Lost Automotive Sales

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Abstract

Background

In 2020 there was a sharp decline in auto sales in the United States. The conventional wisdom is that sales were lost due to the consumers' lack of ability to visit dealership and purchase a new car and the lack of availability of new cars due to COVID-related production shutdowns. These are likely two reasons sales were depressed, but I'd like to also quantify the lost sales due to the reduction in driving.

Problem Statement

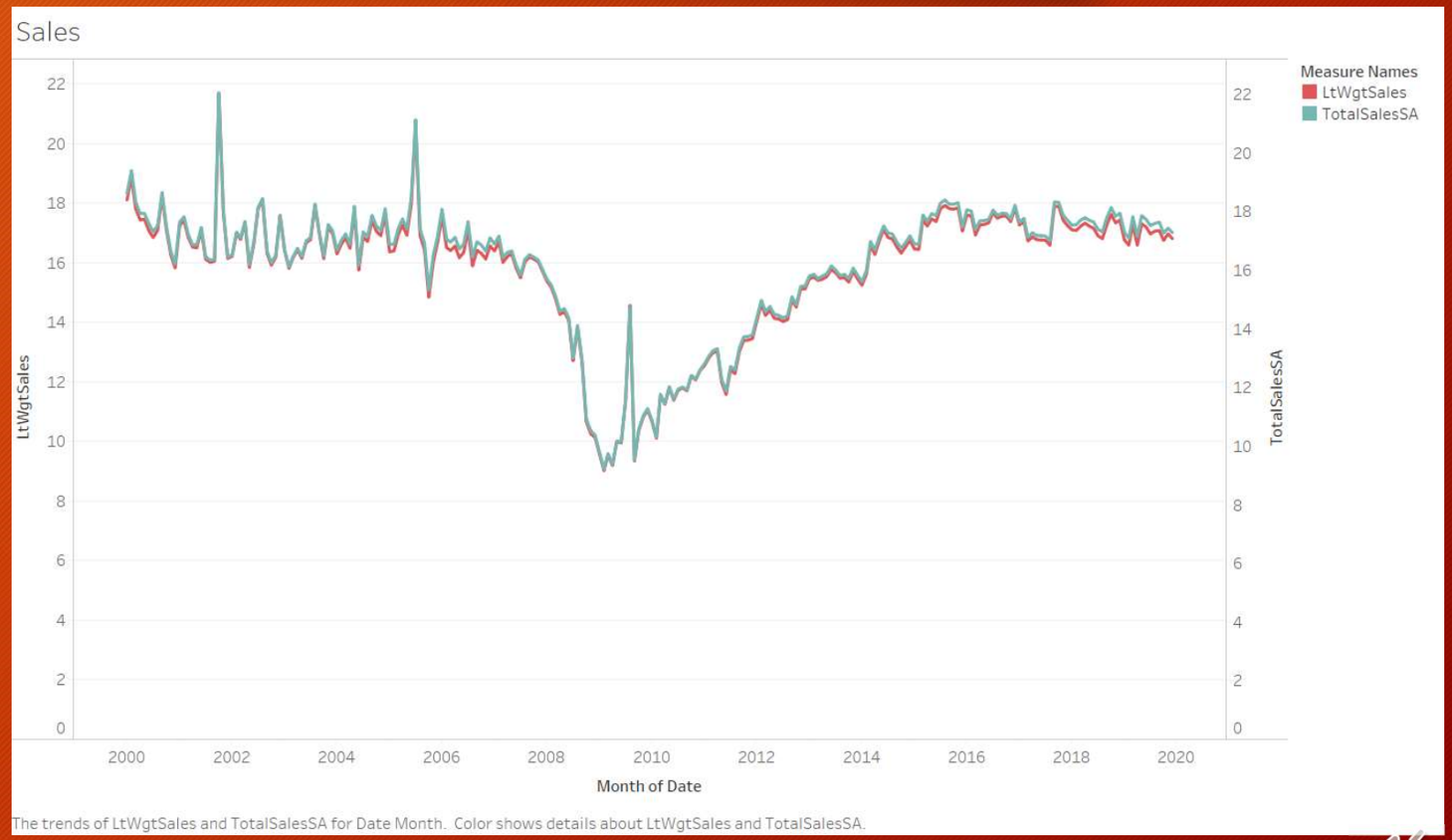
This project will investigate the shortfall in auto sales year-to-date in 2020. It will specifically look to quantify the number of vehicles that would have been sold (in a non-pandemic circumstances) and then forecast when those sales will be made up.

Scope

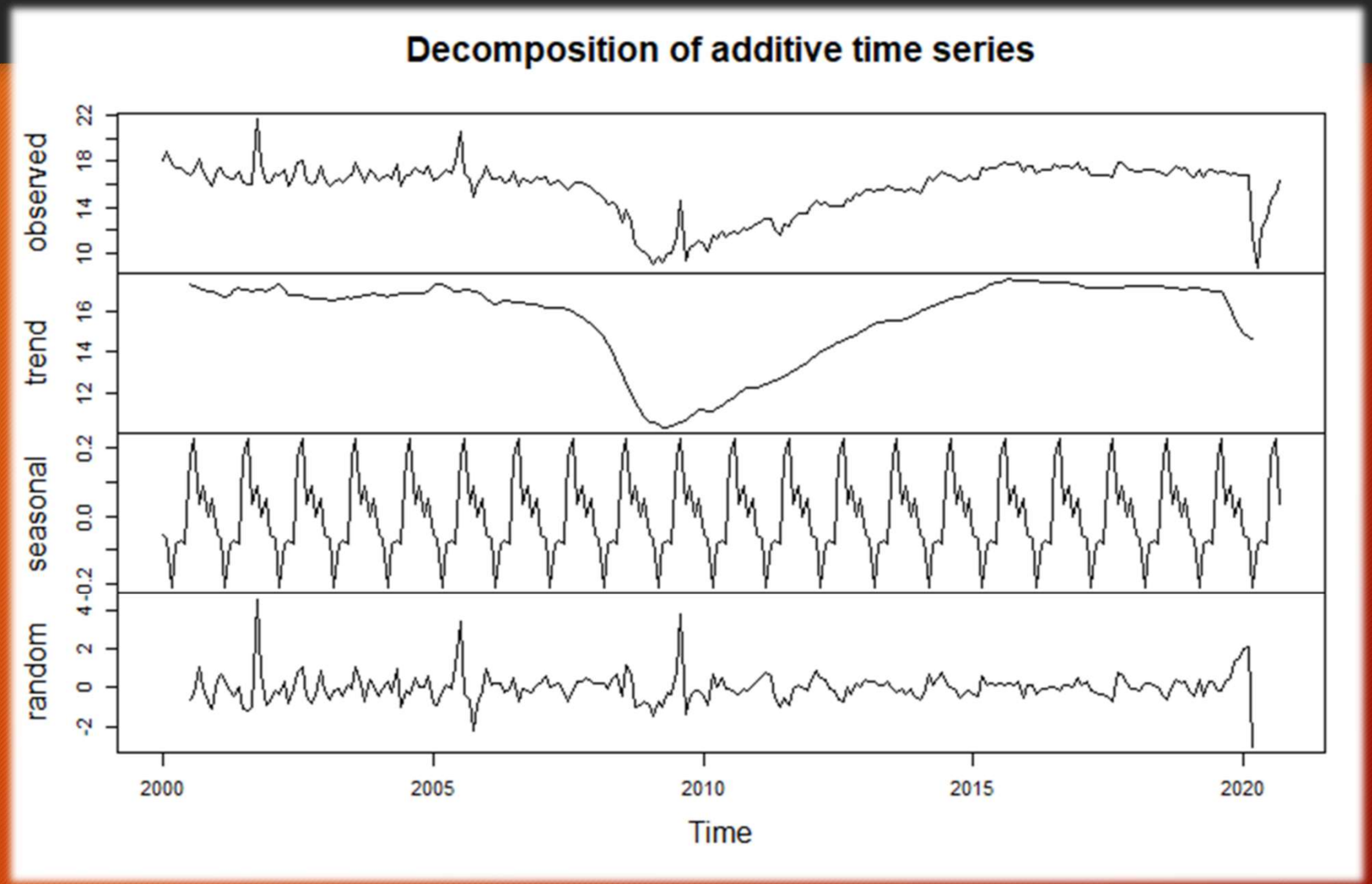
Defining the share of sales that have been permanently lost versus sales that were delayed to the next few years is out of scope.

Automotive Sales

Series ID:	Series ID:
ALTSALES	TOTALSA
U.S. Bureau of Economic Analysis, Light Weight Vehicle Sales: Autos and Light Trucks [ALTSALES], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/ALTSALES, October 15, 2020.	
Title:	Title:
Light Weight Vehicle Sales: Autos and Light Trucks	**Total Vehicle Sales**
Source:	Source:
U.S. Bureau of Economic Analysis	U.S. Bureau of Economic Analysis
Release:	Release:
Supplemental Estimates, Motor Vehicles	Supplemental Estimates, Motor Vehicles
Units:	Units:
Millions of Units	Millions of Units
Frequency:	Frequency:
Monthly	Monthly
Seasonal Adjustment:	Seasonal Adjustment:
Seasonally Adjusted Annual Rate	Seasonally Adjusted Annual Rate



Decomposing Automotive Sales

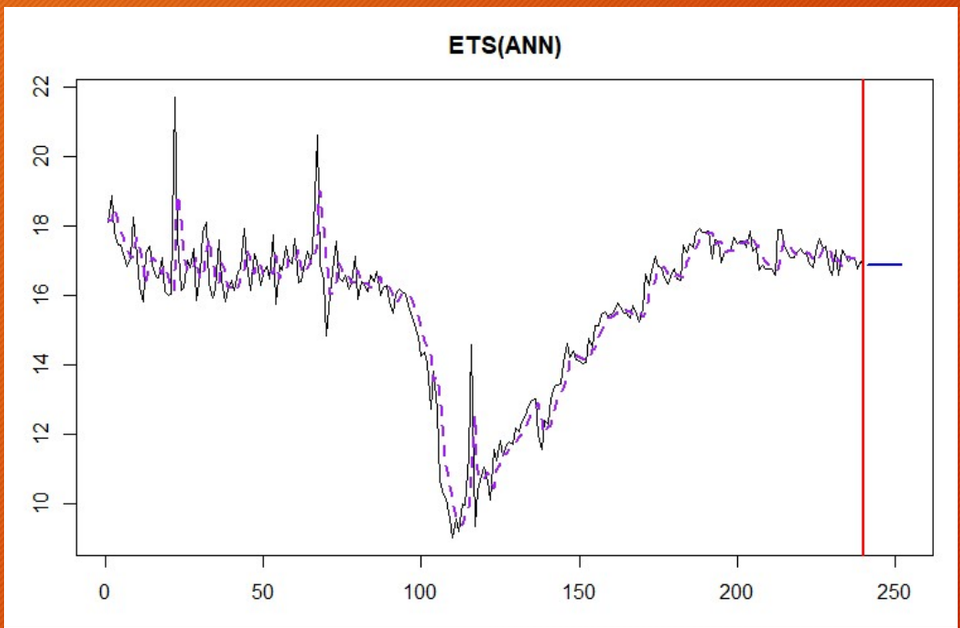


Methodology

1. A baseline for expected 2020 sales was set using baseline for data through 2019.
2. Actual sales were compare to the baseline to quantify the sales gap.
3. A regression was used to determine the relationship between economic drivers and automotive sales.
4. The change in the economic drivers vs. expectations were used to allocate the gap to various dynamics in the economy.

2.235 Million Lost Light Auto Sales

Exponential Smoothing Model



Actual Sales vs. Expected

DATE	LtWgtSales		
Jan-20	16.865		
Feb-20	16.765		
Mar-20	11.354	16.879	5.525
Apr-20	8.714	16.879	8.165
May-20	12.104	16.879	4.775
Jun-20	13.009	16.879	3.870
Jul-20	14.624	16.879	2.255
Aug-20	15.183	16.879	1.696
Sep-20	16.341	16.879	0.538
			2.235

Candidate for Explanatory Variables

Domestic Auto Production
- Domestic auto production is defined as all autos assembled in the U.S. (Thousands of Units, Monthly, Not Seasonally Adjusted)

Employment
- All Employees, Total Nonfarm, Thousands of Persons, Monthly, Seasonally Adjusted

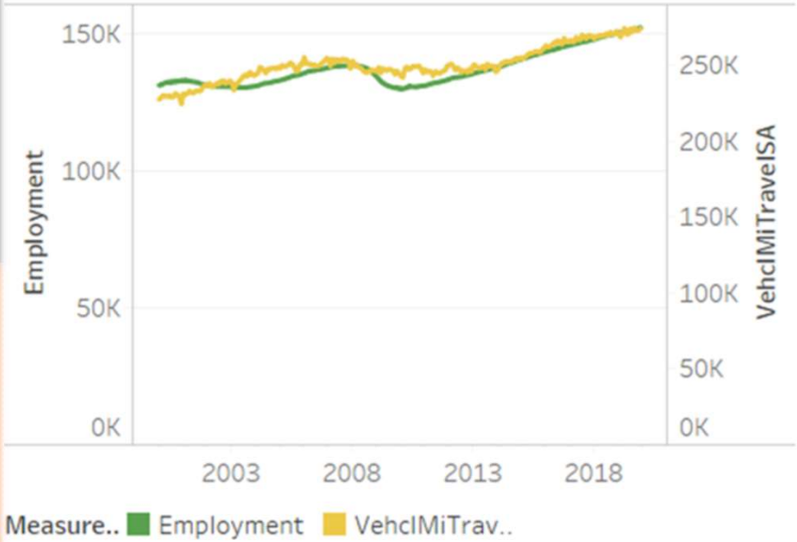
Oil Prices
- Crude Oil Prices: Brent - Europe, Dollars per Barrel, Monthly, Not Seasonally Adjusted

Vehicle Miles Traveled
- Vehicle Miles Traveled and the 12-Month Moving Vehicle Miles Traveled

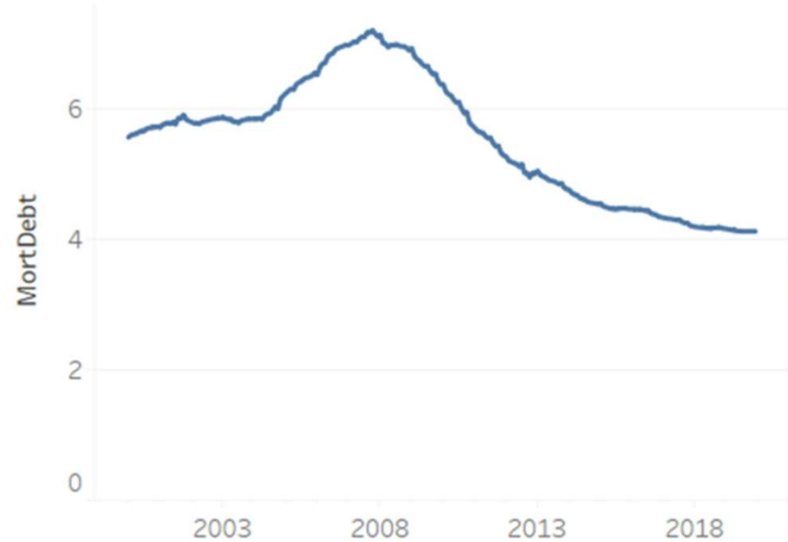
Mortgage Debt Service Burden
- Monthly mortgage payments (Seasonally Adjusted)

Inventory to Sales Ratio
- Monthly inventory divided monthly sales

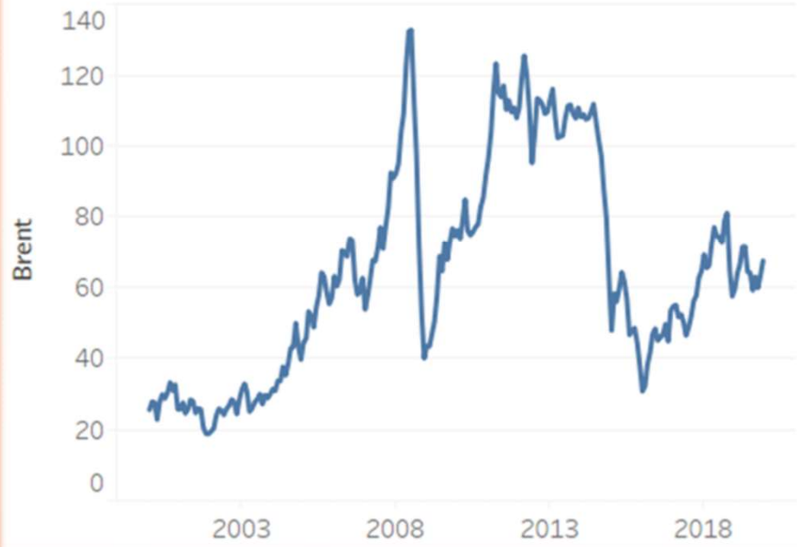
Mi Traveled vs Emp.



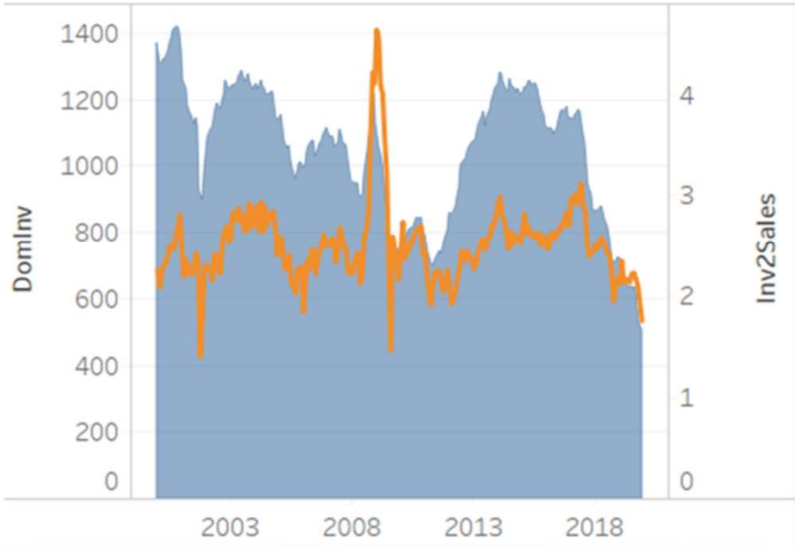
Mort DSB



Brent Prices



Inventory to Sales



Candidate Equations

Model 1

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-1.800e+01	2.683e+00	-6.708	1.48e-10 ***
Employment	1.019e-04	2.473e-05	4.119	5.28e-05 ***
Inv2Sales	-1.434e+00	1.575e-01	-9.103	< 2e-16 ***
VehclMiTravelSA	7.722e-05	1.483e-05	5.208	4.19e-07 ***
Brent	-2.623e-02	2.202e-03	-11.912	< 2e-16 ***
DomProdSA	2.092e-02	1.161e-03	18.020	< 2e-16 ***
MortDebt	-1.735e-01	8.460e-02	-2.051	0.0414 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.917 on 233 degrees of freedom
Multiple R-squared: 0.8335, **Adjusted R-squared: 0.8292**
F-statistic: 194.4 on 6 and 233 DF, p-value: < 2.2e-16

Model 2

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	1.248e+01	3.215e+00	3.881	0.000136 ***
Employment	2.226e-04	3.676e-05	6.056	5.52e-09 ***
Inv2Sales	-2.215e+00	2.338e-01	-9.476	< 2e-16 ***
VehclMiTravelSA	-6.874e-05	1.917e-05	-3.586	0.000409 ***
Brent	-3.690e-02	3.274e-03	-11.271	< 2e-16 ***
MortDebt	-3.696e-01	1.295e-01	-2.853	0.004716 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.416 on 234 degrees of freedom
Multiple R-squared: 0.6015, **Adjusted R-squared: 0.593**
F-statistic: 70.64 on 5 and 234 DF, p-value: < 2.2e-16

Model 3

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-2.428e+01	3.012e+00	-8.062	3.86e-14 ***
Employment	1.076e-04	2.873e-05	3.746	0.000227 ***
VehclMiTravelSA	8.066e-05	1.722e-05	4.684	4.77e-06 ***
Brent	-2.061e-02	2.456e-03	-8.393	4.53e-15 ***
DomProdSA	2.383e-02	1.297e-03	18.377	< 2e-16 ***
MortDebt	-2.199e-01	9.811e-02	-2.242	0.025914 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.065 on 234 degrees of freedom
Multiple R-squared: 0.7743, **Adjusted R-squared: 0.7695**
F-statistic: 160.6 on 5 and 234 DF, p-value: < 2.2e-16

Adjusted Candidate Equations

Model 4

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-1.894e+01	2.644e+00	-7.165	1.01e-11 ***
Employment	9.462e-05	2.465e-05	3.839	0.000159 ***
log(Inv2Sales)	-3.867e+00	4.173e-01	-9.266	< 2e-16 ***
VehclMiTravelSA	8.377e-05	1.476e-05	5.677	4.05e-08 ***
Brent	-2.581e-02	2.177e-03	-11.853	< 2e-16 ***
DomProdSA	2.181e-02	1.132e-03	19.276	< 2e-16 ***
MortDebt	-1.912e-01	8.411e-02	-2.274	0.023905 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9127 on 233 degrees of freedom
Multiple R-squared: 0.8351, **Adjusted R-squared: 0.8308**

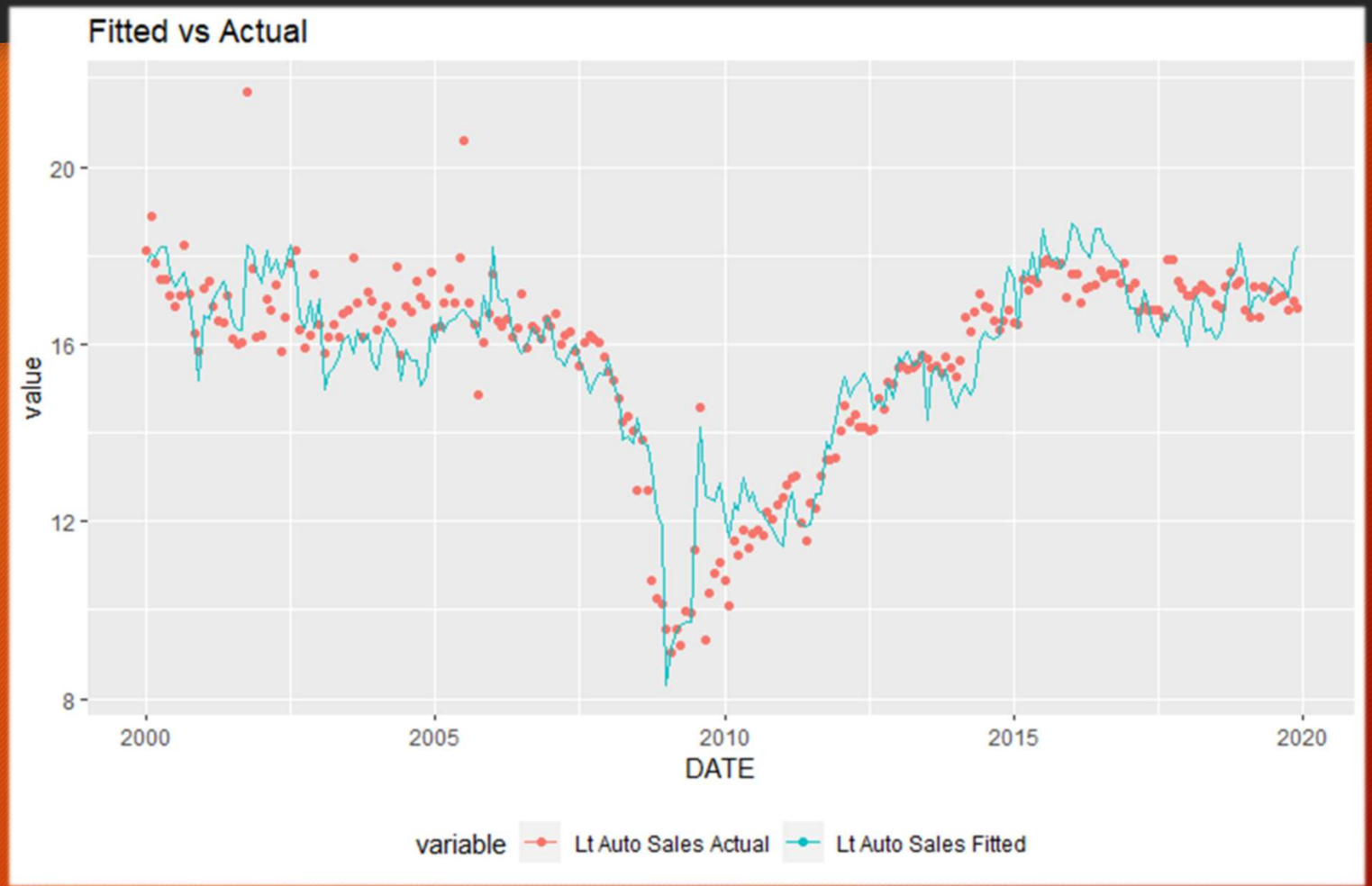
Model 5

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-2.509e+02	4.153e+01	-6.041	6.00e-09 ***
Employment	9.955e-05	2.374e-05	4.193	3.91e-05 ***
log(Inv2Sales)	-3.914e+00	4.170e-01	-9.387	< 2e-16 ***
log(VehclMiTravelSA)	2.030e+01	3.537e+00	5.741	2.91e-08 ***
Brent	-2.626e-02	2.184e-03	-12.028	< 2e-16 ***
DomProdSA	2.168e-02	1.115e-03	19.455	< 2e-16 ***
MortDebt	-1.996e-01	8.397e-02	-2.377	0.0183 *

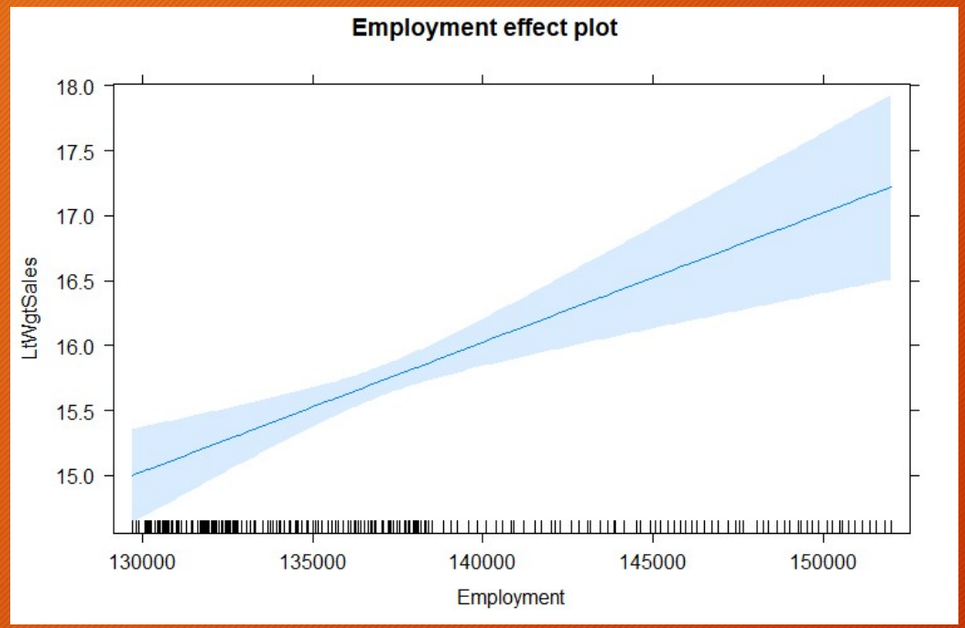
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

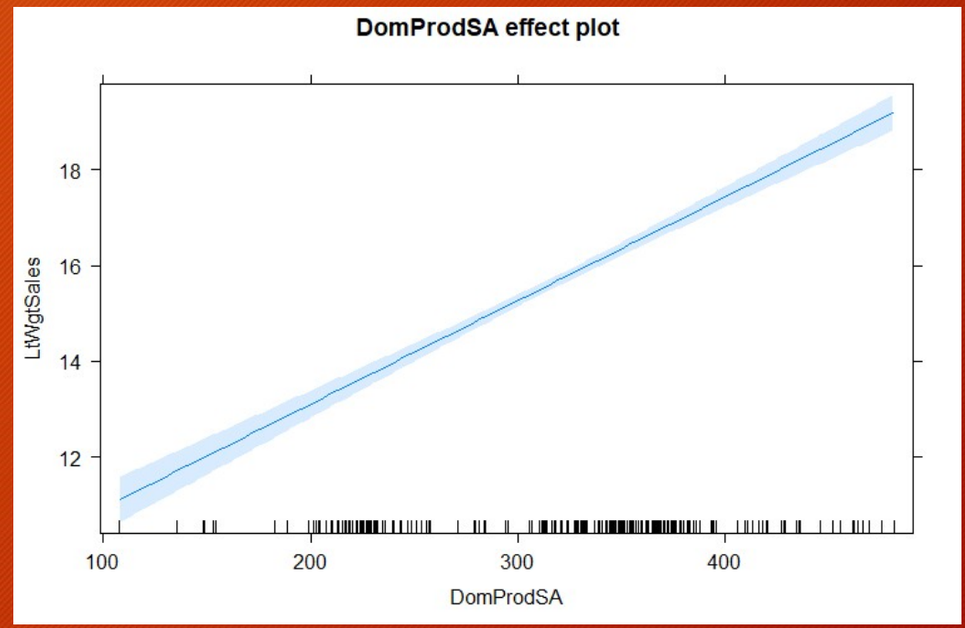
Residual standard error: 0.9115 on 233 degrees of freedom
Multiple R-squared: 0.8355, **Adjusted R-squared: 0.8313**
F-statistic: 197.3 on 6 and 233 DF, p-value: < 2.2e-16

Fitted vs Actual

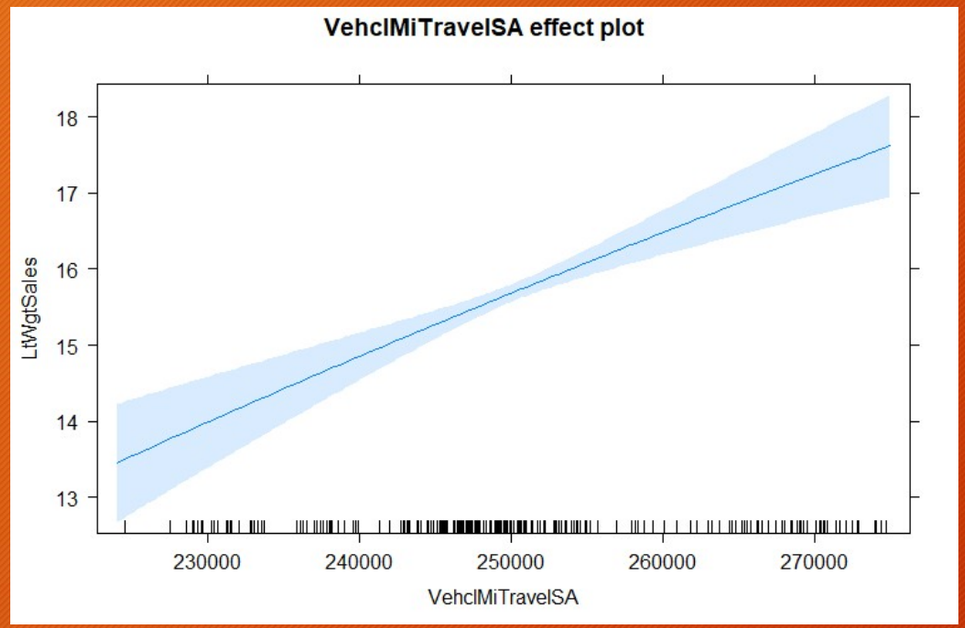


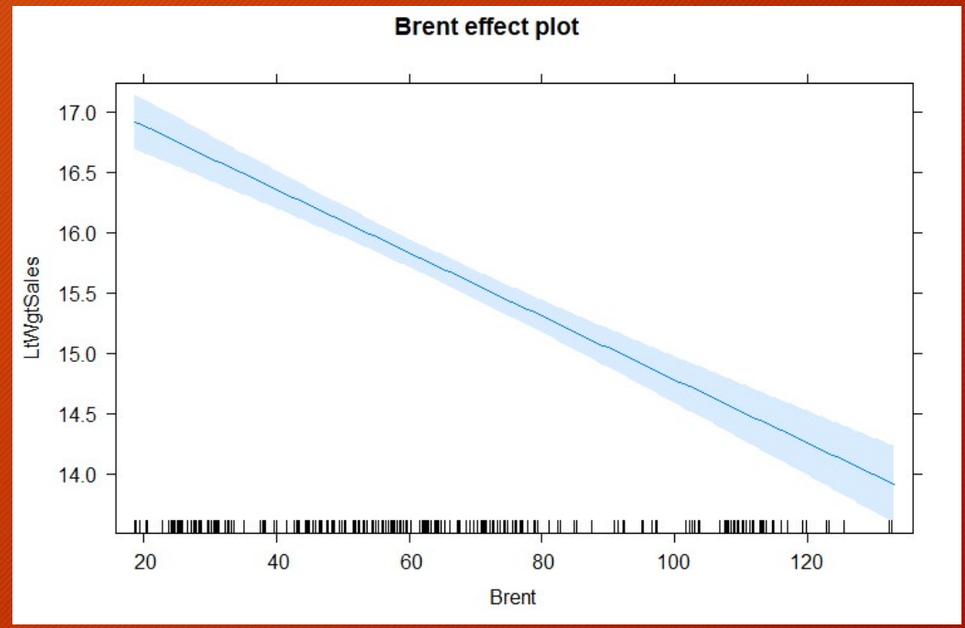
Explanatory Variables



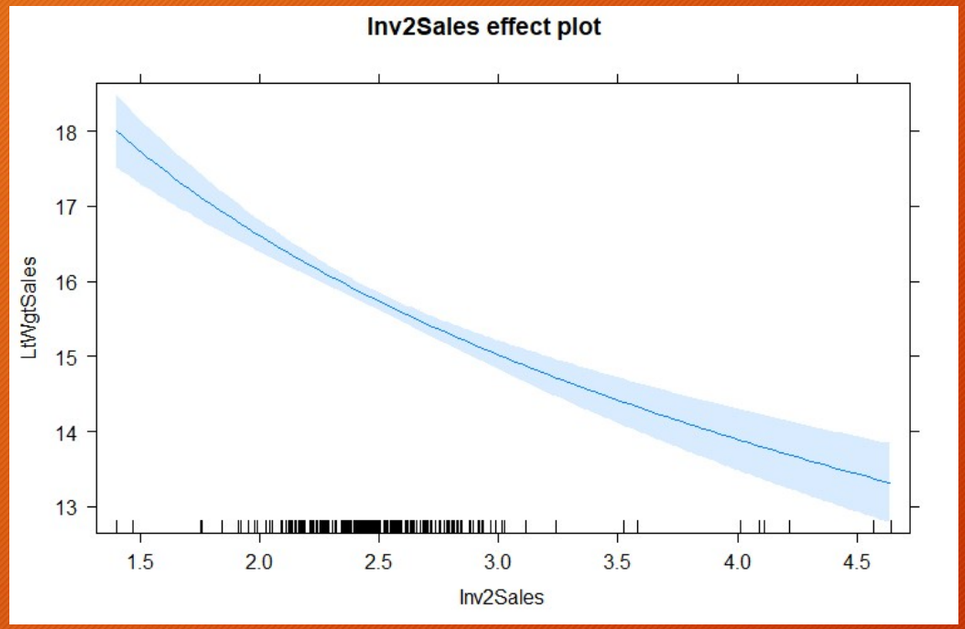


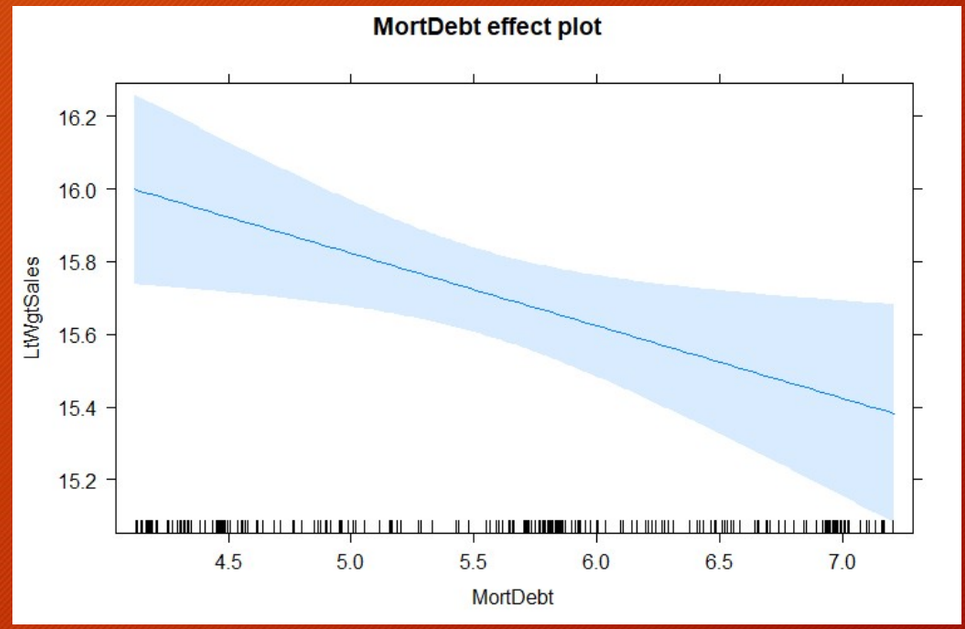
Explanatory Variables



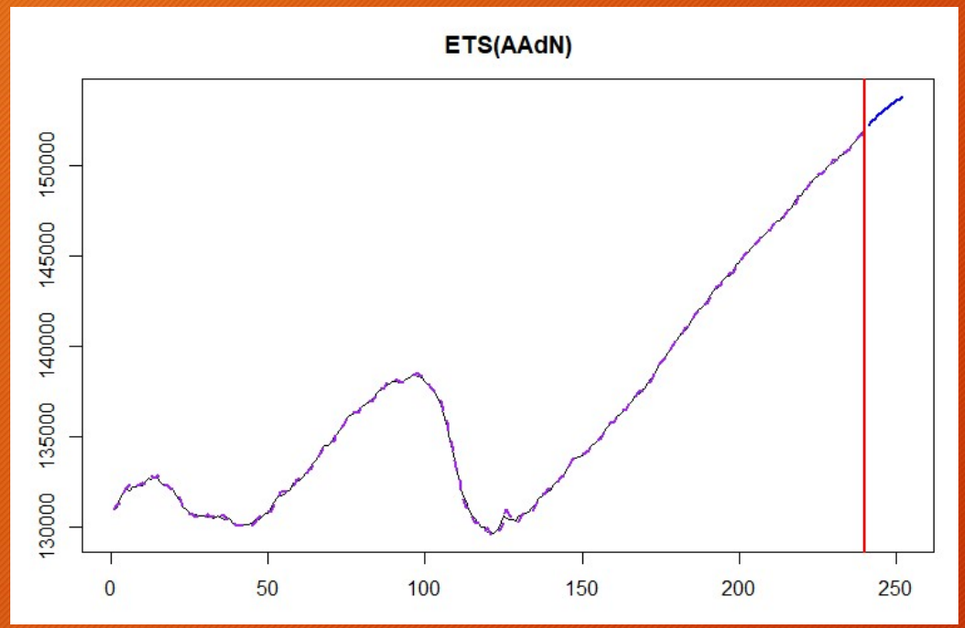


Explanatory Variables



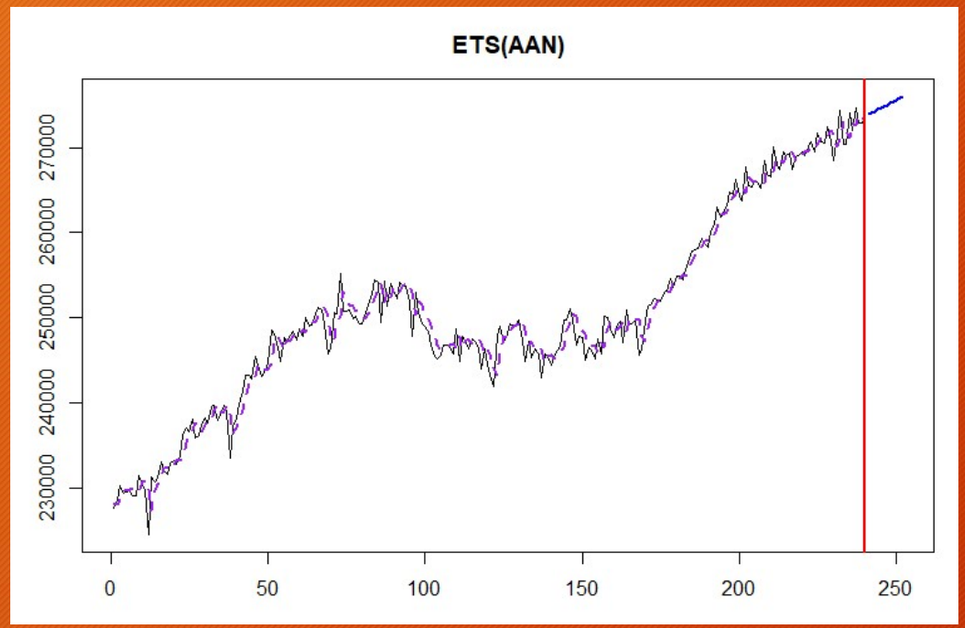


800k Loss due to Unemployment



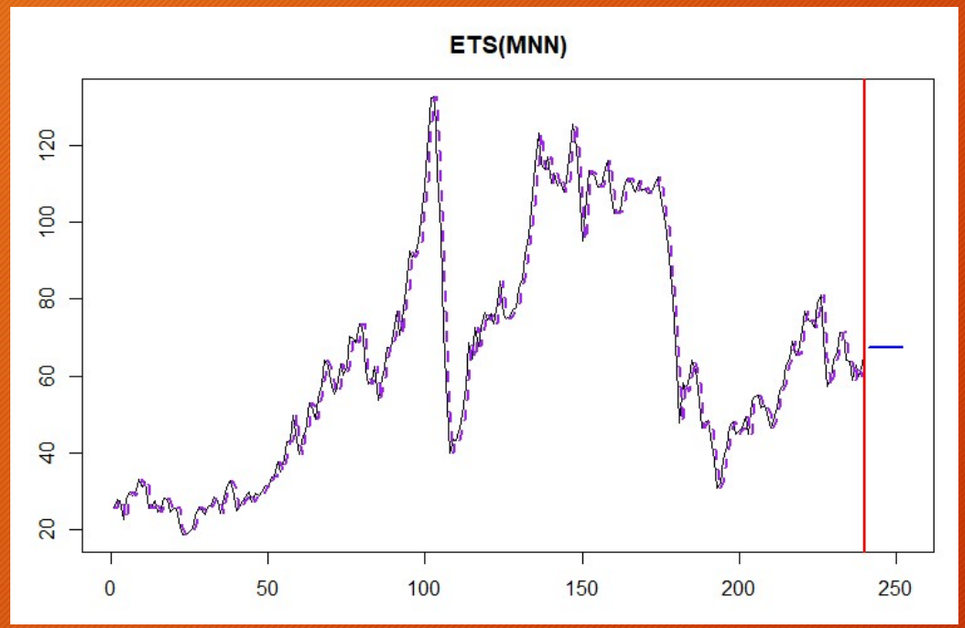
DATE	PAYEMS			0.0000996
Jan-20	152,212	152,190		
Feb-20	152,463	152,371		
Mar-20	151,090	152,544	1,454	0.145
Apr-20	130,303	152,708	22,405	2.230
May-20	133,028	152,865	19,837	1.975
Jun-20	137,809	153,014	15,205	1.514
Jul-20	139,570	153,156	13,586	1.352
Aug-20	141,059	153,291	12,232	1.218
Sep-20	141,720	153,419	11,699	1.165
				0.800

1.14 Million lost due to Fewer Miles Traveled



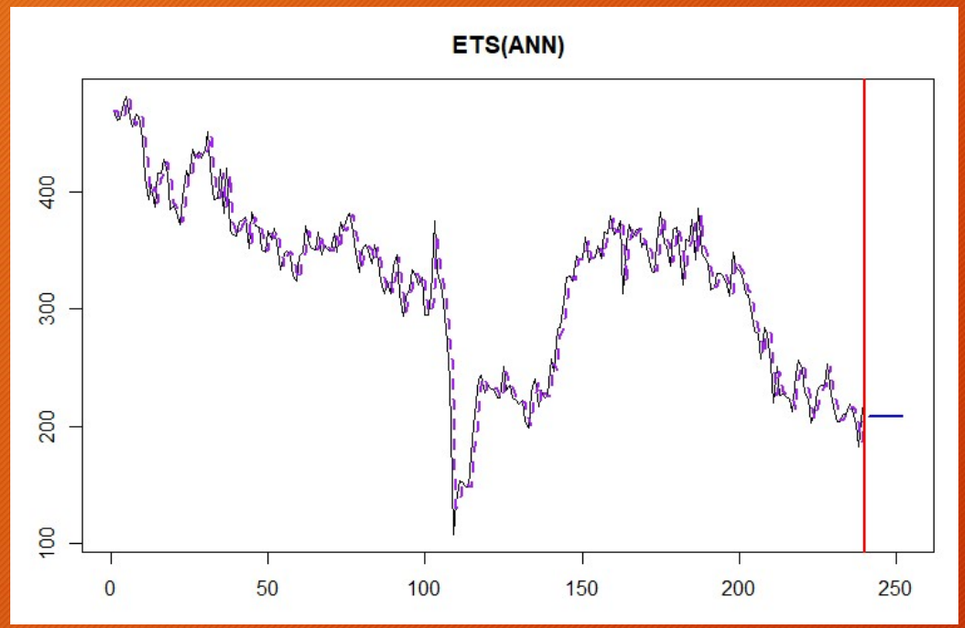
DATE	TRFVOLUSM227SFWA			20.30
Jan-20	275,502	273,904		
Feb-20	275,060	274,095		
Mar-20	219,962	274,286	0.0959	1.946
Apr-20	161,497	274,477	0.2303	4.676
May-20	199,733	274,668	0.1384	2.809
Jun-20	230,466	274,858	0.0765	1.553
Jul-20	239,668	275,049	0.0598	1.214
Aug-20	248,870	275,240	0.0437	0.888
Sep-20	258,072	275,431	0.0283	0.574
				1.138

486k increase due to Lower Oil Prices



DATE	MCOILBRENTEU			(0.026)
Jan-20	63.65	67.31		
Feb-20	55.66	67.31		
Mar-20	32.01	67.31	35.30	(0.927)
Apr-20	18.38	67.31	48.93	(1.285)
May-20	29.38	67.31	37.93	(0.996)
Jun-20	40.27	67.31	27.04	(0.710)
Jul-20	43.24	67.31	24.07	(0.632)
Aug-20	44.74	67.31	22.57	(0.593)
Sep-20	40.91	67.31	26.40	(0.693)
				-0.486

839k lost due to Lower Auto Production



DATE	DAUPSA			0.022
Jan-20	217.7	207.8342		
Feb-20	224.3	207.8342		
Mar-20	150.2	207.8342	57.63	1.250
Apr-20	1.7	207.8342	206.13	4.469
May-20	46.5	207.8342	161.33	3.498
Jun-20	138.1	207.8342	69.73	1.512
Jul-20	222.0	207.8342	(14.17)	(0.307)
Aug-20	214.0	207.8342	(6.17)	(0.134)
Sep-20	218.0	207.8342	(10.17)	(0.220)
				0.839

Putting the Pieces Together

800,000 due to unemployment
1,400,000 due to less travel
-486,000 due to lower oil prices
839,000 due to auto lower production
318,000 due to unexplained factors
2,235,000 Total reduction

Next Steps

- Follow-up study next year to determine how many sales were clawed back over time
- Estimate long term change in automotive demand