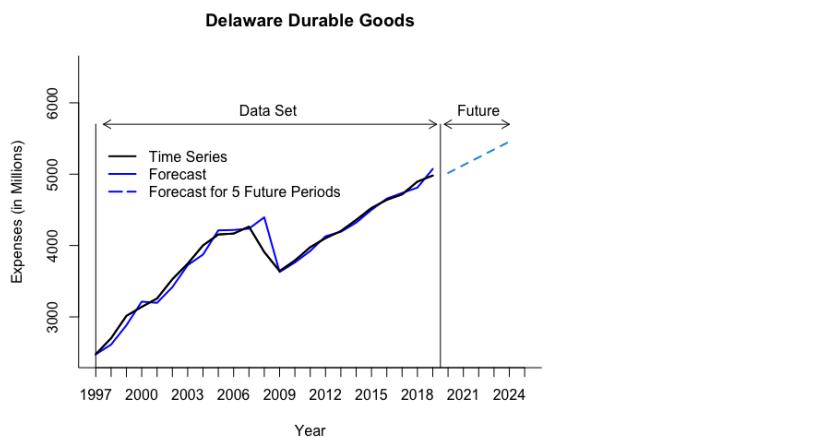
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set -81.911	5515.377	4223.846	-0.009	3.151	0.066	0.588



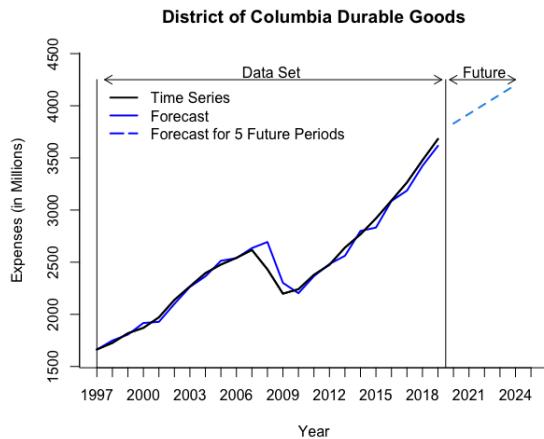
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set -14.698 658.461 509.705 -0.148 2.654 0.091 0.539



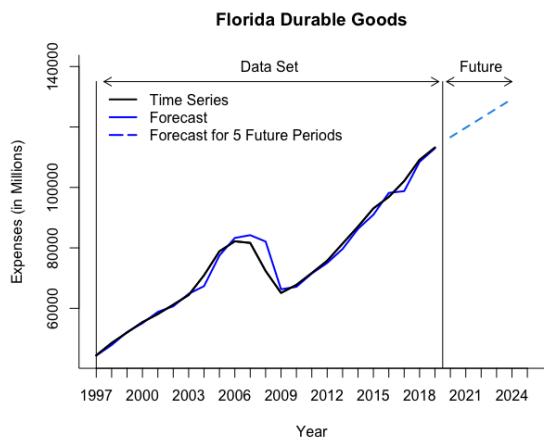
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set -7.378 381.973 246.749 0.035 1.732 -0.045 0.551



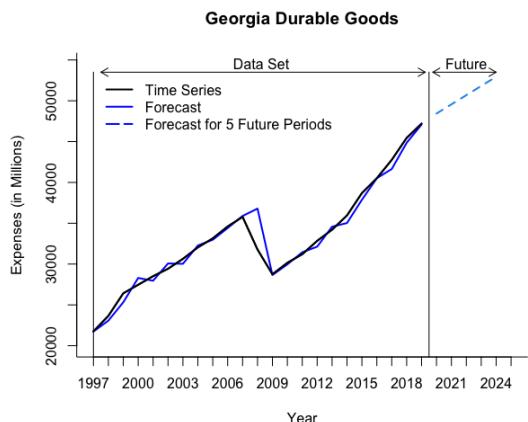
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 0.052 119.723 71.64 0.103 1.9 -0.073 0.576



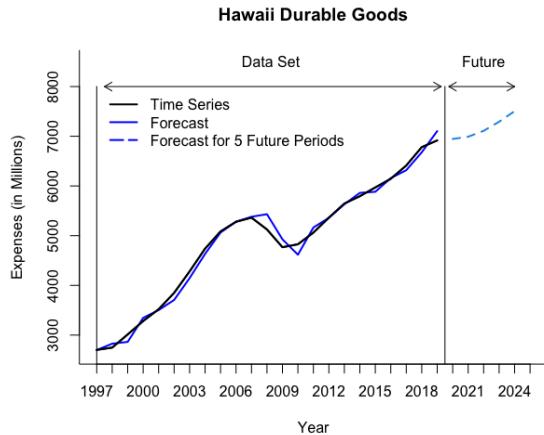
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 1.046 71.624 47.001 -0.107 1.884 0.242 0.509



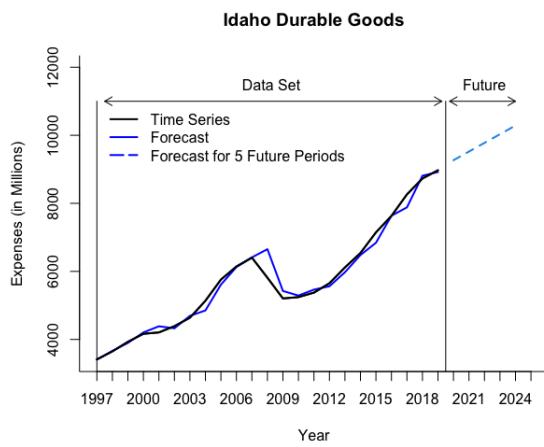
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set -8.35 2496.55 1493.571 -0.084 1.95 0.275 0.459



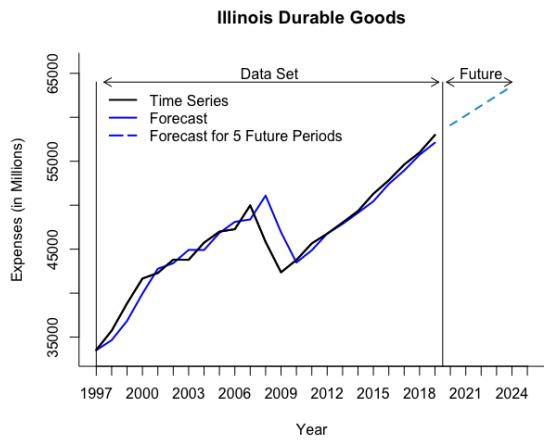
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 16.175 1188.631 663.16 -0.006 2.07 -0.027 0.583



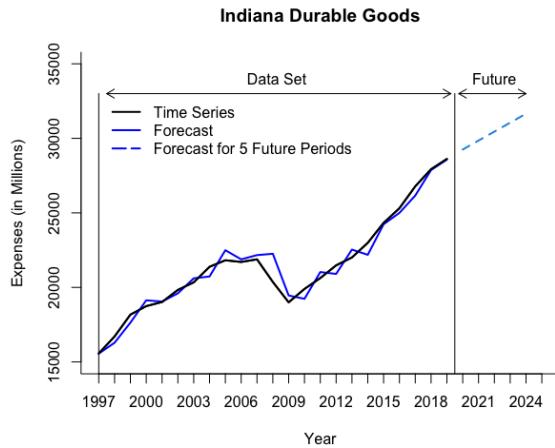
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 3.827	118.834	90.758	0.155	1.949	-0.017	0.432



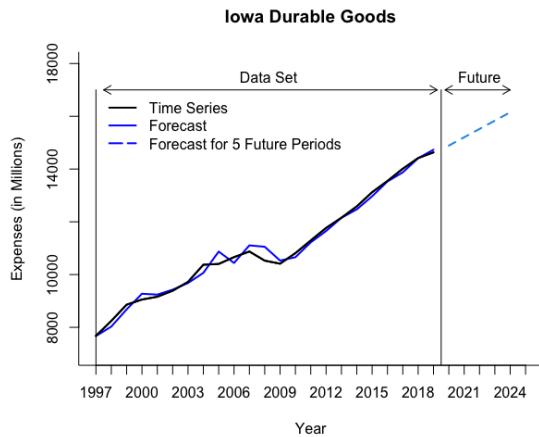
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set -0.008	227.232	137.226	-0.179	2.355	0.182	0.537



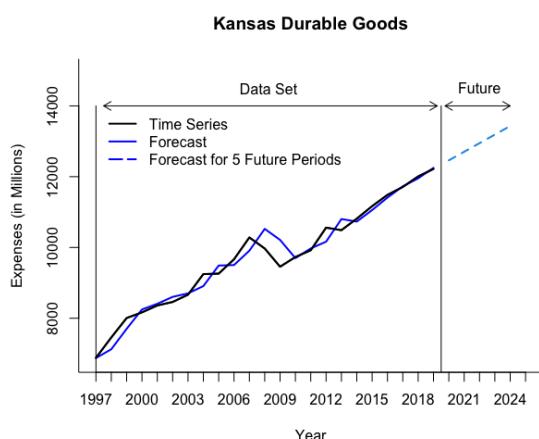
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 1.41	1684.822	1069.335	-0.016	2.398	0.27	0.806



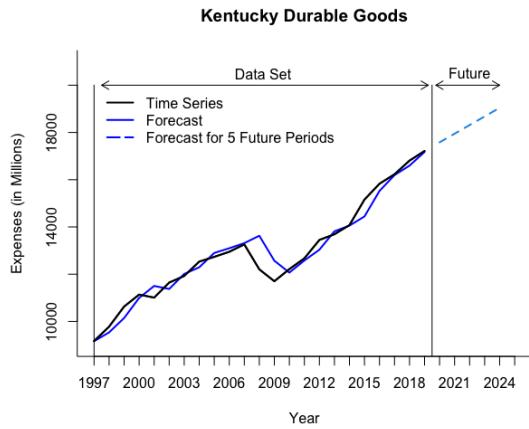
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	-3.833	584.642	439.662	-0.055	2.101	-0.036	0.611



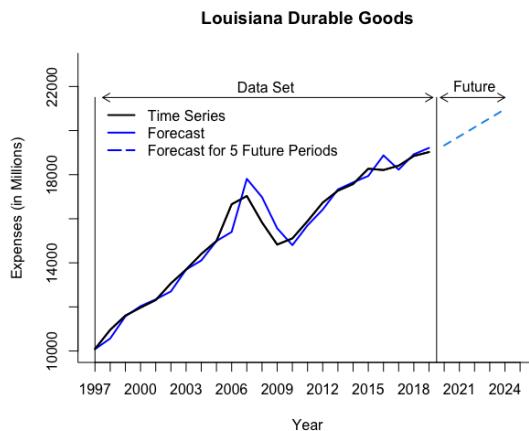
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	-1.555	203.798	153.763	-0.028	1.467	-0.06	0.53



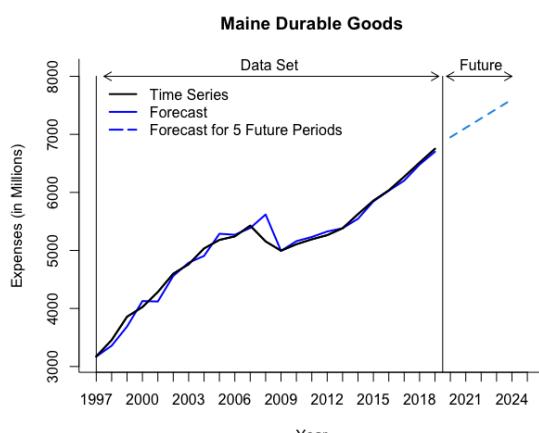
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.289	274.99	197.271	0.028	2.086	0.034	0.725



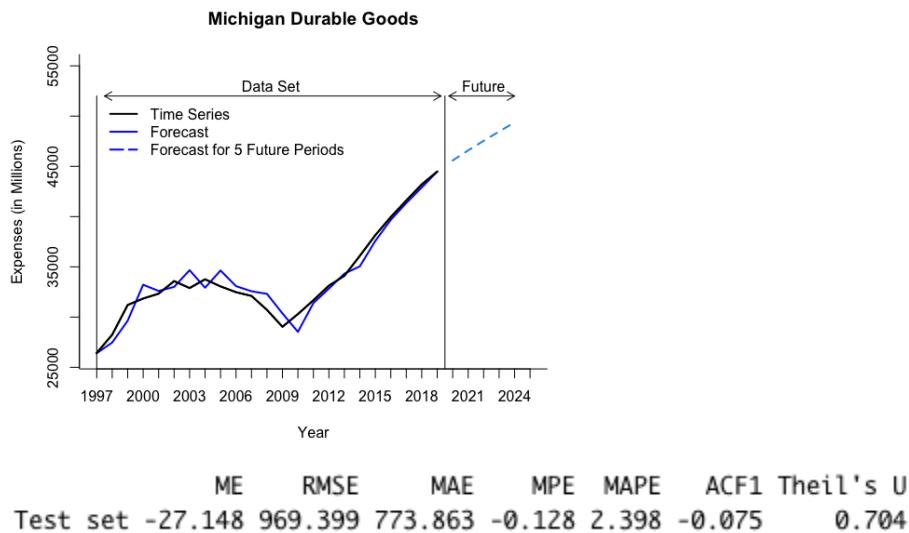
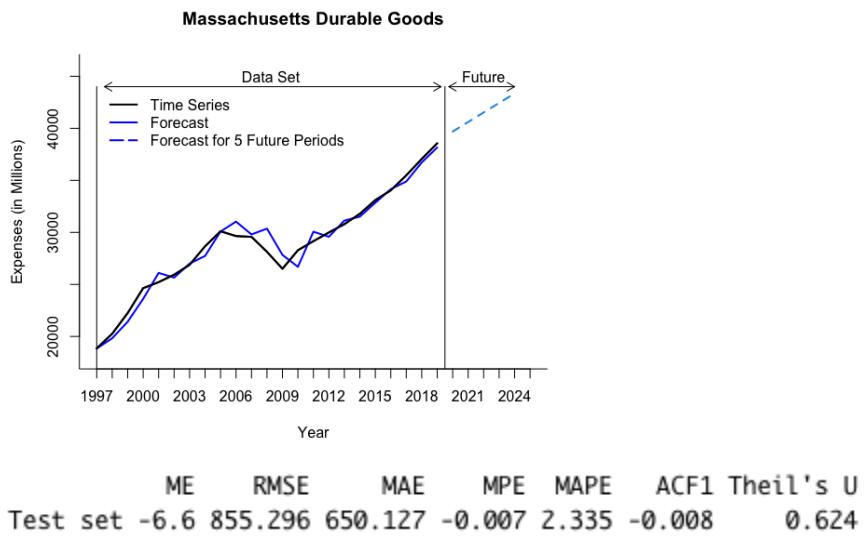
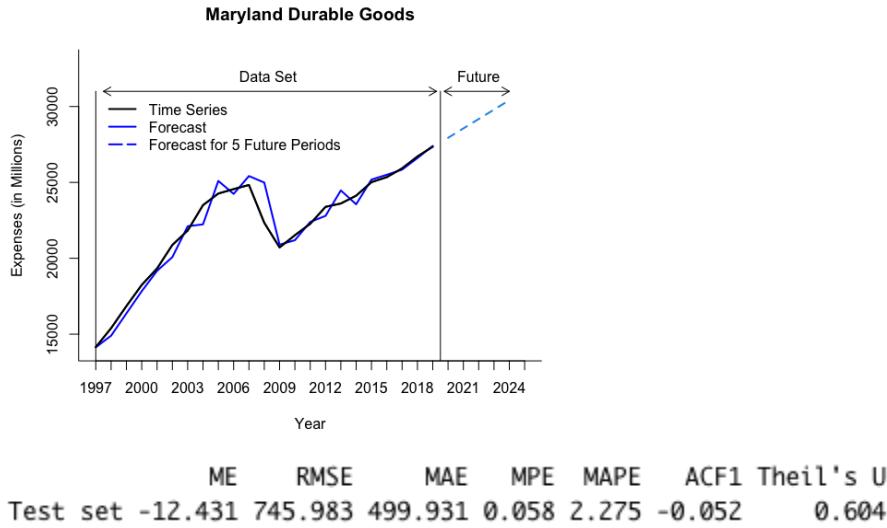
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.383	437.084	292.699	-0.081	2.356	0.313	0.756

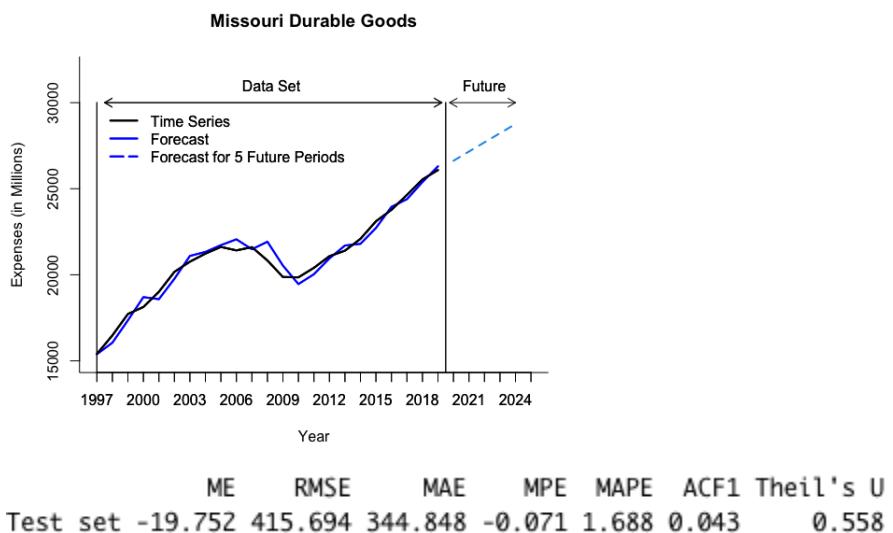
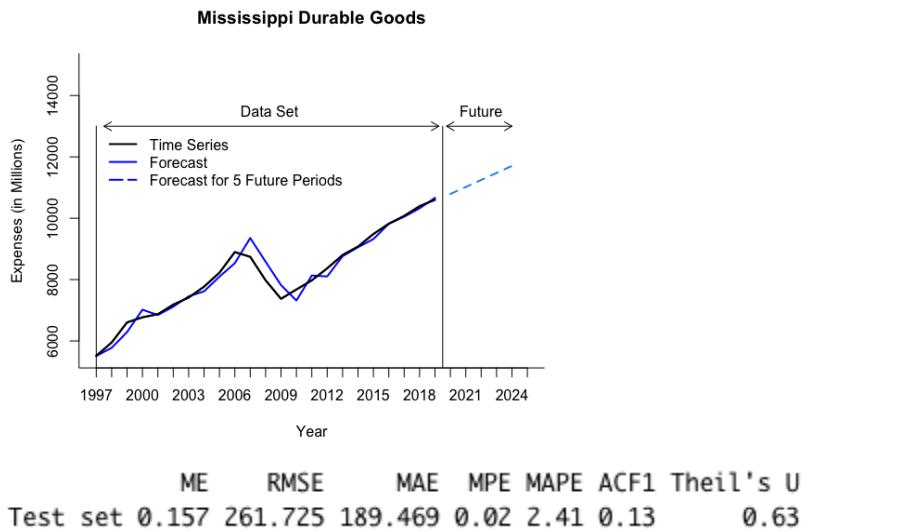
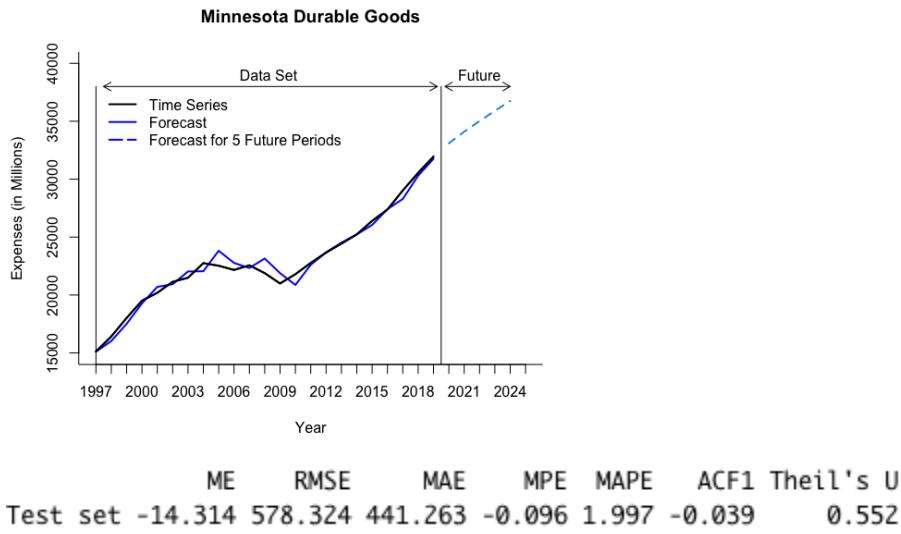


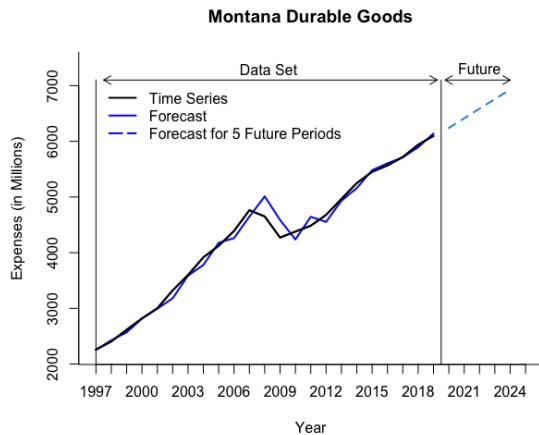
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set -6.323	479.15	325.7	0.038	2.07	0.054	0.631



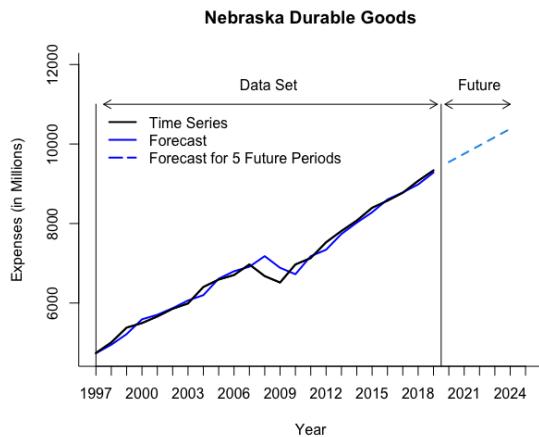
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.534	122.711	77.361	0.075	1.614	-0.109	0.532



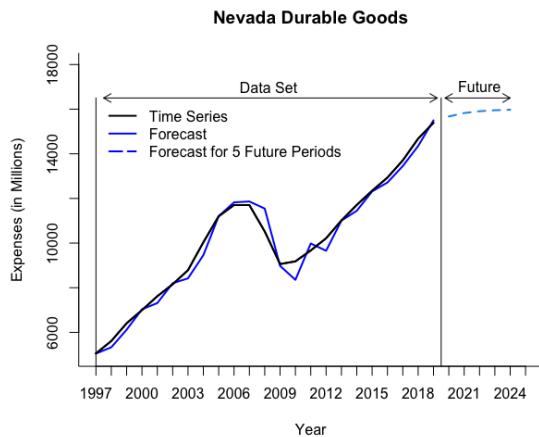




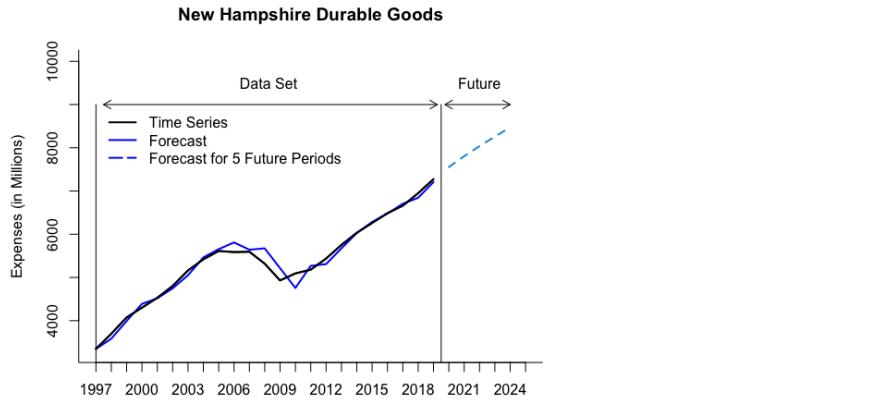
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.364	128.973	89.58	0.083	2.074	-0.021	0.489



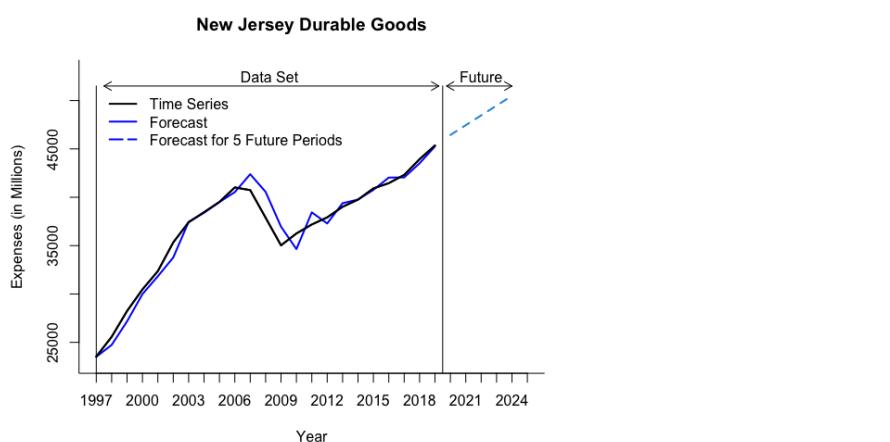
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.197	164.498	113.536	-0.051	1.693	0.076	0.616



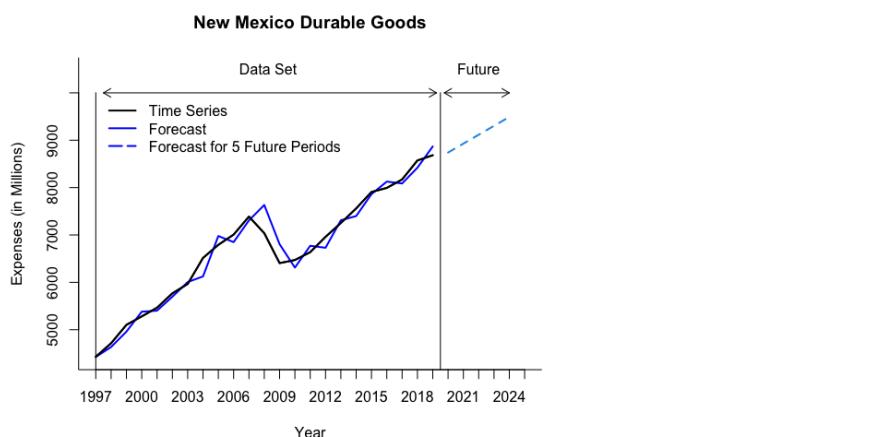
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	112.238	373.993	269.731	1.308	2.801	-0.072	0.484



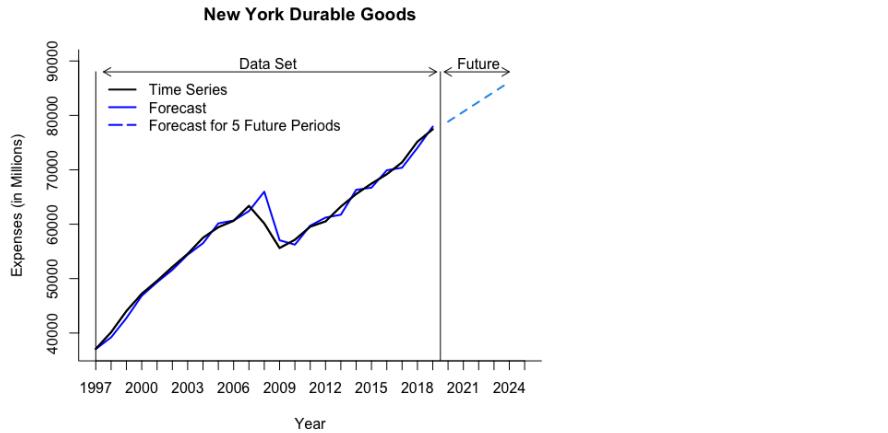
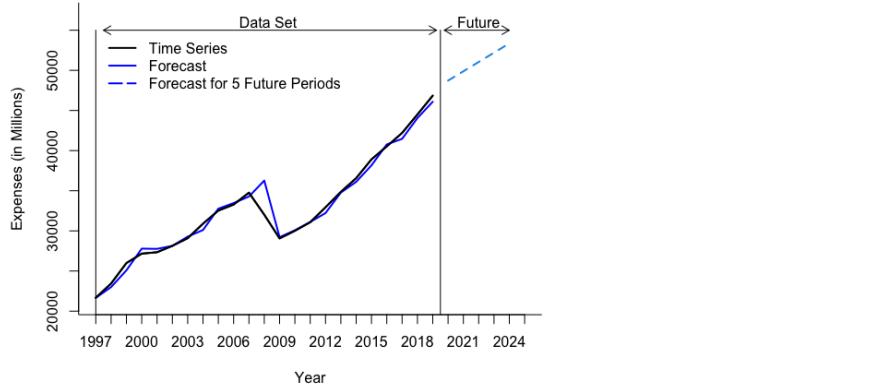
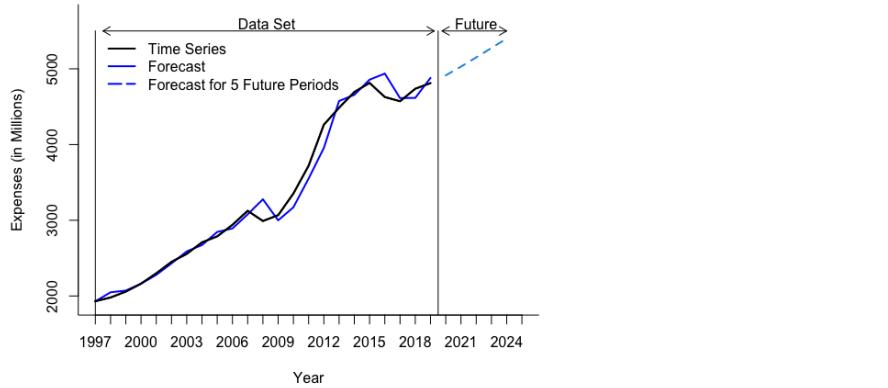
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set -5.483 142.518 102.264 -0.077 1.977 0.036 0.521

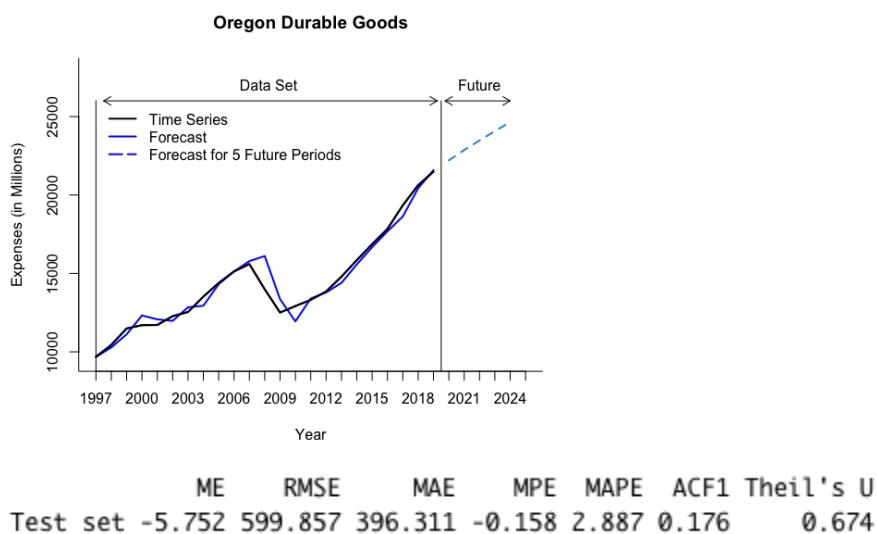
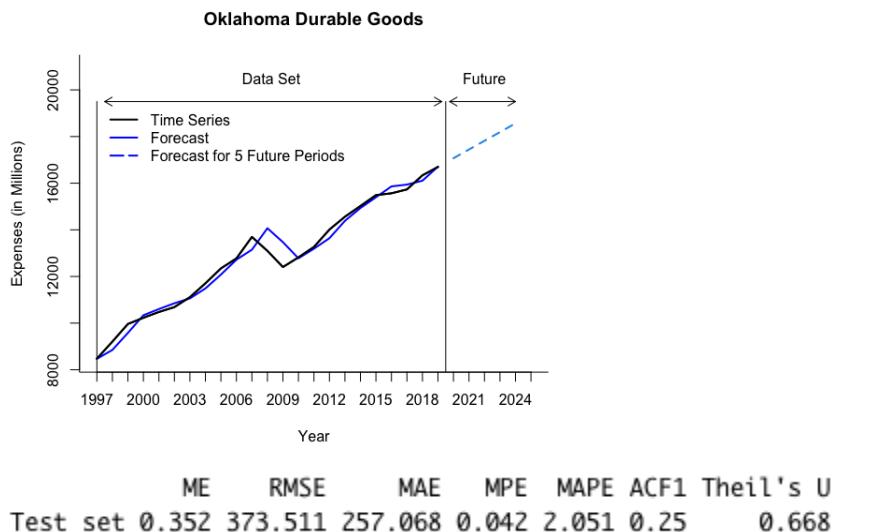
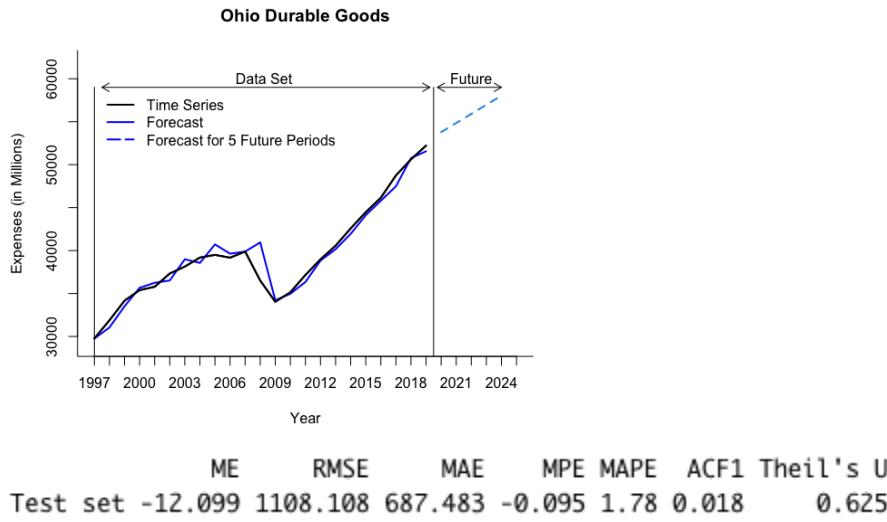


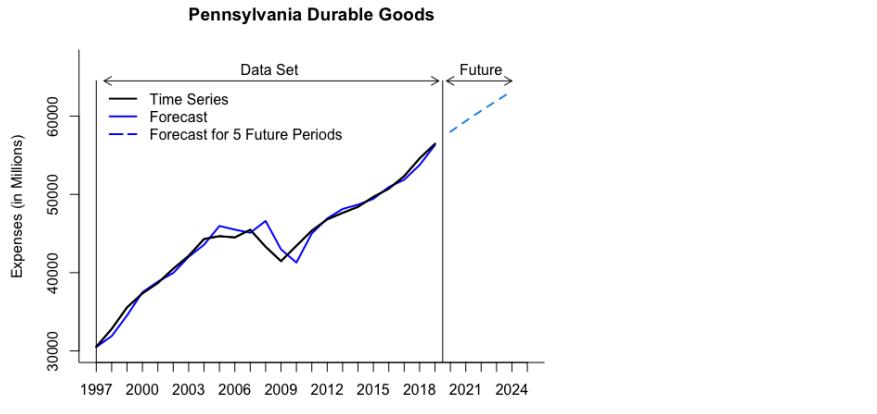
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set -11.761 1020.657 727.539 0.086 2.039 0.208 0.551



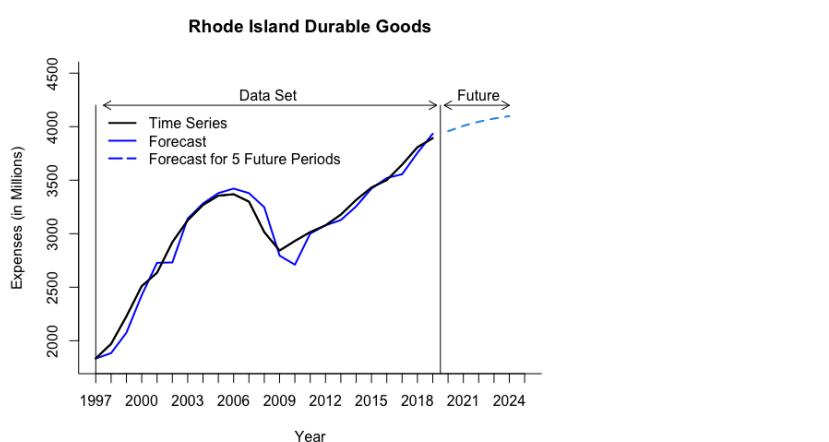
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set -0.344 207.45 158.936 0.043 2.358 -0.087 0.63

**North Carolina Durable Goods****North Dakota Durable Goods**

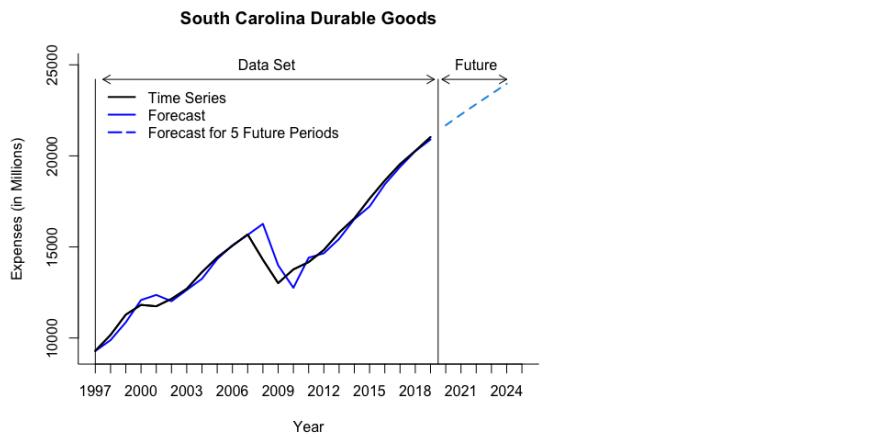




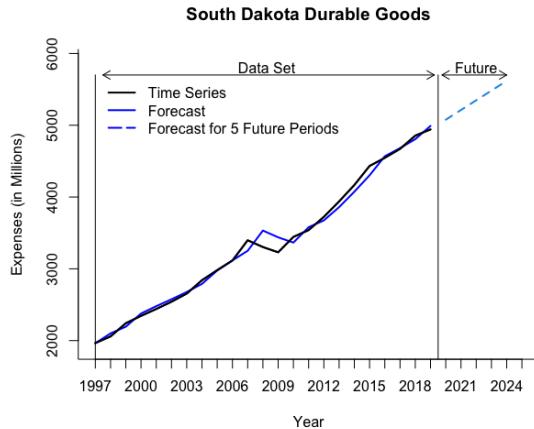
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	-24.644	1039.838	718.199	-0.03	1.67	0.103	0.594



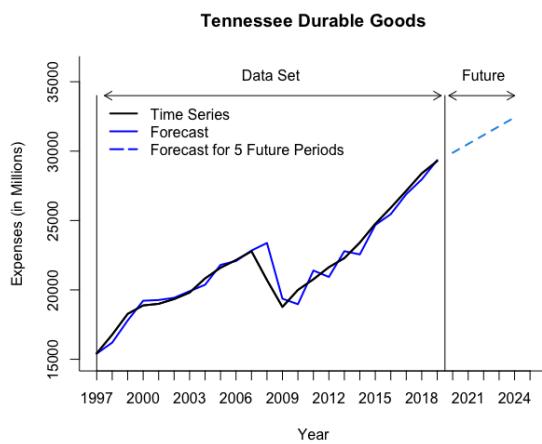
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	21.369	97.251	71.001	0.871	2.474	0.084	0.604



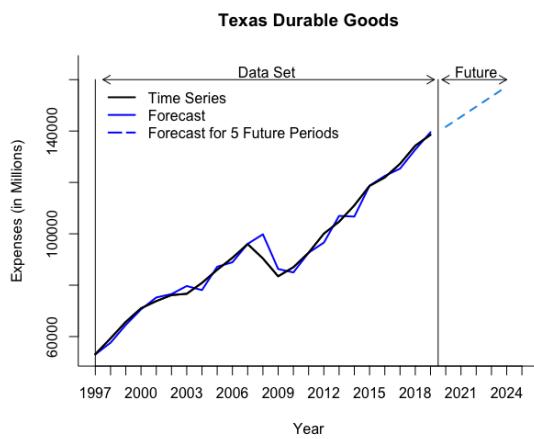
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	-7.184	560.271	348.647	-0.122	2.542	0.136	0.665



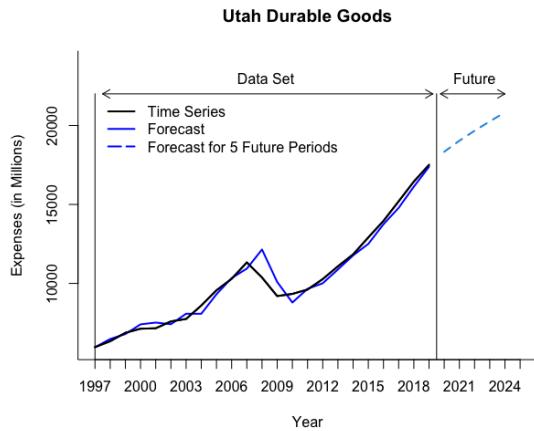
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 0.08 87.605 63.744 -0.137 1.909 0.051 0.525



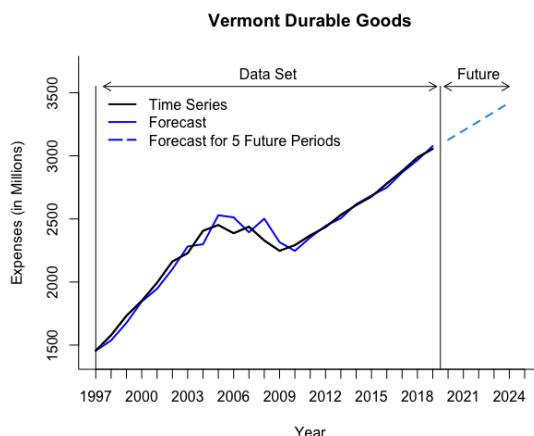
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set -5.35 719.399 474.775 -0.076 2.268 -0.03 0.645



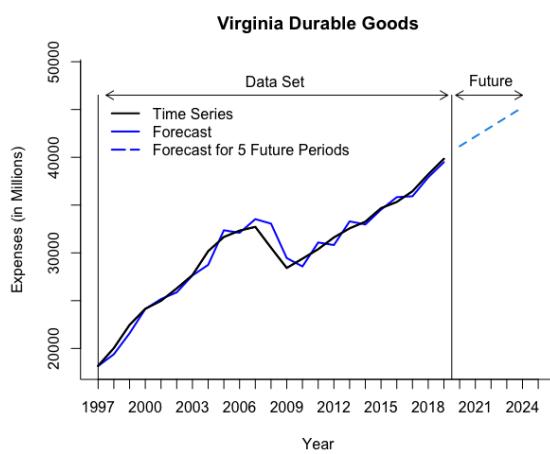
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set -45.649 2739.195 1894.168 -0.084 2.101 -0.037 0.49



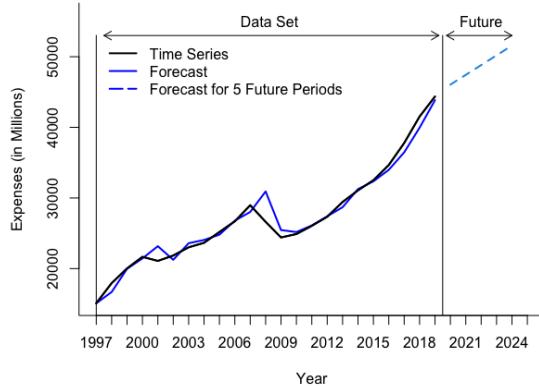
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	5.453	498.906	341.565	-0.281	3.466	0.118	0.65



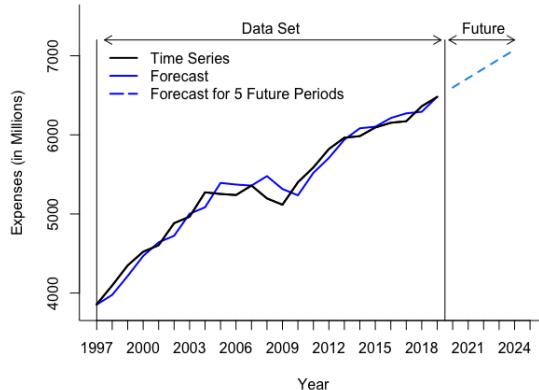
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	-1.178	62.088	46.235	0.033	2.033	-0.065	0.555



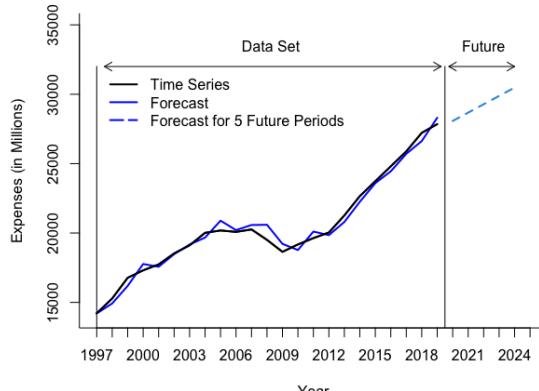
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	-11.658	814.474	613.391	0.04	2.067	0.071	0.503

**Washington Durable Goods**

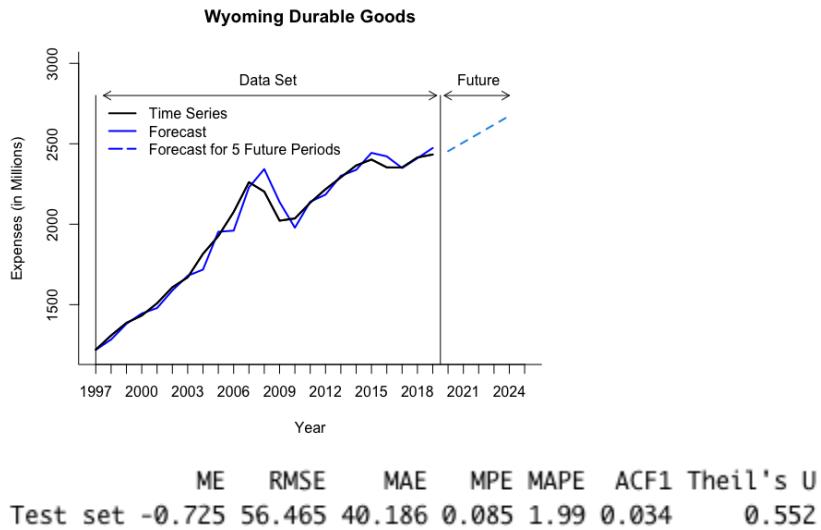
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set -25.258	1200.308	763.747	-0.329	2.889	0.071	0.601

**West Virginia Durable Goods**

ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.163	119.568	95.528	0.06	1.841	0.115	0.686

**Wisconsin Durable Goods**

ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set -0.224	443.088	370.764	-0.024	1.836	0.109	0.514



After reviewing each states' forecast for Durable Goods, every state can see an increase in expenditure at some point within the next five years (2020 - 2024). The MAPE for each state varies between, the lowest at 1.467 (Iowa), and, the largest at 3.466 (Utah). The 2% gap in MAPE is larger than expected. A probable possibility for this outcome is because an Auto ARIMA model is not the very best model to forecast each states' Durable Goods. The RMSE for each state also has a larger gap than anticipated; ranging from 56.465 (Wyoming) to 5,515.377 (California). Even though there is no claim to a universal number as a good RMSE because every state's data is different, a good RMSE score can be considered when taking the total average RMSE score. In this case, the average RMSE score is approximately 704. Eighteen out of 50 states have a higher RMSE score than the total average. The forecasts for those eighteen states are experiencing overfitting, causing the Auto ARIMA forecast to seem inaccurate. On the contrary, each states' Theil's U statistic is significantly below the guessing threshold of 1; the smallest being 0.49 (Arkansas) and the highest being 0.806 (Illinois). With this in mind, the Auto ARIMA model for each state is a forecasting technique far better than guessing.

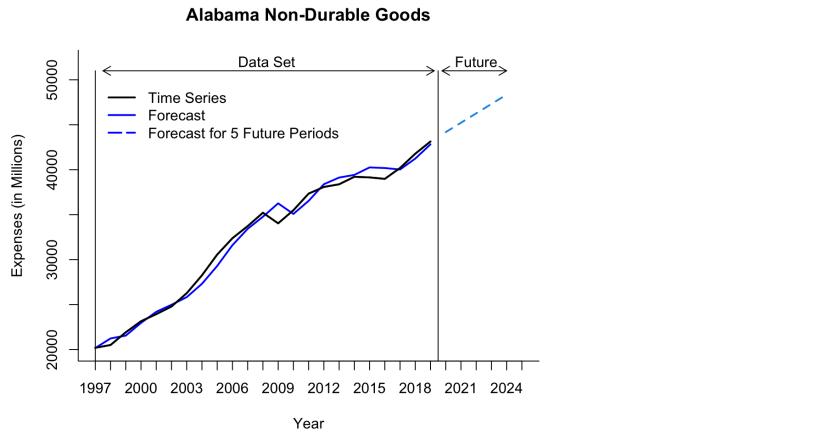
A forecast that stood out was Nevada's. Most of the forecasts for each state seem to be linear; at no point within the next five years are expenditures for Durable Goods going to be less than the year before. On the other hand, Nevada's forecast is trending in a negative direction; increasing only 1.88% over the five year period, far worse than the second least increasing state.

Each year, Nevada's expenditure for Durable Goods is decreasing. Increasing 152.07 from 2020 to 2021, 81.62 from 2021 to 2022, 43.81 from 2022 to 2023, and 23.51 from 2023 to 2024.

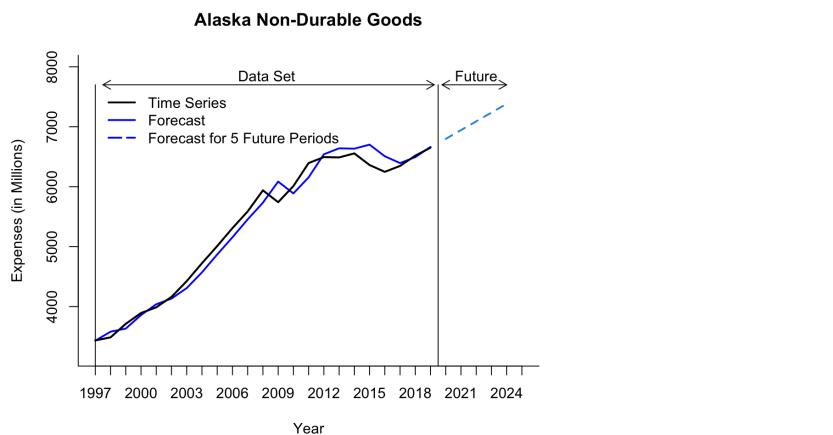
Year	Forecast
2020	15673.82
2021	15825.89
2022	15907.51
2023	15951.32
2024	15974.83

Each year, Nevada's expenditure for Durable Goods is decreasing. Increasing 152.07 from 2020 to 2021, 81.62 from 2021 to 2022, 43.81 from 2022 to 2023, and 23.51 from 2023 to 2024. Nevada should focus their economic policy on increasing spending on Durable Goods or else it will see a negative slope on Durable Goods within a ten year period. Nevada needs more people to move to the state and for them to spend more money on cars, furniture, and other durable goods. Of course, no machine can predict catastrophic events on the market such as the pandemic the world is facing right now, but, surprisingly, the pandemic helped Nevada achieve having a greater population. The pandemic caused an upswing in state-to-state relocation, which ended up saving Nevada from having a negative slope in Durable Goods. In the first quarter of 2021, Nevada recorded roughly 300,000 new residents moving into the state. This tremendously helped Nevada's Durable Goods problem because more people means more money to be spent.

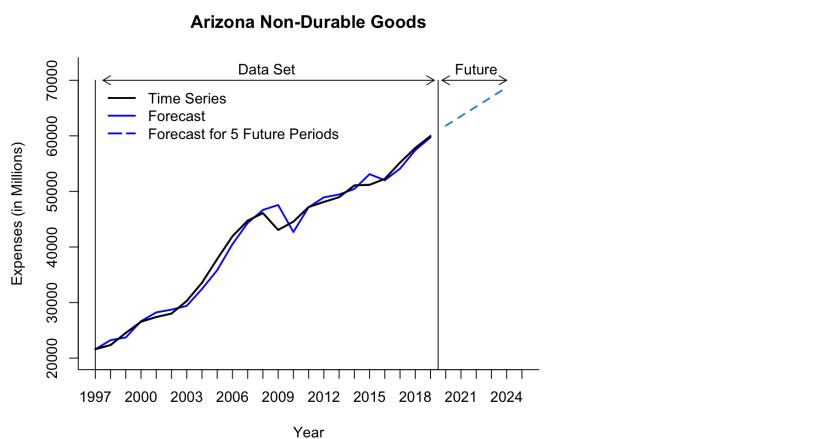
## Non-Durable Goods for Each State



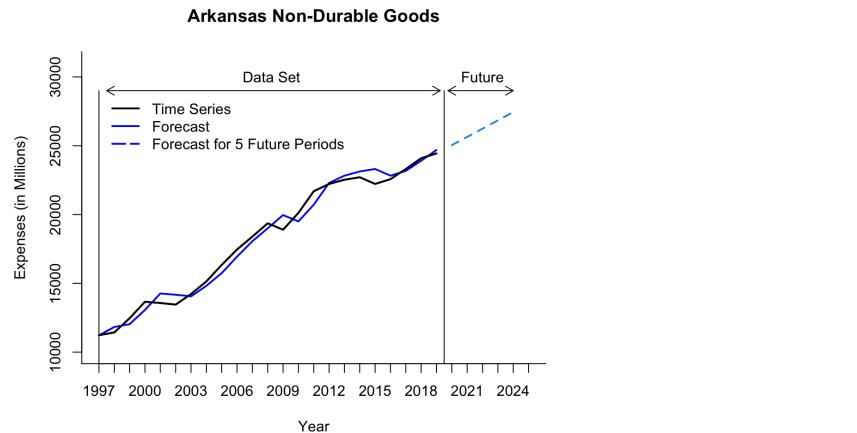
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 0.833 778.668 607.743 0.041 1.88 0.205 0.555



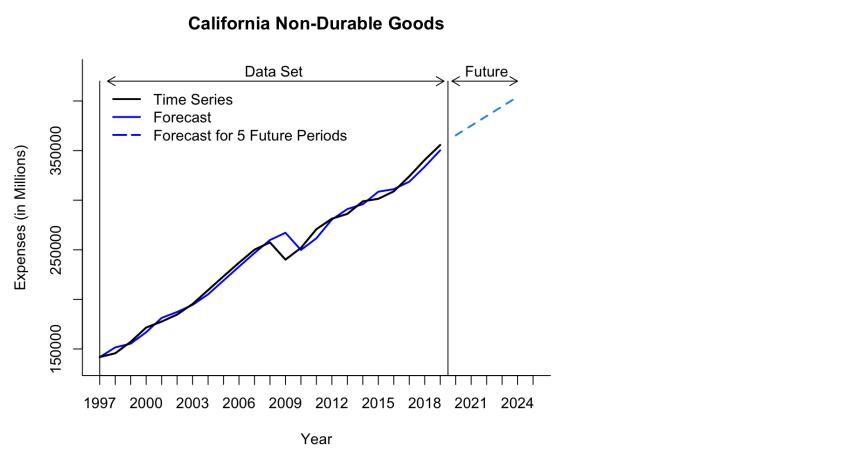
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 0.143 157.032 124.235 0.113 2.26 0.27 0.652



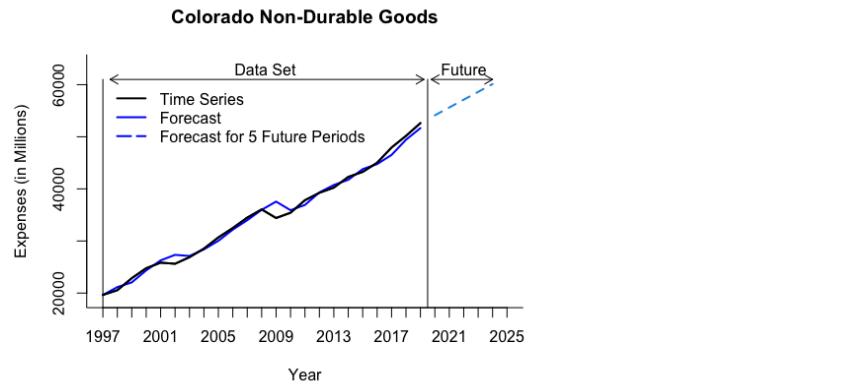
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	17.551	1341.761	958.514	0.017	2.456	-0.022	0.542



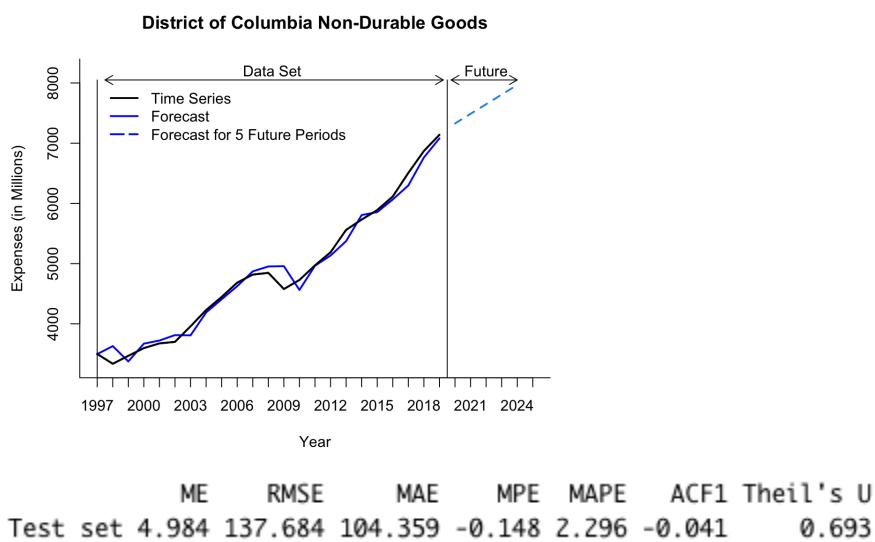
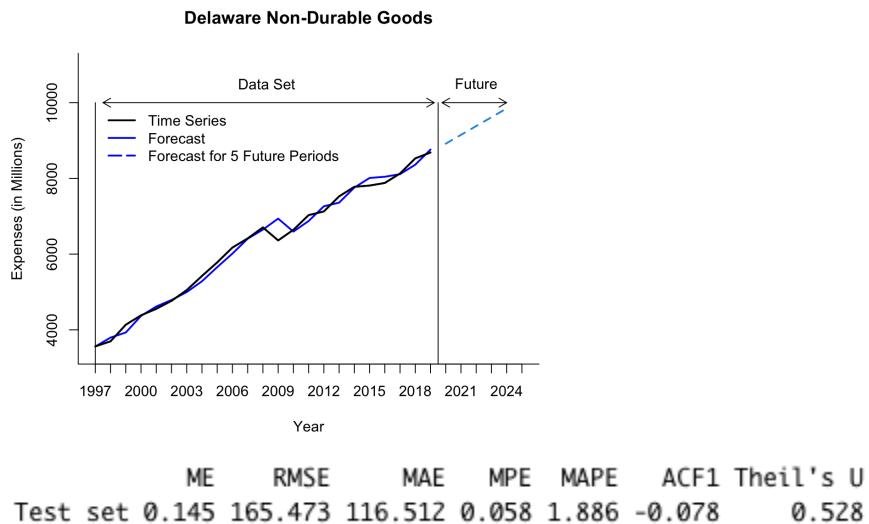
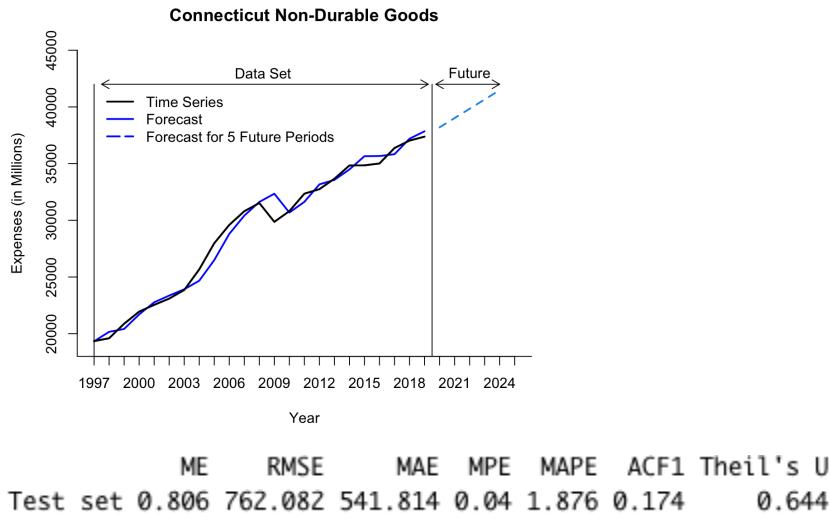
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.462	543.474	456.725	0.018	2.631	0.178	0.65



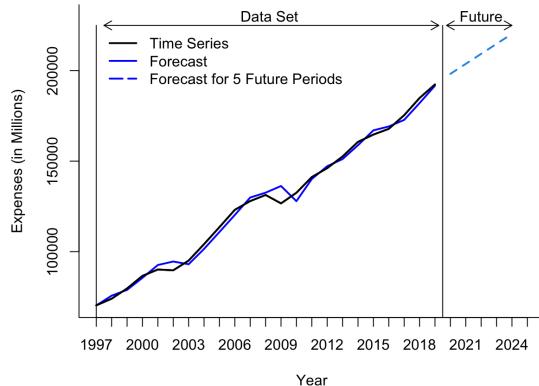
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	5.745	7124.569	4873.694	-0.107	2.032	0.09	0.558



	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.789	945.22	673.449	-0.187	2.02	0.169	0.53

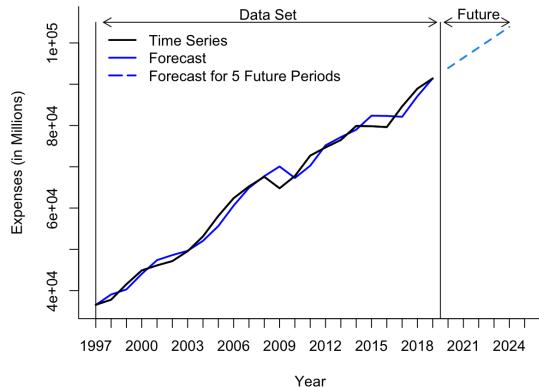


### Florida Non-Durable Goods



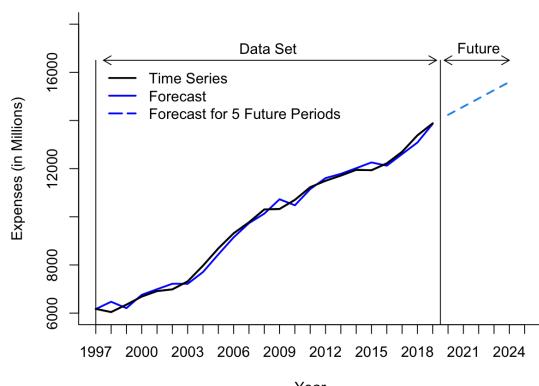
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	27.539	3021.037	2339.382	-0.091	1.95	-0.033	0.471

### Georgia Non-Durable Goods

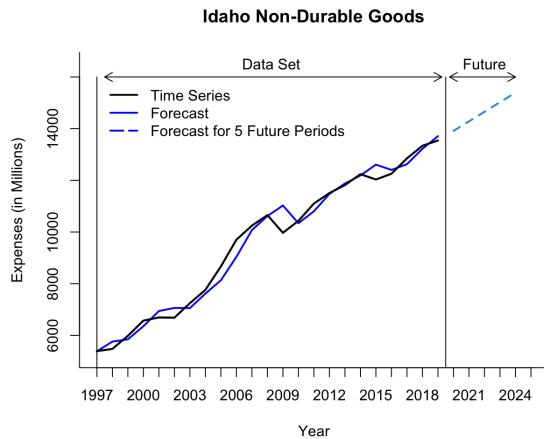


	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	1.481	1832.796	1390.529	-0.042	2.211	0.107	0.553

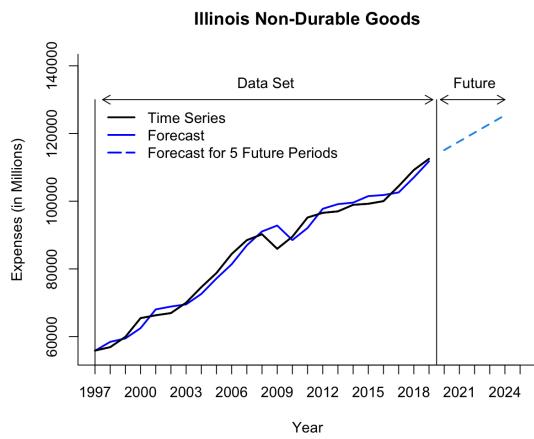
### Hawaii Non-Durable Goods



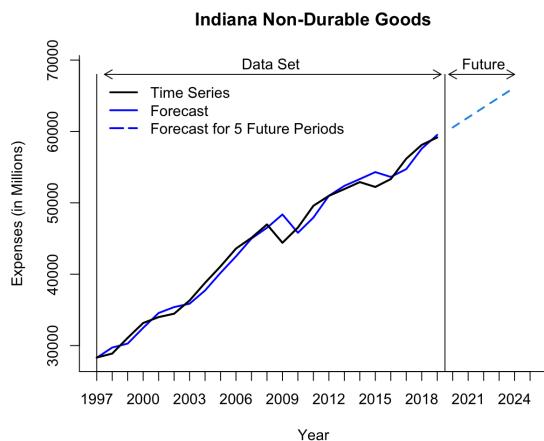
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	7.339	200.773	163.129	-0.037	1.825	-0.036	0.536



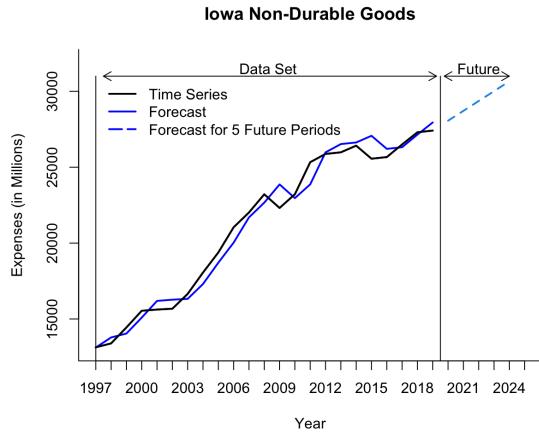
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.218	351.187	254.187	-0.031	2.83	0.164	0.656



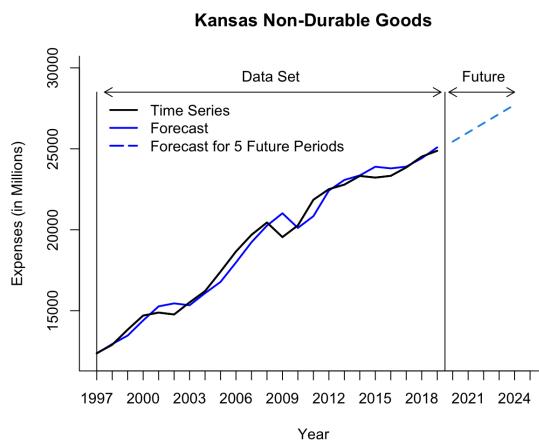
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 2.317	2268.064	1823.977	-0.016	2.184	0.172	0.639



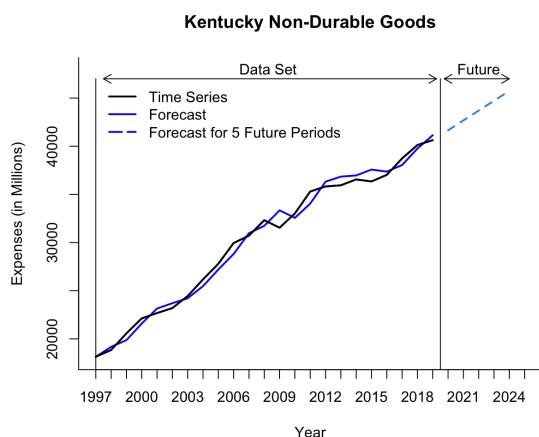
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 1.17	1196.529	865.506	-0.001	2.006	0.014	0.61



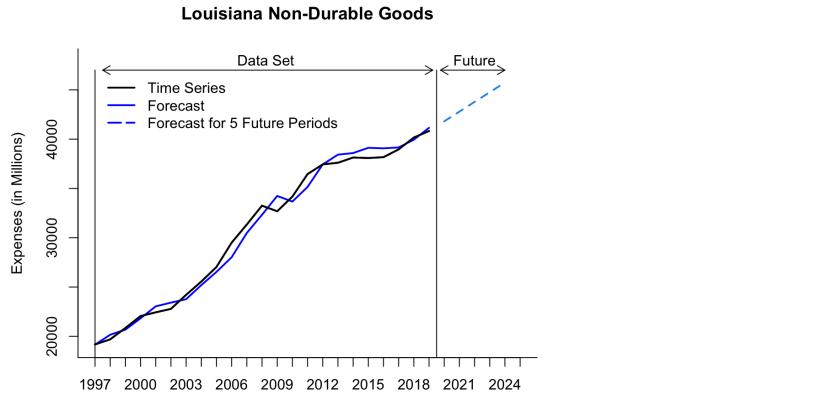
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 0.543 710.923 569.955 0.07 2.727 0.17 0.682



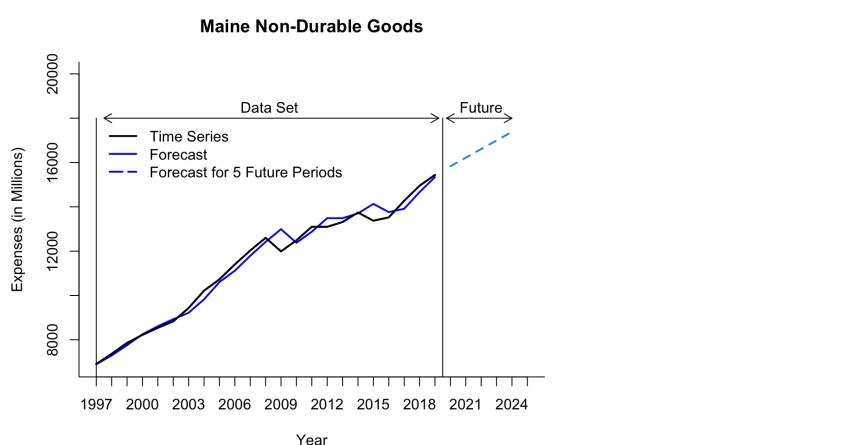
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 0.513 511.971 374.003 0.047 1.995 0.181 0.631



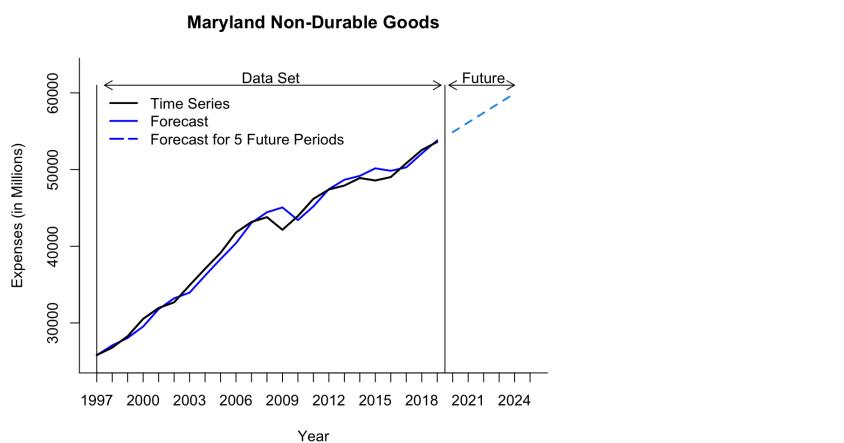
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 0.745 744.185 631.74 0.079 2.09 0.038 0.538



ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.791	744.409	608.715	0.035	1.98	0.261	0.565

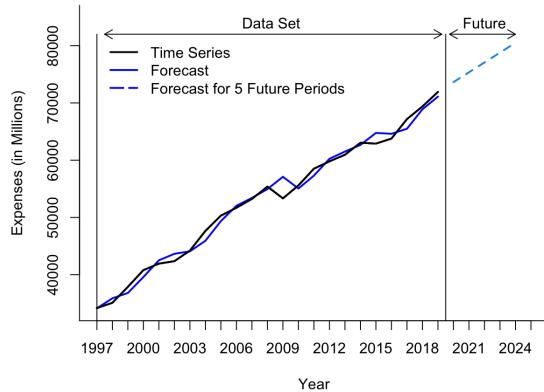


ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.283	331.363	239.434	0.063	1.999	0.069	0.566



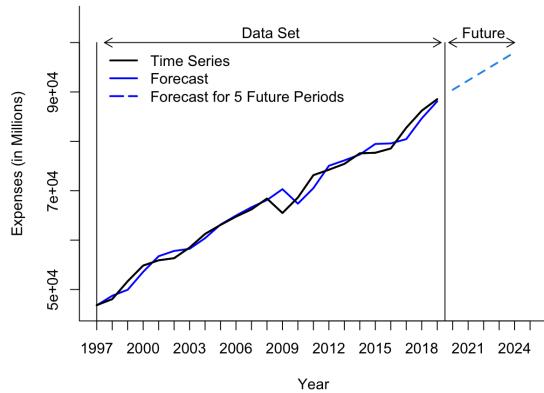
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 1.067	938.466	700.321	0.092	1.707	0.247	0.543

### Massachusetts Non-Durable Goods



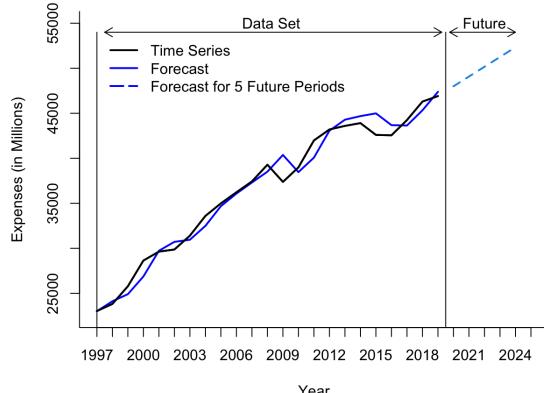
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 1.411	1216.474	927.468	-0.008	1.788	-0.03	0.559

### Michigan Non-Durable Goods

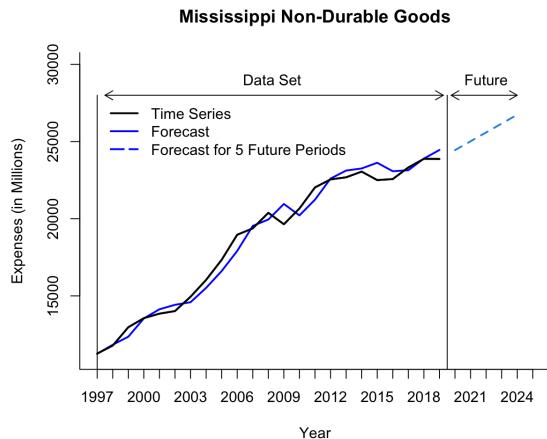


ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 1.954	1534.163	1118.954	-0.032	1.672	-0.031	0.614

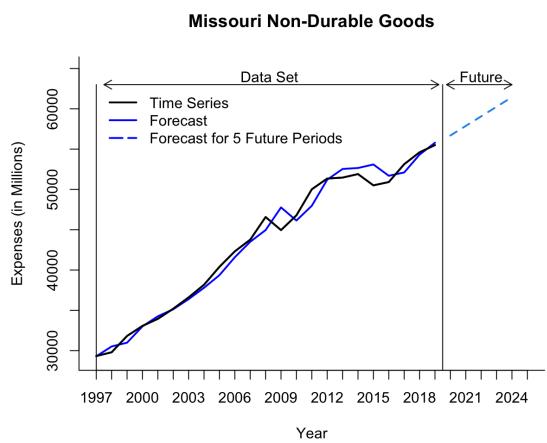
### Minnesota Non-Durable Goods



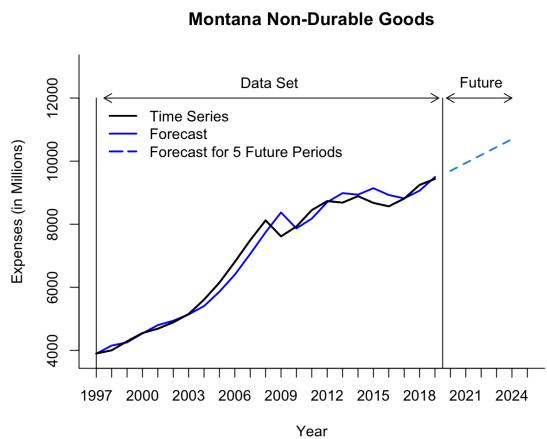
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.954	1130.147	844.093	0.113	2.292	0.124	0.662



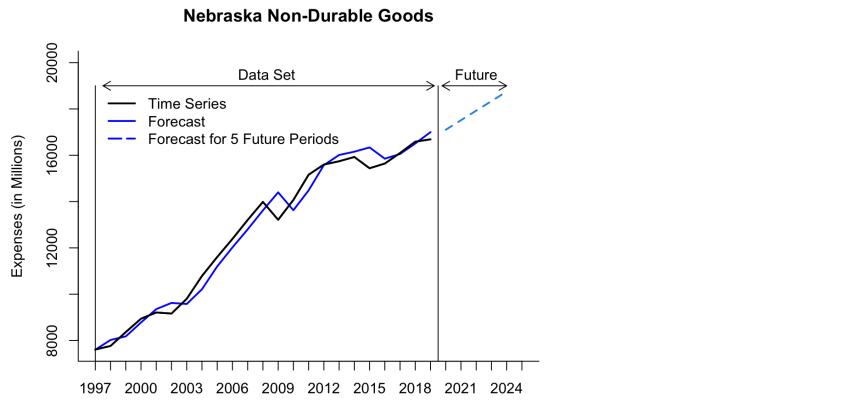
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.465	572.791	446.85	0.143	2.374	0.134	0.639



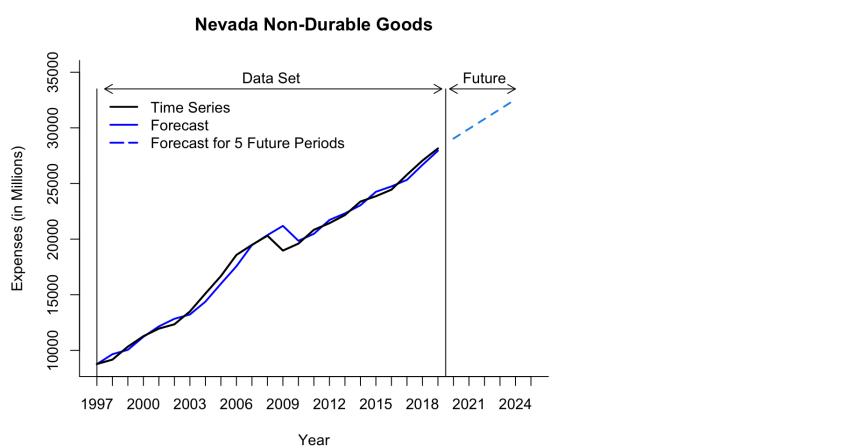
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 1.223	1114.536	813.212	0.038	1.806	0.018	0.626



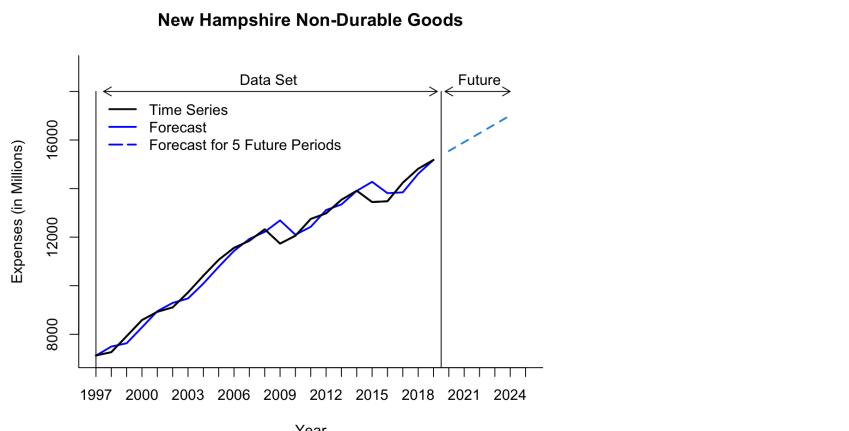
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.159	278.658	201.118	0.042	2.773	0.222	0.66



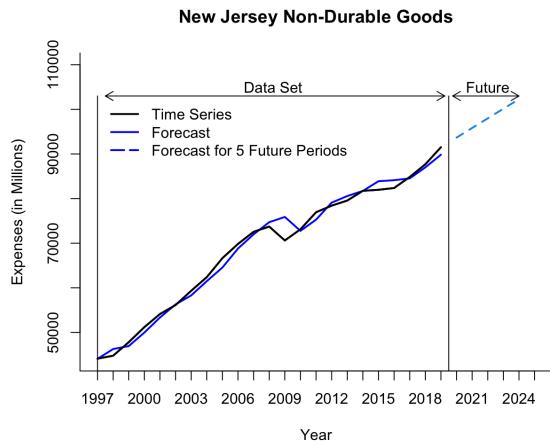
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 0.313 441.457 345.094 0.062 2.762 0.113 0.67



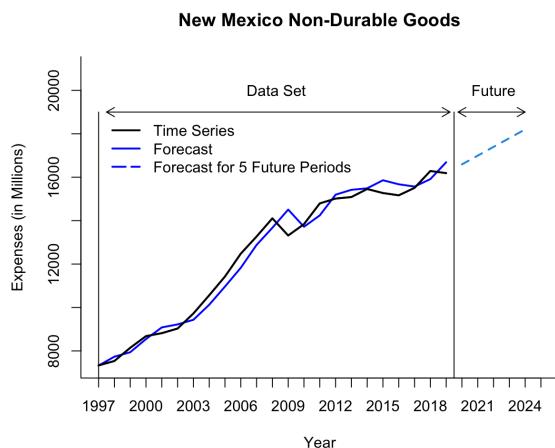
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 0.343 615.688 420.592 -0.087 2.443 0.211 0.529



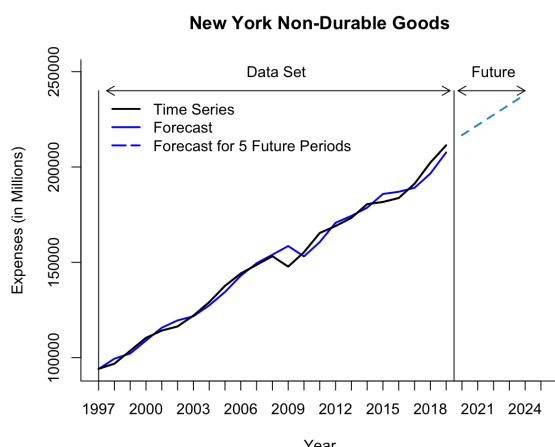
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 0.294 337.786 244.856 0.06 2.173 0.092 0.621



ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 1.825	1562.46	1154.452	0.046	1.697	0.232	0.546

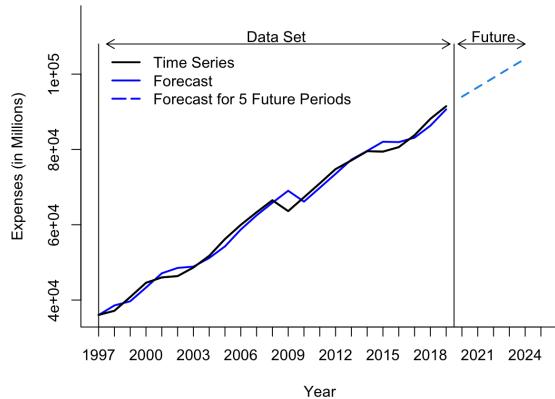


ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.301	434.48	352.149	0.106	2.8	0.116	0.657



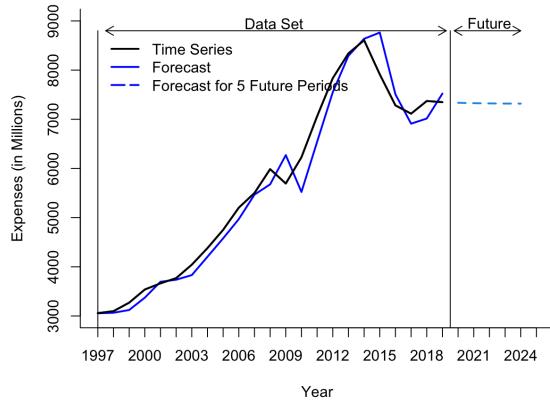
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 3.862	3429.361	2600.842	-0.092	1.715	0.106	0.517

### North Carolina Non-Durable Goods



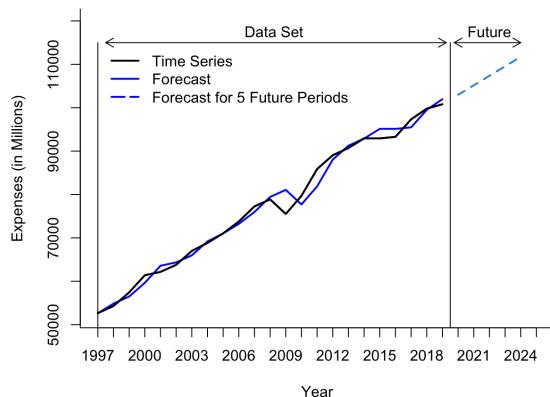
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 1.458	1672.16	1268.156	-0.074	2.117	0.072	0.536

### North Dakota Non-Durable Goods

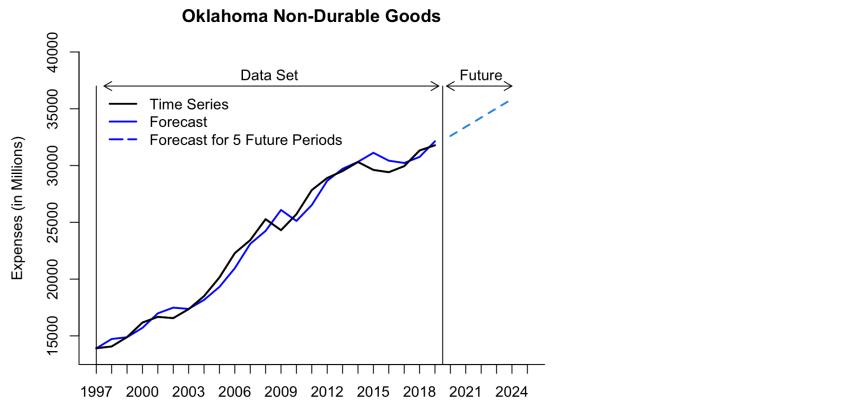


ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 76.053	327.368	240.178	1.628	4.023	0.054	0.76

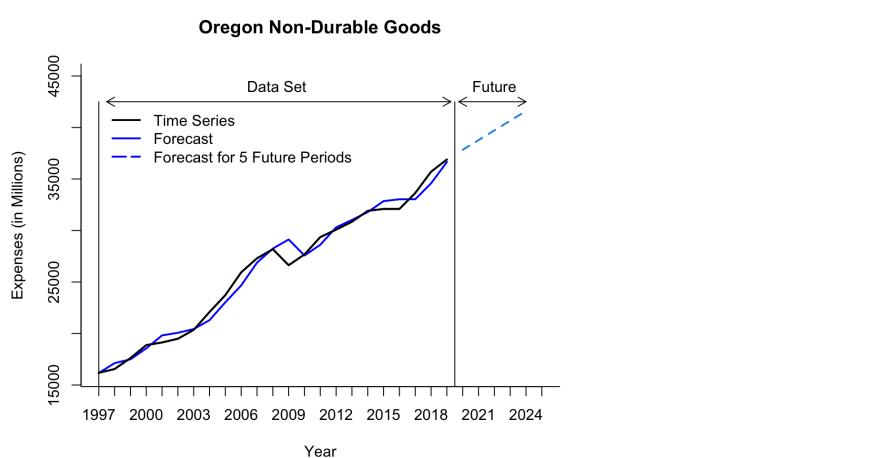
### Ohio Non-Durable Goods



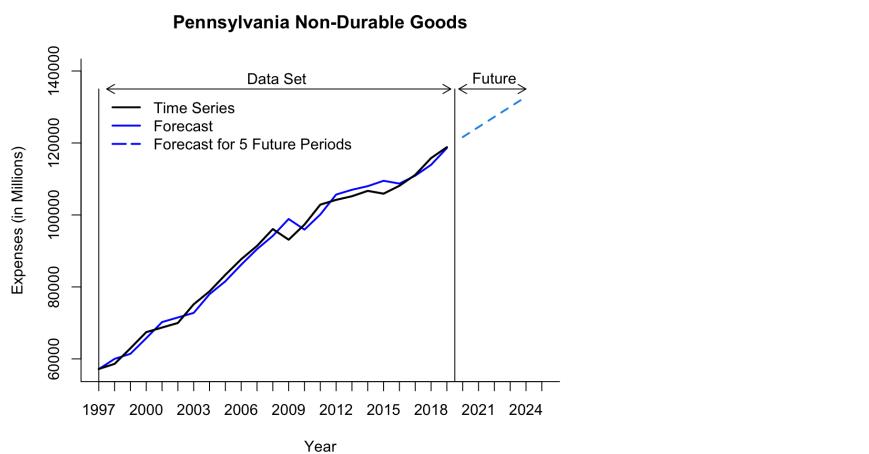
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 2.195	1807.397	1285.527	0.01	1.65	0.036	0.604



ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.57	794.986	615.087	-0.031	2.656	0.135	0.662

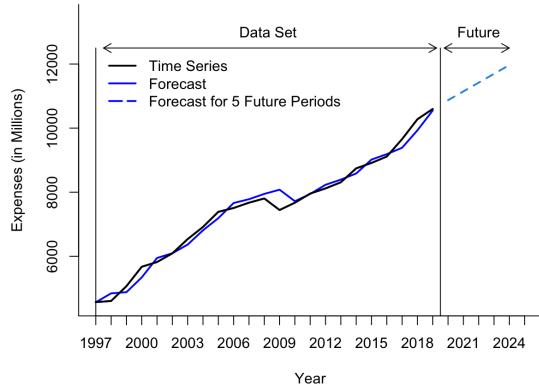


ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.663	785.987	571.498	-0.097	2.213	0.205	0.618



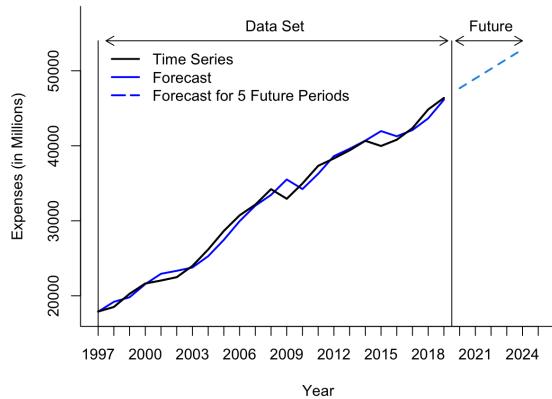
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 2.366	2025.799	1650.055	0.04	1.886	-0.01	0.552

### Rhode Island Non-Durable Goods



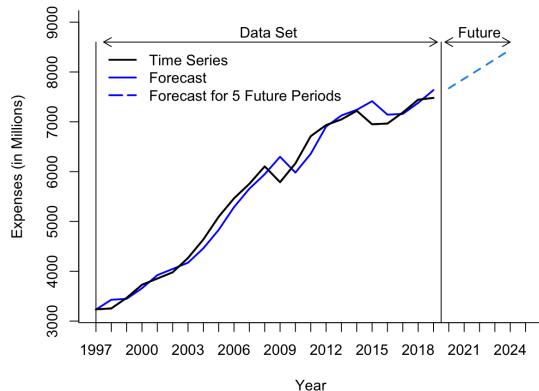
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.187	210.025	159.117	-0.05	2.227	0.207	0.605

### South Carolina Non-Durable Goods

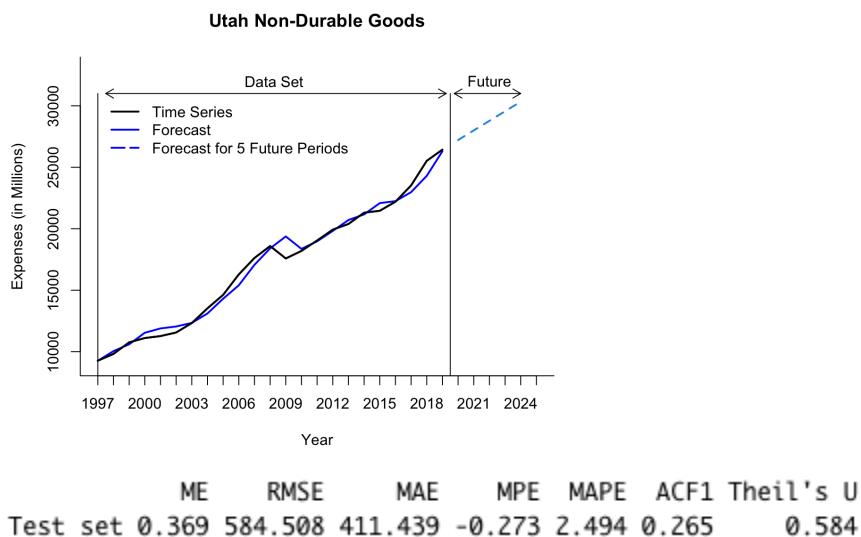
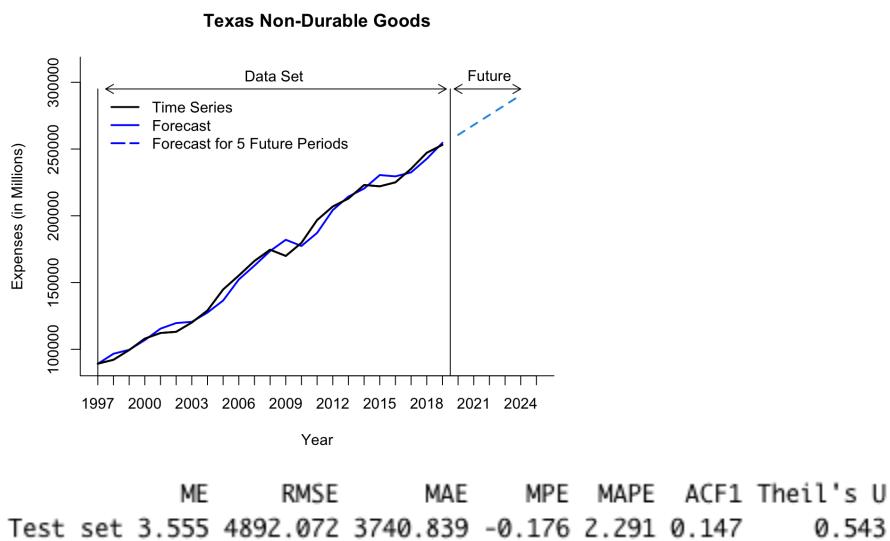
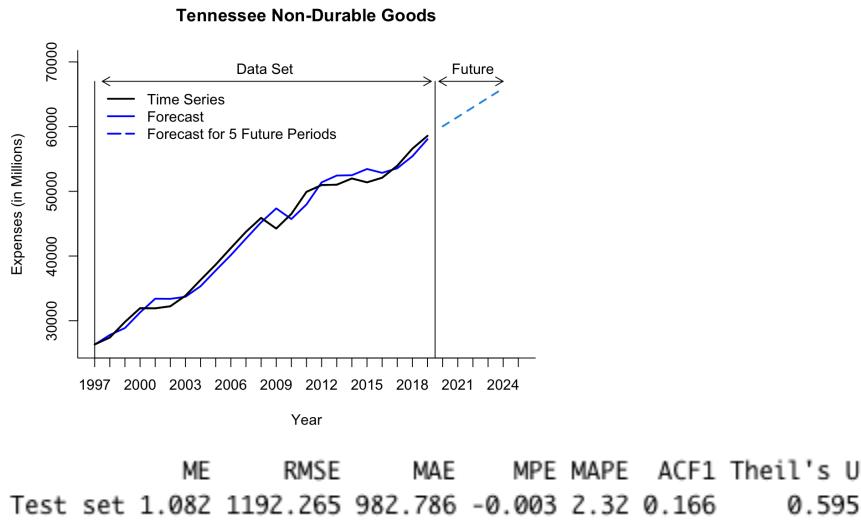


	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.722	927.971	696.455	-0.077	2.26	0.035	0.553

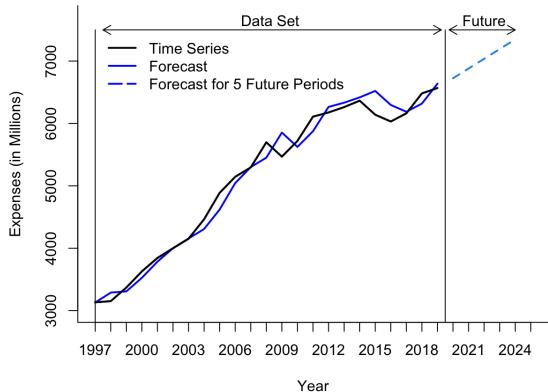
### South Dakota Non-Durable Goods



	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.132	200.311	149.493	0.037	2.677	0.123	0.653

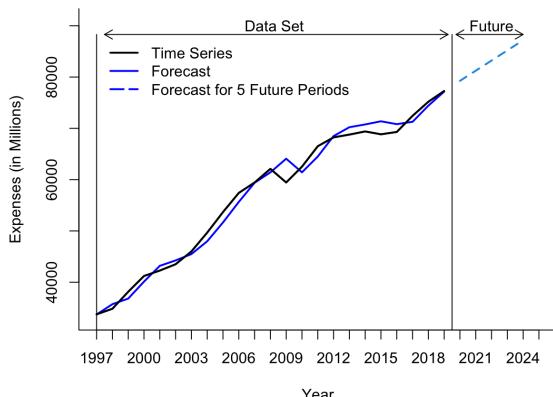


### Vermont Non-Durable Goods



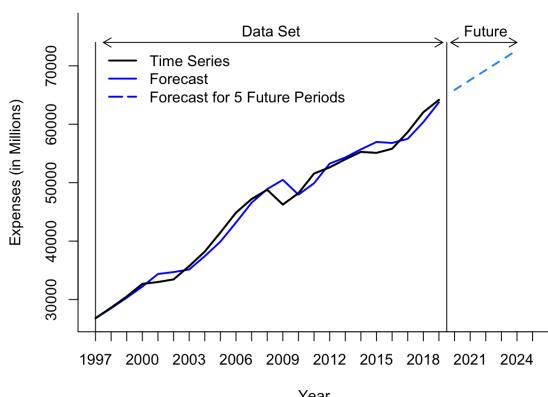
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.129	171.825	129.359	0.107	2.462	0.092
						0.664

### Virginia Non-Durable Goods

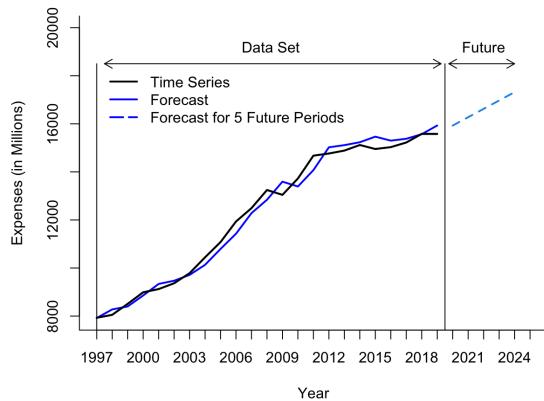


ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	1.381	1579.345	1245.797	0.078	2.214	0.171
						0.569

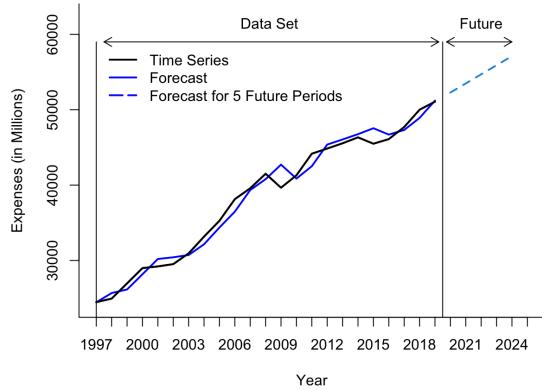
### Washington Non-Durable Goods



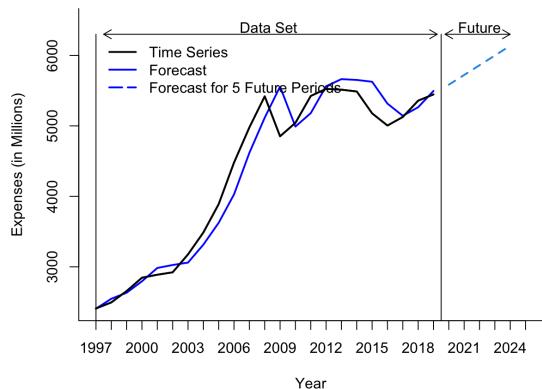
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	1.092	1330.381	977.236	-0.035	2.143	0.225
						0.573

**West Virginia Non-Durable Goods**

ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.33	307.655	259.625	0.077	2.076	0.175	0.607

**Wisconsin Non-Durable Goods**

ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 1.011	1099.988	865.747	0.013	2.31	0.073	0.637

**Wyoming Non-Durable Goods**

ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.099	253.995	185.534	0.105	4.101	0.3	0.791

The forecast for each state, except for North Dakota's, expenditures on Non-Durable Goods shows great economic growth in the next five forecasted years. The Theil's U statistic ranges from 0.471 (Florida) to 0.791 (Wyoming), which are both better than the high and low of the Durable Goods Theil's U statistic. The MAPE ranges from 1.65 (Ohio) to 4.101 (Wyoming); a larger gap than the MAPE range for Durable Goods. When looking at only MAPE, there are two outliers that stand out immediately: North Dakota (4.023) and Wyoming (4.101). With Idaho (MAPE of 2.83) being the third-highest, the Auto ARIMA forecasting model for North Dakota and Wyoming could be a problem when trying to predict the future expenditure for Non-Durable Goods. Another problem that occurred with the Auto ARIMA model is the gap between RMSE. The lowest RMSE score goes to Alabama (157.032) and the highest goes to California (7,124.569). Thirty-two states and the District of Columbia have a lower RMSE score with the average being roughly 1,100. Therefore, it is safe to say nineteen states are experiencing overfitting with an Auto ARIMA forecasting model.

When looking at the time series graphs for North Dakota and Wyoming, there is one similarity that could describe the high MAPE for the two states: in 2014, expenditure for Non-Durable Goods declined, more so for North Dakota than Wyoming. This could have caused the forecasting model problems because there was no such rapid decline, except for one year in 2007 during the depression when all of the other states jumped back up to their normal rate just a year or two later, to any other state.

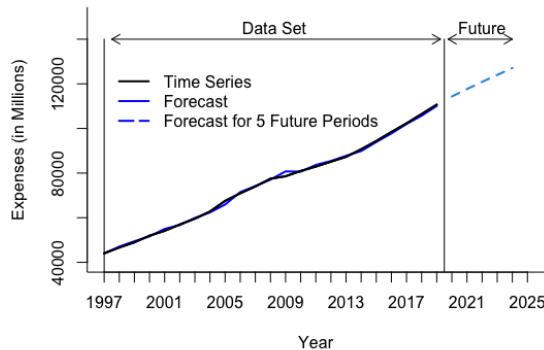
Looking at the forecasted graph of North Dakota, it stands out because it is the only forecast which is trending negatively.

Year	Forecast
2020	7335.23
2021	7327.31
2022	7322.65
2023	7319.91
2024	7318.30

If this forecast is determined to be correct, this would mean a 15% overall decrease in Non-Durable Goods since 2014. When digging deeper into this problem, there were two areas of concern that were noticeable: a decline in agriculture, forestry, fishing, hunting, and manufacturing, more specifically, clothing and footwear manufacturing. Since 1990, Manufacturing in Midwestern states, like North Dakota, has been a lifeline by which those states have survived. By 2019, manufacturing in Midwestern states has “represented a larger share of payroll employment than the national average except North Dakota” (bls.gov, 2021). The decline in North Dakota manufacturing happened because a more competitive marketplace and an increase in capital intensity occurred in United States manufacturing as a whole. In order to combat the negative flow of Non-Durable Goods, North Dakota should attempt to expand their employment and average hours worked to bring back their economy. By doing so at a healthy pace, it could show the United States workforce that North Dakota is as competitive in manufacturing as its neighboring states and bring back their expenditure for Non-Durable Goods.

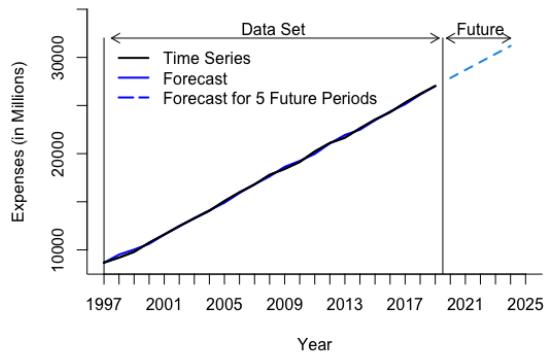
## Services for Each State

**Alabama Services**



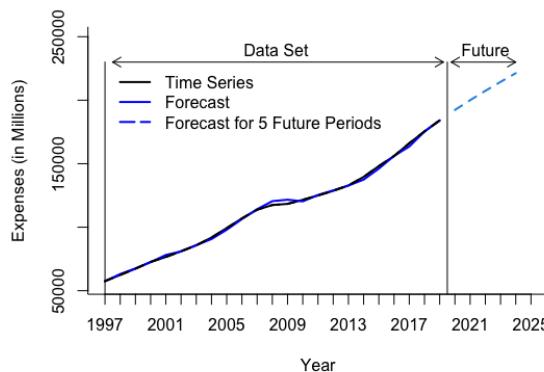
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	14.922	740.58	576.779	-0.045	0.784	-0.083	0.24

**Alaska Services**

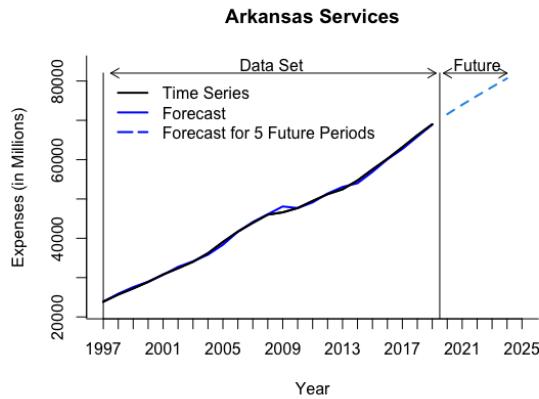


	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.341	148.914	117.011	-0.102	0.761	-0.064	0.212

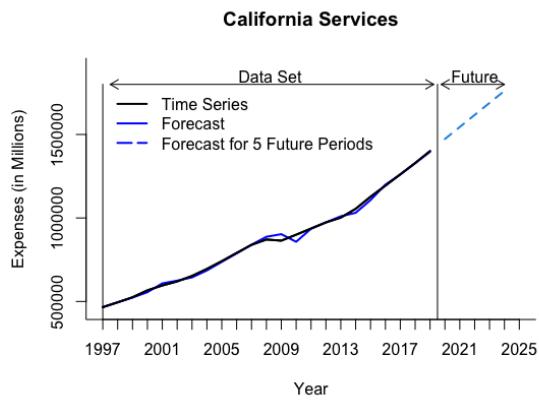
**Arizona Services**



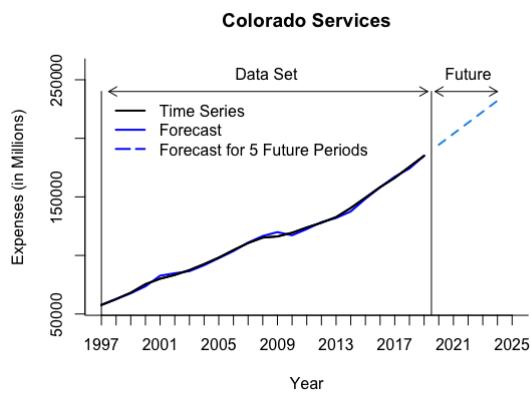
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	59.582	1373.412	945.491	-0.037	0.836	0.279	0.214



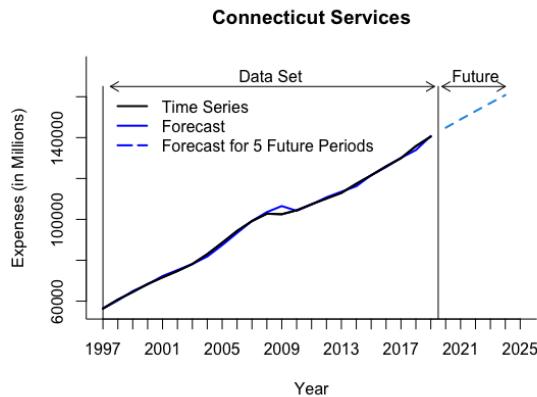
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	12.132	469.362	333.245	-0.05	0.75	0.184	0.211



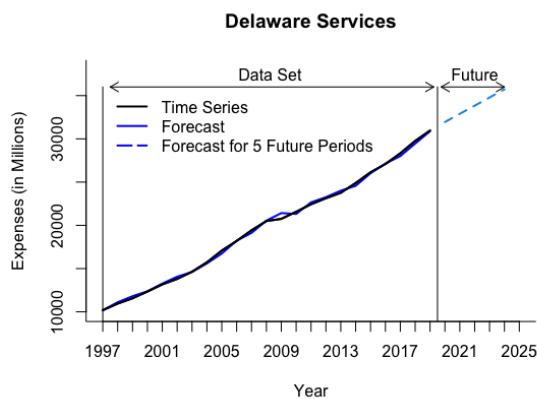
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	1872.939	14981.51	9515.072	0.193	1.129	-0.165	0.335



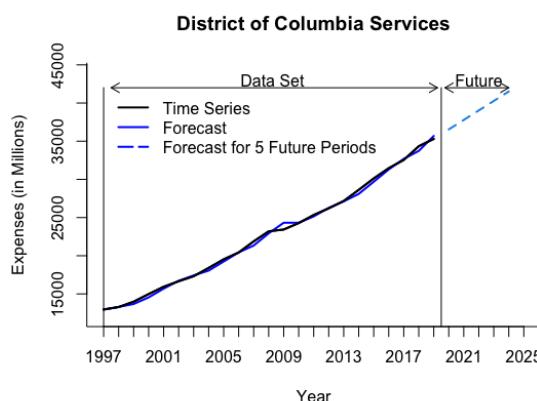
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	191.065	1493.658	1152.589	0.13	1.069	0.049	0.259



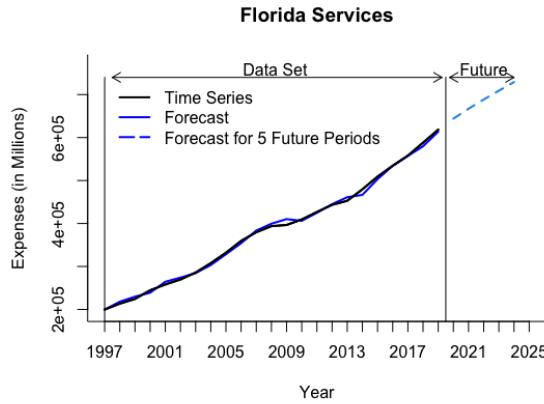
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	-11.957	1094.394	688.406	-0.024	0.702	0.12	0.243



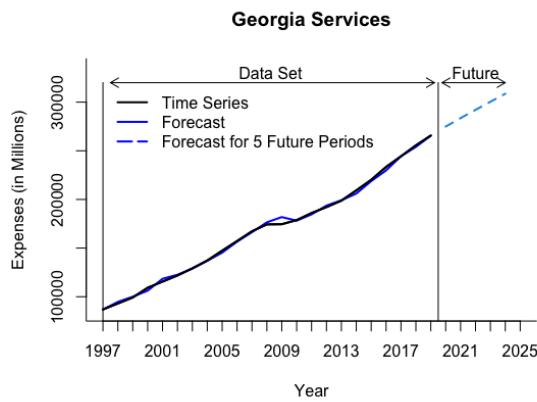
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	1.729	242.642	190.485	-0.12	0.99	0.006	0.246



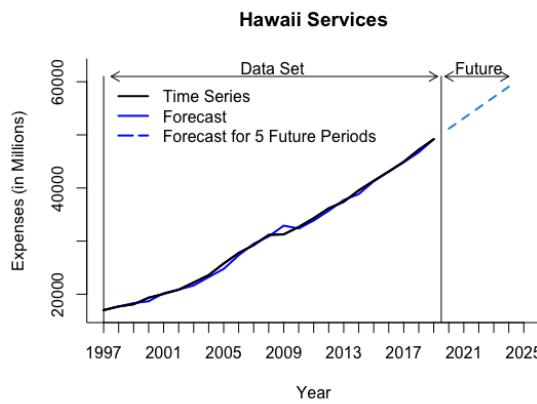
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	117.609	349.986	267.446	0.579	1.181	-0.079	0.337



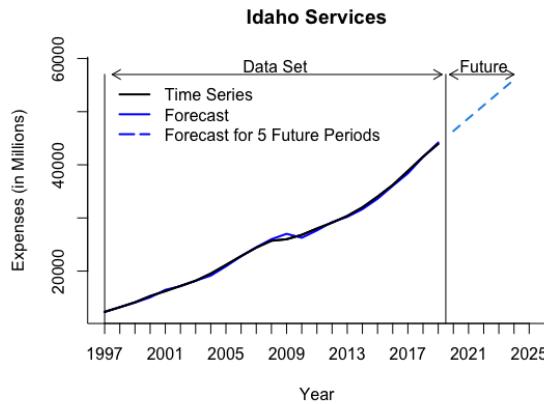
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U	
Test set	190.85	5955.83	4844.065	-0.107	1.337	0.104	0.307



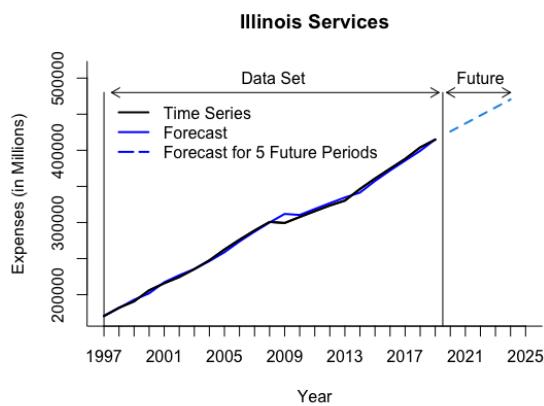
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U	
Test set	67.948	2264.942	1598.155	-0.049	1.012	0.096	0.272



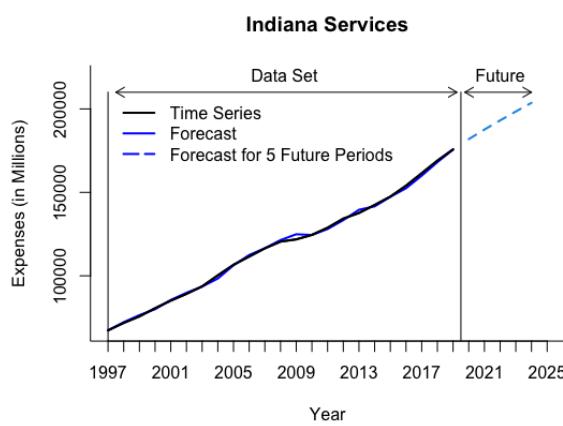
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U	
Test set	145.383	528.021	372.206	0.514	1.298	-0.131	0.377



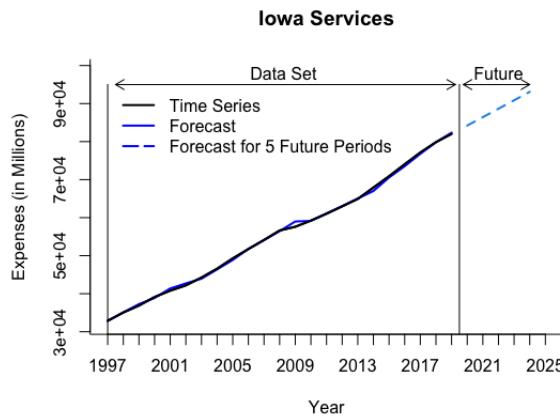
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	66.593	332.111	242.373	0.247	0.941	0.072	0.221



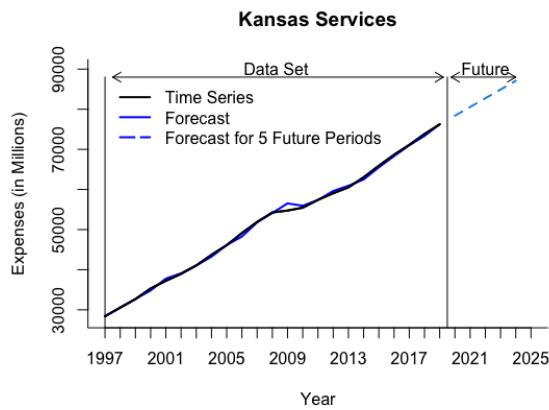
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	6.929	3805.639	2834.371	-0.027	0.968	0.259	0.301



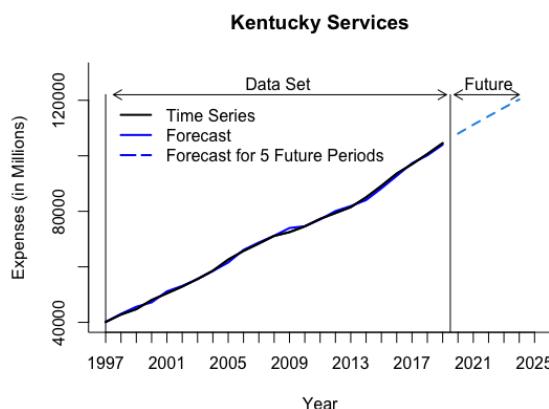
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	24.545	1103.351	821.307	-0.032	0.698	0.154	0.208



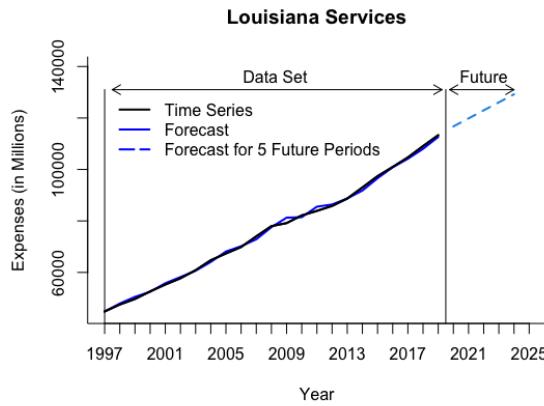
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 2.821	444.604	310.327	-0.041	0.577	0.05	0.195



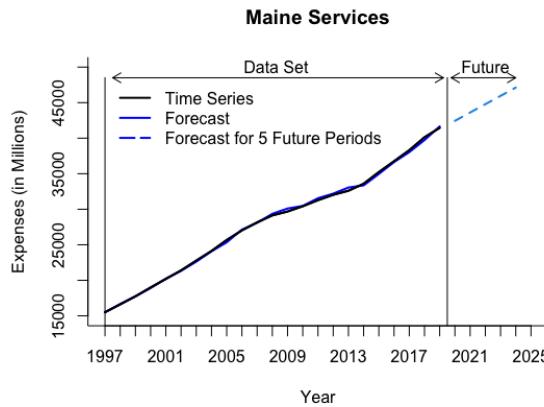
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set -1.438	524.458	352.965	-0.011	0.681	0.125	0.215



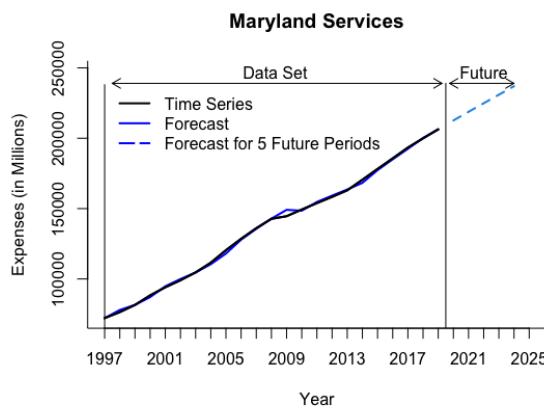
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 10.006	648.066	522.415	-0.054	0.77	0.026	0.226



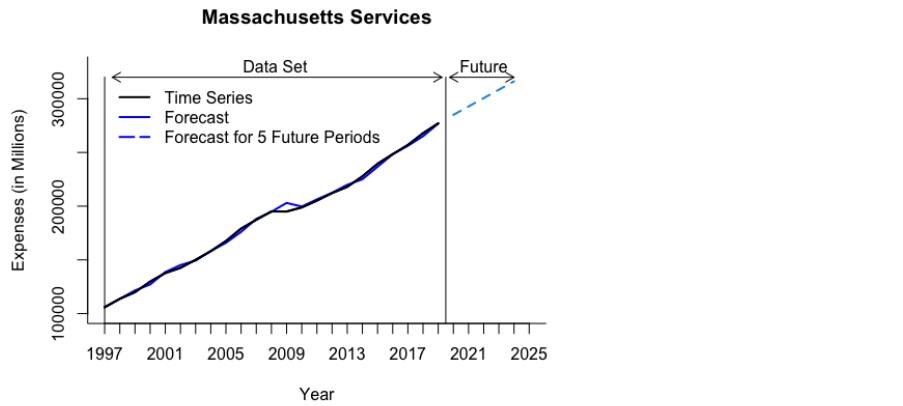
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 3.136	832.459	668.155	-0.095	0.875	0.009	0.252



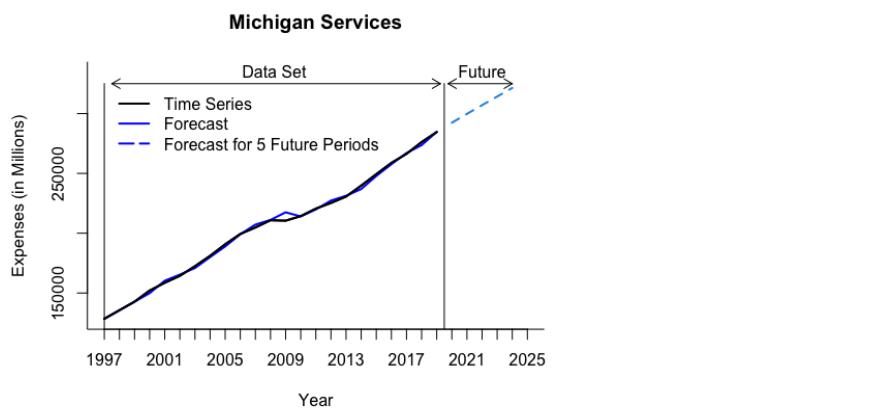
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.805	218.758	173.201	0.001	0.568	0.238	0.15



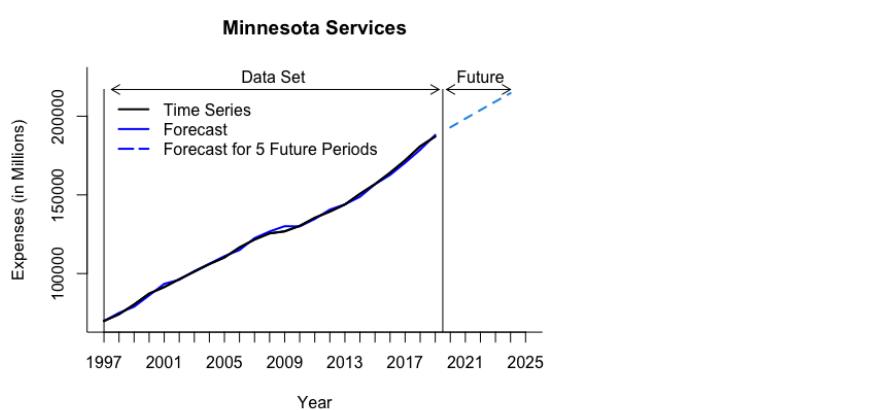
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 52.836	1361.947	954.475	0.005	0.744	0.063	0.217



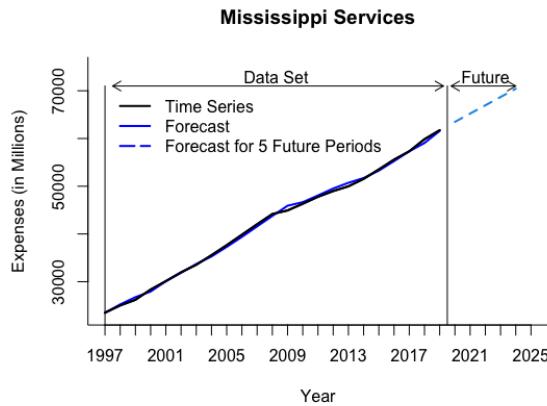
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set -6.833	2333.643	1576.226	-0.044	0.862	0.055	0.275



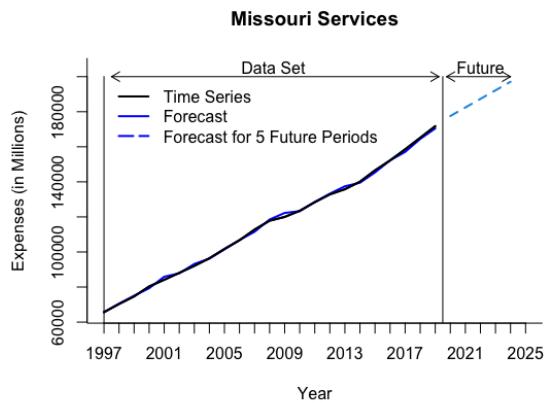
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 5.514	2024.361	1383.366	-0.005	0.673	0.021	0.258



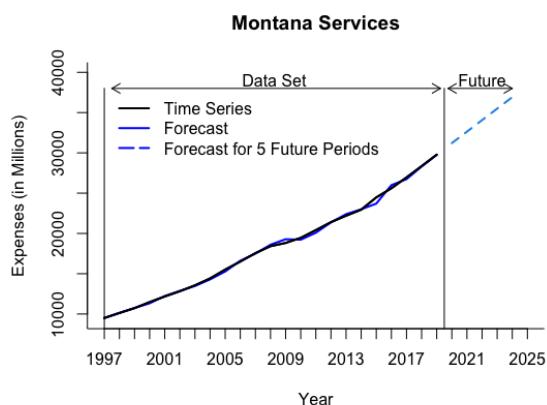
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 34.194	1348.022	1095.584	-0.021	0.904	0.03	0.245



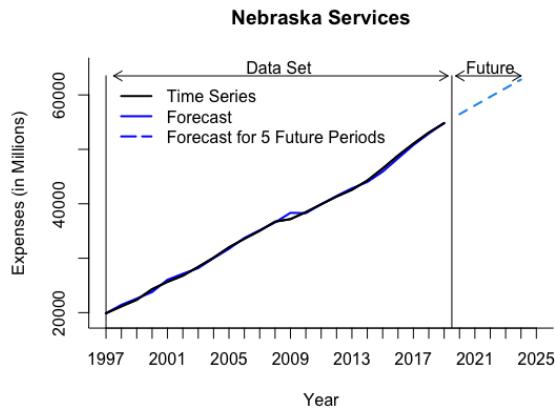
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	0.946	427.805	349.335	-0.021	0.843	0.321	0.228



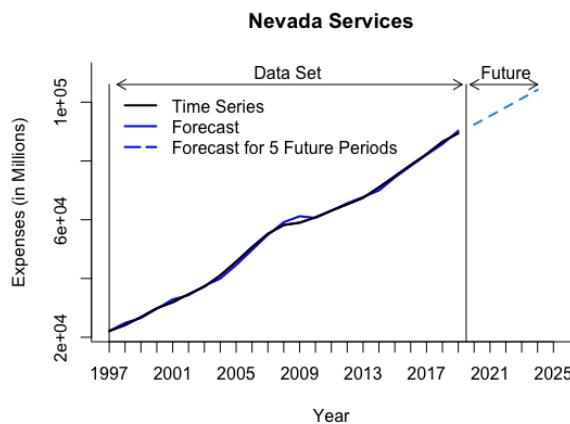
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	-9.684	977.744	746.899	-0.067	0.653	-0.042	0.197



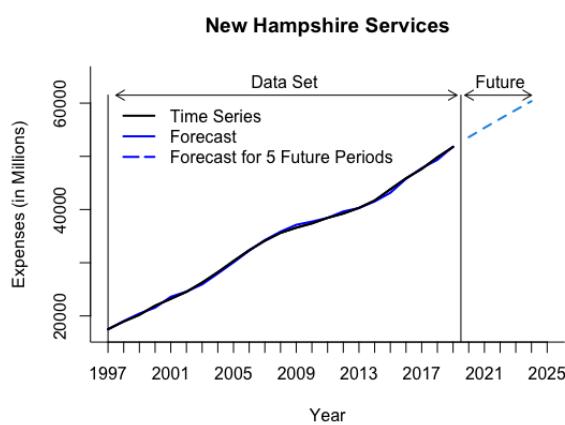
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	34.608	243.165	165.909	0.175	0.853	-0.284	0.227



	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	8.384	366.551	276.07	-0.05	0.819	0.003	0.234

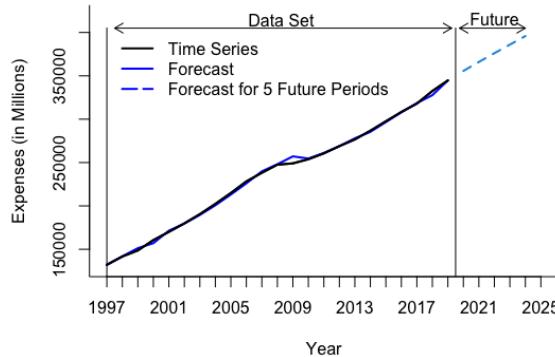


	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	34.726	782.707	607.483	0.019	1.237	0.202	0.244



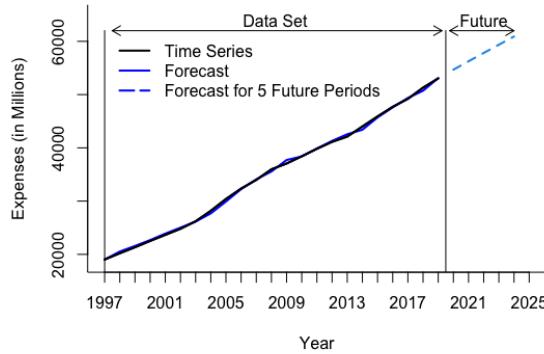
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	6.065	296.782	237.352	-0.007	0.733	0.169	0.181

### New Jersey Services



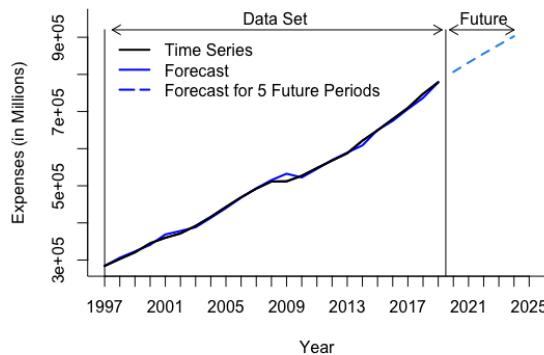
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	11.552	2380.512	1543.348	-0.008	0.69	-0.008	0.231

### New Mexico Services



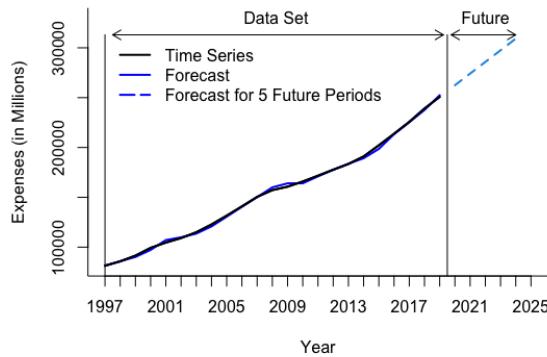
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	9.911	323.543	256.833	-0.051	0.773	-0.018	0.208

### New York Services



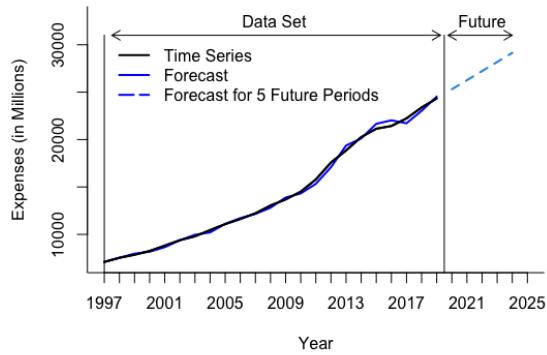
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	139.748	6532.432	4594.845	-0.085	0.95	0.026	0.28

### North Carolina Services



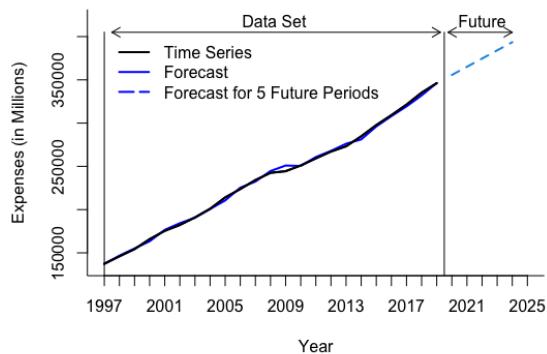
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	314.345	1668.916	1303.498	0.215	0.898	0.162	0.229

### North Dakota Services

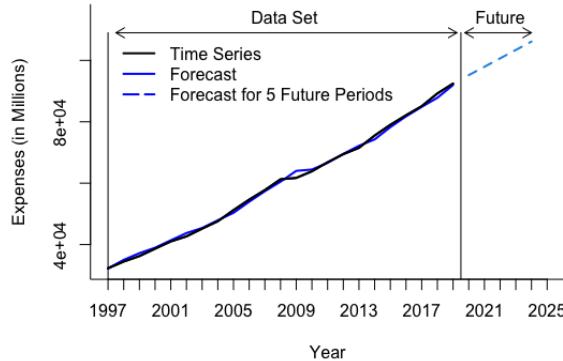


	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	22.588	300.248	233.07	0.203	1.457	-0.045	0.309

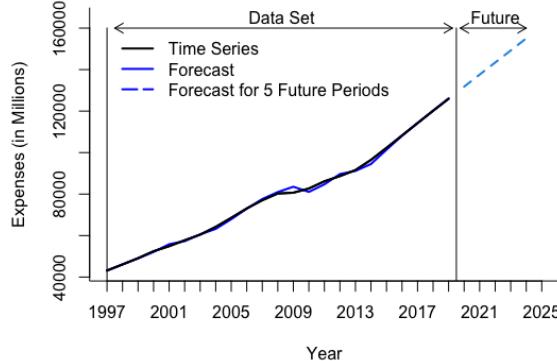
### Ohio Services



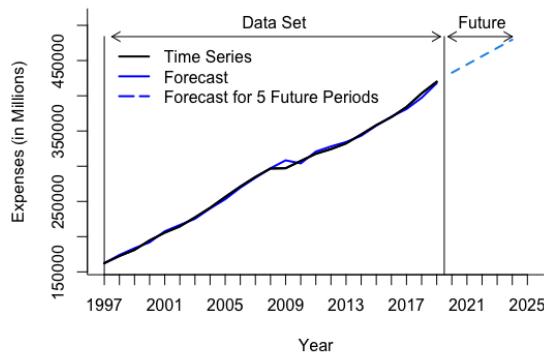
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	5.74	2313.093	1800.798	-0.038	0.762	0.04	0.225

**Oklahoma Services**

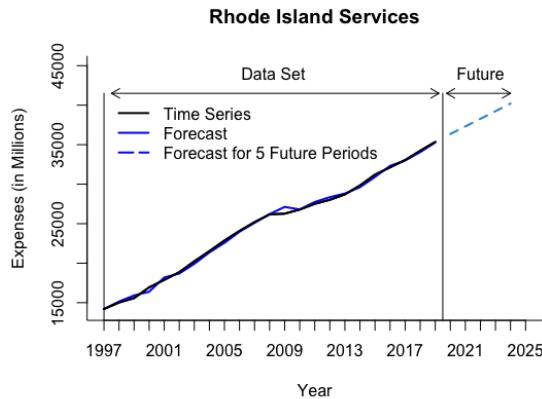
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	1.284	820.02	649.154	-0.199	1.135	0.226	0.296

**Oregon Services**

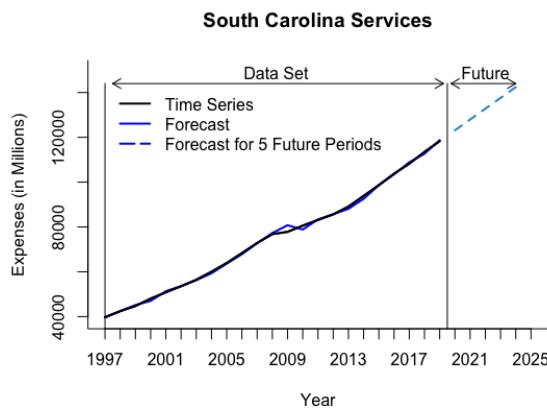
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	124.215	989.643	680.542	0.136	0.869	0.02	0.247

**Pennsylvania Services**

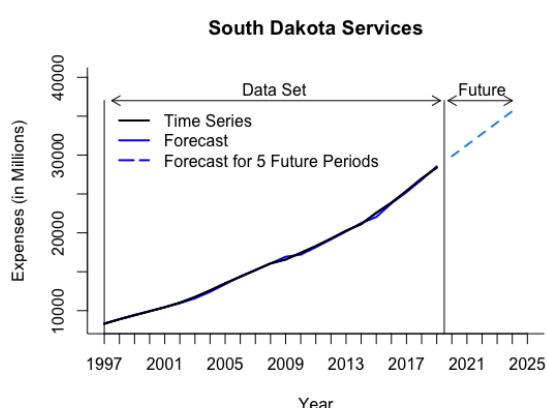
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	10.842	3410.948	2536.222	-0.051	0.899	0.012	0.26



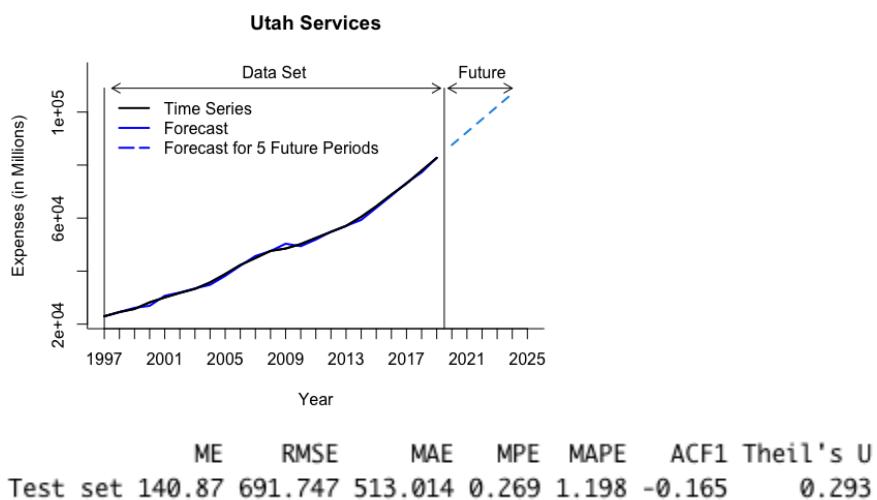
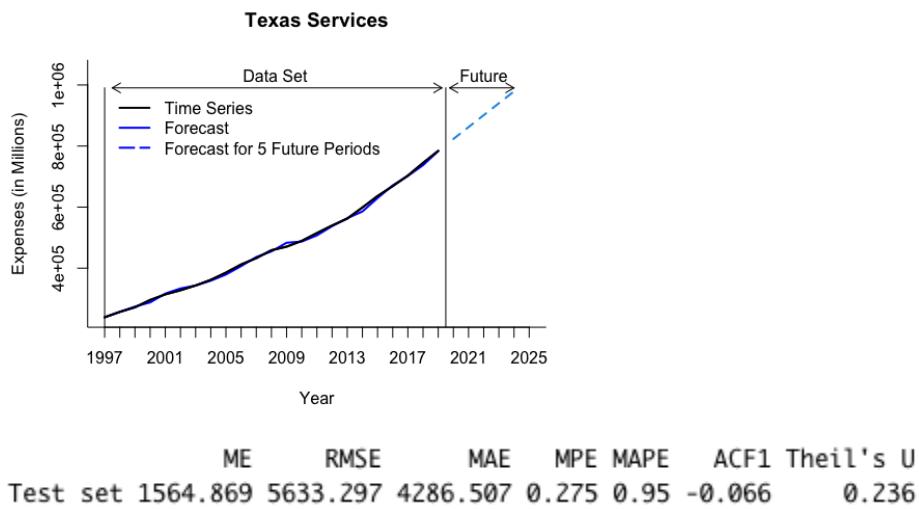
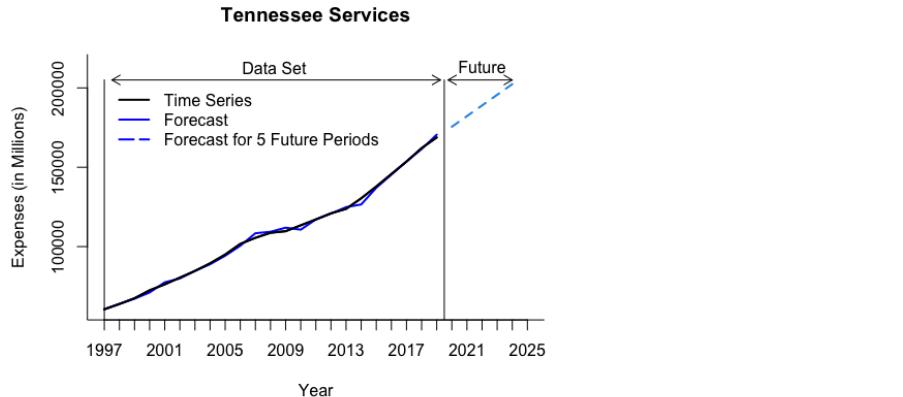
ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set -1.367 288.551 220.354 0 0.975 -0.014 0.302

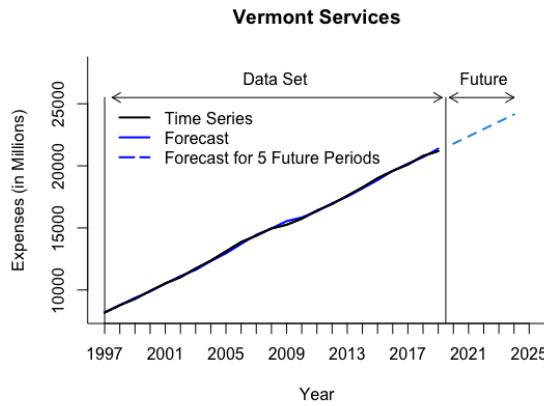


ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 89.803 896.231 605.297 0.115 0.814 -0.242 0.238

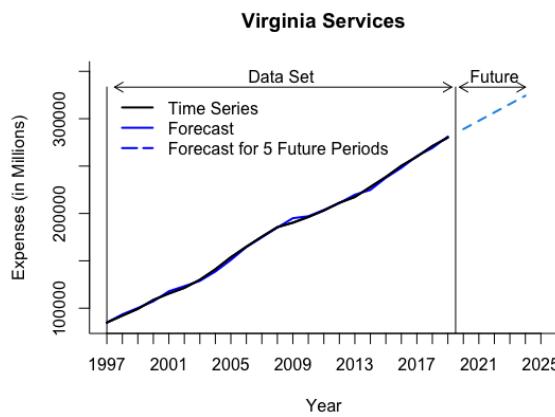


ME RMSE MAE MPE MAPE ACF1 Theil's U  
Test set 53.336 173.788 124.533 0.292 0.706 -0.128 0.175

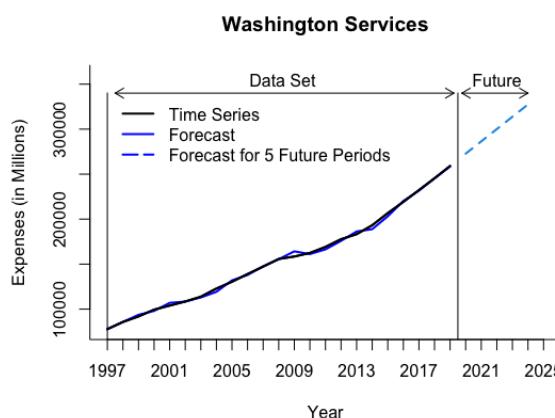




ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 0.33	110.849	87.167	0.011	0.586	0.057	0.167

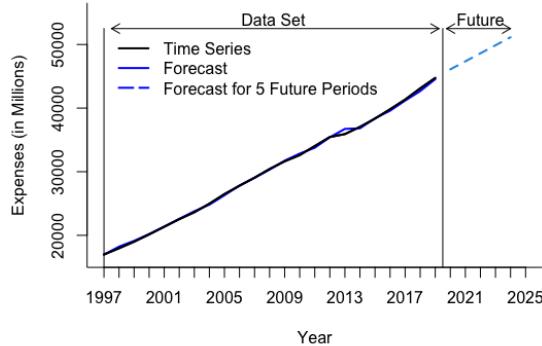


ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 44.279	1853.322	1493.317	-0.034	0.911	0.037	0.206



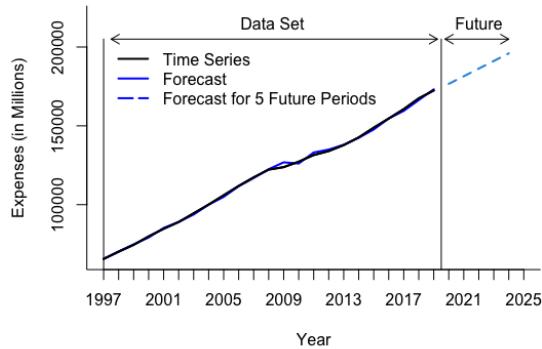
ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set 245.921	2285.711	1683.633	0.082	1.135	-0.164	0.278

### West Virginia Services



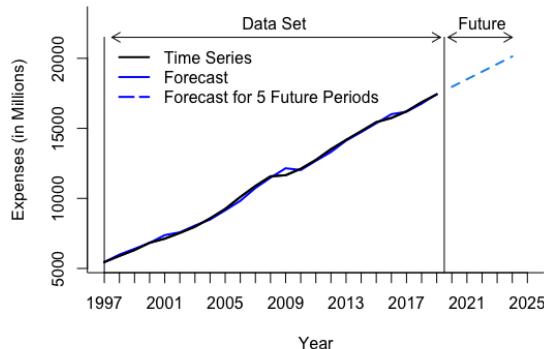
	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	3.622	241.169	170.661	-0.059	0.55	-0.028	0.167

### Wisconsin Services



	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	-1.905	967.244	699.345	-0.006	0.578	-0.119	0.172

### Wyoming Services



	ME	RMSE	MAE	MPE	MAPE	ACF1	Theil's U
Test set	1.003	163.466	119.39	-0.11	1.146	0.043	0.286

When only examining the graphs of each states' data, they seem extremely similar to one another, but the accuracy measures tell another story. The MAPE for Services range from 0.55 (West Virginia) to 1.457 (North Dakota), and the Theil's U statistic ranges from 0.15 (Maine) to 0.377 (Hawaii), which are remarkable accuracy measures. The statistic which gives slightly more insight is the RMSE score of each state. RMSE ranges from 14,981.51 (California), which is distinctly high, to 110.849 (Vermont), which shows very high accuracy. California's RMSE score for Services is concerning because the next highest RMSE score is 6,532.432 (New York), which is also fairly high compared with the average; this is a case of overfitting. Even though California's MAPE is 1.129 and Theil's U statistic is 0.335, the Auto ARIMA model cannot be used to make accurate forecasts on this data. This goes for New York (6,532.432 RMSE), Texas (5,633.297 RMSE), and twelve other states, despite the fact that the MAPE and Theil's U statistic show great accuracy, respectively. Using the Auto ARIMA forecasting model, based on the average RMSE scores of all of the other states, an accurate forecast for Services expenditure in each state will consist of an RMSE score in the region of 1,600 or less.

Forecasts for each state's expenditures on Services are trending upwards when analyzing this data. Of course, some states will be doing better than others. Utah, for example, will experience an increased expenditure on Services by 18.12% from 2020-2024, and North Carolina is going to see an increase of 15.12%. While some states, like Rhode Island, are only going to see expenditures on Services increase by 9.6%, which is still a positive movement in the right direction.

### Conclusion

Starting with four different models, Regression with Linear Trend, Regression with Quadratic Trend, Holt's Model, and Auto Arima Model, on personal expenditures of the entire United States, the Auto Arima Model was chosen to forecast Durable Goods, Non-Durable Goods, and Services for each state.

<b>Linear Trend</b>	MAPE	RMSE	Theil's U
Durable Goods	7.861	124,352.5	2.318
Non-Durable Goods	4.051	114,922.6	1.232
Services	4.681	494,278.1	1.28
Average	5.531	244,517.73	1.61

<b>Quadratic Trend</b>	MAPE	RMSE	Theil's U
Durable Goods	21.883	334,381.5	6.206
Non-Durable Goods	2.19	72782.39	0.764
Services	6.463	666,306.6	1.722
Average	10.179	357,823.49	2.897

<b>Holt's Model</b>	MAPE	RMSE	Theil's U
Durable Goods	5.499	88,671.83	1.653
Non-Durable Goods	3.486	99,218.33	1.082
Services	4.484	471,994	1.222
Average	4.489	219,961.39	1.319

<b>Auto ARIMA Model</b>	MAPE	RMSE	Theil's U
Durable Goods	3.01	56,818.46	1.064
Non-Durable Goods	2.823	83,573.36	0.9
Services	4.784	503,290.1	1.303
Average	3.539	214,560.64	1.089

The Auto ARIMA model had the best average MAPE, RMSE, and Theil's U statistic in every category, which was why it was chosen to be the model to forecast.

In Durable Goods, every state is going to see an increase in personal expenditures. The MAPE ranged from 1.467 to 3.466, RMSE ranged from 56.465 to 5,515.377, and Theil's U statistic ranged from 0.49 to 0.806. Eighteen states had a higher RMSE score than the average of 704, and therefore are experiencing overfitting of the data. Since every states' Theil's U statistic stayed well below 1, this forecast is far better than guessing. Nevada must improve its expenditures on Durable Goods due to seeing a forecasted increase of 1.88% from 2020 to 2024, an influx in population due to the pandemic might have saved Nevada from seeing a negative slope in Durable Goods.

For Non-Durable Goods, every state except for North Dakota can expect an increase in personal expenditures. MAPE was slightly worse than Durable Goods, ranging from 1.65 to 4.101, RMSE was also worse, ranging from 157.032 to 7,124.569, and Theil's U statistic was marginally better, ranging from 0.471 to 0.791. The average RMSE score was approximately 1,100 with nineteen states having scores higher than the average, experiencing overfitting. North Dakota's

expenditure is going to experience a 15% decrease from 2014 to 2024 due to a decline in food and manufacturing; leaving the state in a bad economic position.

Every state can look for an upward trend in personal expenditure of Services. With a MAPE score ranging from 0.55 to 1.457 and Theil's U statistic ranging from 0.15 to 0.377, the Auto ARIMA model had great accuracy forecasting this data. Unfortunately, RMSE ranged from 110.849 to 14,981.51 with an average of around 1,600, proving that this model is overfitting. Overall, the Auto ARIMA forecasting model had very good accuracy, disregarding the RMSE scores. Due to these high RMSE scores, this model was overfitting the data, which may have caused some forecasts to be inaccurate, even though MAPE and Theil's U statistic might have been low. We also have to take into account that a pandemic like we are facing at the moment cannot be predicted, therefore the forecasted data for each state might be completely misleading. In conclusion, the Auto ARIMA forecasting model might have had lower RMSE scores if the forecast was less than five years. Taking into account MAPE scores and Theil's U statistics, the forecasting model provided valuable insights to multiple states on how they could see their personal expenditure rise or fall in the coming years.

## Appendix

### Sources

IBM Cloud Education. (2021, March 3). *What is overfitting?* IBM. From <https://www.ibm.com/cloud/learn/overfitting>.

“Personal Consumption Expenditures: Nondurable Goods: Clothing and Footwear for North Dakota 2021 Forecast 1997-2020 Historical.” *Personal Consumption Expenditures: Nondurable Goods: Clothing and Footwear for North Dakota - 2021 Data 2022 Forecast 1997-2020 Historical*,

<https://tradingeconomics.com/united-states/personal-consumption-expenditures-nondurable-goods-clothing-and-footwear-for-north-dakota-fed-data.html>.

*Midwest Economy: August State-by-State Glance.* Associated Press, 1 Sept. 2021, <https://apnews.com/article/Midwest Economy: August State-by-State Glance>. Associated Press, From <https://apnews.com/article/business-economy-696a6728c044fb28e787a8ed359f0615>.

“Exploring Midwest Manufacturing Employment from 1990 to 2019 : Monthly Labor Review.” *U.S. Bureau of Labor Statistics*, U.S. Bureau of Labor Statistics, 1 Nov. 2021, <https://www.bls.gov/opub/mlr/2021/article/exploring-midwest-manufacturing-employment-from-1990-to-2019.htm>.

Horwath, Bryan. "Las Vegas Visitation in July Strongest since Onset of Pandemic." *Las Vegas Sun*, 26 Aug. 2021,

<https://lasvegassun.com/news/2021/aug/26/las-vegas-visitation-in-july-strongest-since-onset/#:~:text=Las%20Vegas%20recorded%2019%20million,2019%2C%20according%20to%20the%20authority>.

*United States Map and Satellite Image,*

<https://geology.com/world/the-united-states-of-america-satellite-image.shtml>.

Roberts, David. *US Personal Expenditures by State 1997-2019*. July 2021,

<https://www.kaggle.com/davidbroberts/us-personal-expenditures-by-state-19972019>

Sag, Maxwell. *US Personal Expenditures by State 1997-2019* (Version 1.0) [R Studio].

December 2021,

<https://github.com/msag31/US-Personal-Expenditures-by-State-1997-2019>