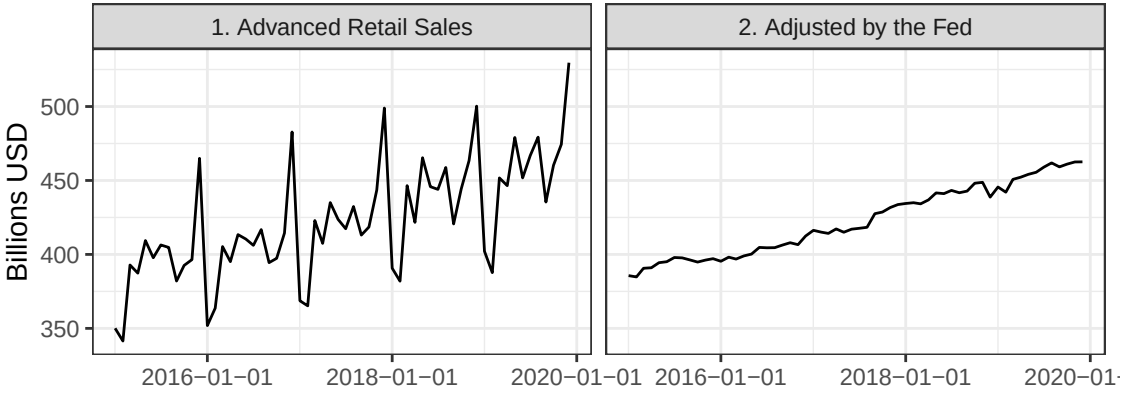
Today's Agenda

Fitting and evaluating linear trend models with seasonality effects

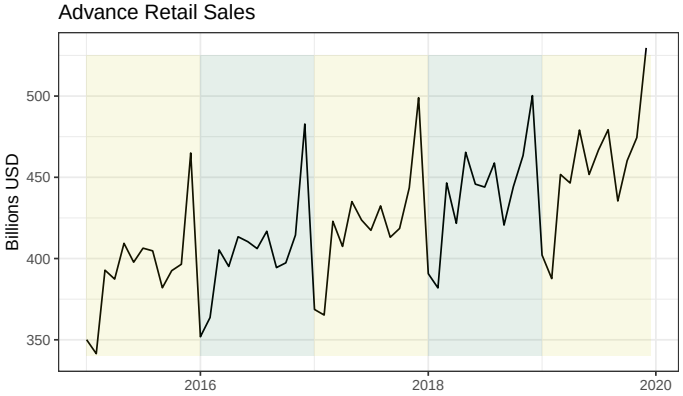
- Dataset: Advanced Retail Sales

Justin Leinaweaver (Spring 2022)

date	year	month	advance_retail_sales	advance_retail_sales_adj
16436	2015	1	350.067	385.672
16467	2015	2	341.459	384.783
16495	2015	3	392.848	390.642



"Seasonality is a characteristic of a time series in which the data experiences regular and predictable changes that recur every calendar year" (Investopedia 2020).



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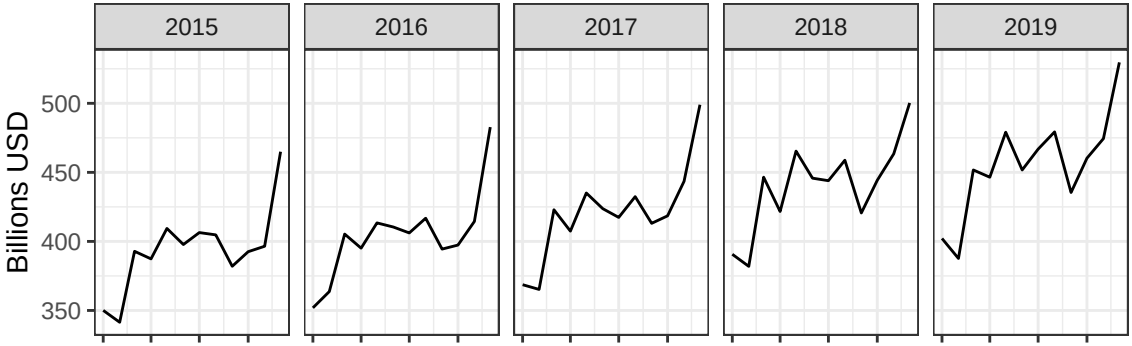

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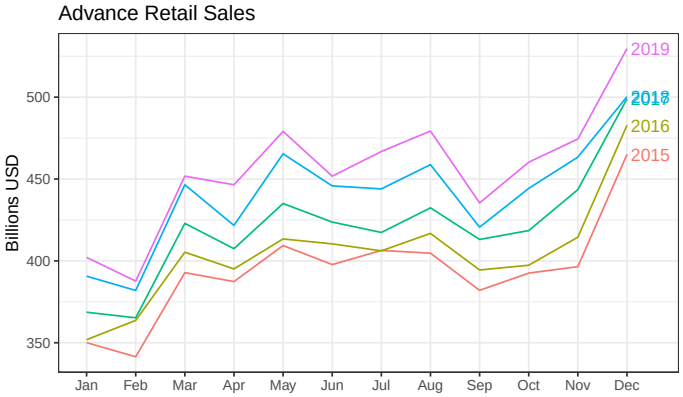
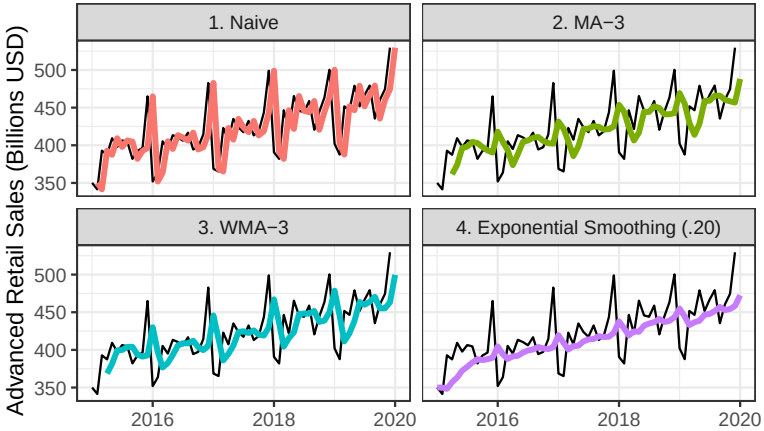




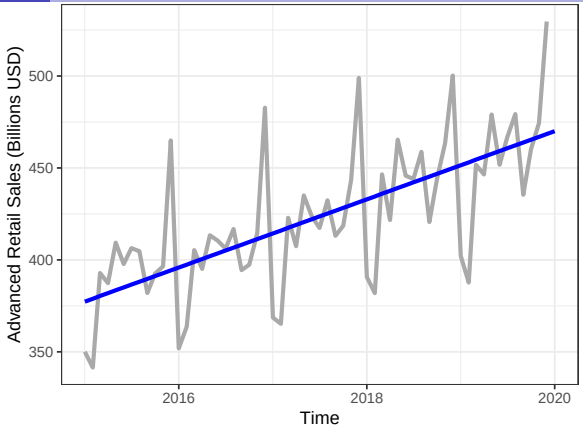
Tools	MSE
Naive	1629
MA-3	1289
WMA-3	1310
ExpSmth (.2)	1075

Model 1

Regress advanced retail sales on time period

1. Fit the model (Time period = 1:60)
2. Visualize the model (line plot)
3. Predict the next 12 months

	Retail Sales
Time	1.54*
	(0.22)
Constant	375.76*
	(7.62)
Observations	60
Adjusted R^2	0.46
Residual Std. Error	29.13 (df = 58)
F Statistic	50.61* (df = 1; 58)
Note:	*p<0.05



Sales = 375.76 + 1.54 x Time

- Time = 61, 62, 63, 64, ...

	Retail Sales
Time	1.54*
	(0.22)
Constant	375.76*
	(7.62)
Observations	60
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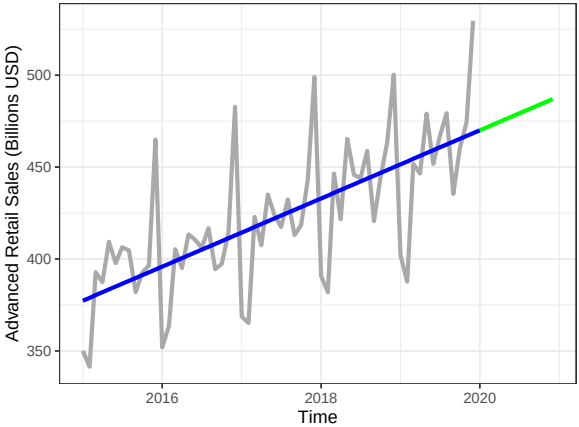
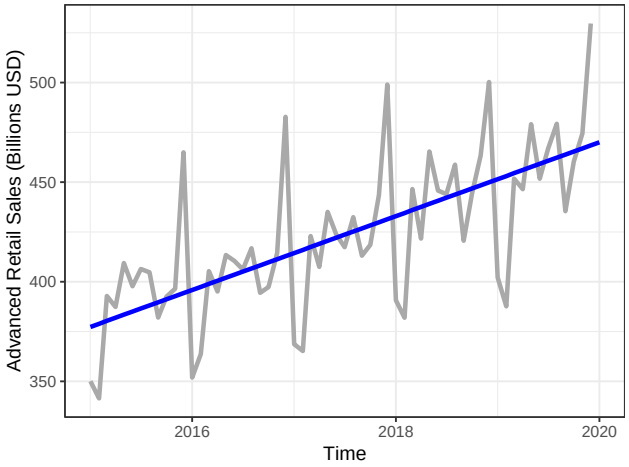


1	2	3	4	5	6	7	8	9	10	11	12
470	472	473	475	476	478	479	481	482	484	485	487

Fitting Linear Trend Models with OLS

Tools	MSE
Naive	1629
WMA-3	1310
MA-3	1289
ExpSmth (.2)	1075
OLS Time	820



Model 2: Regress advanced retail sales on time period and season dummies

1. Fit the model
    - Time period = 1:60
    - Spring = '1' if Apr, May, Jun
    - Summer = '1' if Jul, Aug, Sep
    - Fall = '1' if Oct, Nov, Dec
2. Visualize the model (line plot)
3. Predict the next 12 months

Fitting Linear Trend Models with OLS

	A	B	C	D	E	F	G	H
1	date	year	month	advance_retail_sales	Time	Spring	Summer	Fall
2	2015-01-01	2015	1	350.067	1			
3	2015-02-01	2015	2	341.459	2			
4	2015-03-01	2015	3	392.848	3			
5	2015-04-01	2015	4	387.352	4			
6	2015-05-01	2015	5	409.376	5			
7	2015-06-01	2015	6	397.752	6			
8	2015-07-01	2015	7	406.393	7			
9	2015-08-01	2015	8	404.729	8			
10	2015-09-01	2015	9	382.02	9			
11	2015-10-01	2015	10	392.545	10			
12	2015-11-01	2015	11	396.49	11			
13	2015-12-01	2015	12	464.962	12			

Fitting Linear Trend Models with OLS

	date	year	month	advance_retail_sales	Time	Spring	Summer	Fall
2	2015-01-01	2015	1	350.067	1	0		
3	2015-02-01	2015	2	341.459	2	0		
4	2015-03-01	2015	3	392.848	3	0		
5	2015-04-01	2015	4	387.352	4	1		
6	2015-05-01	2015	5	409.376	5	1		
7	2015-06-01	2015	6	397.752	6	1		
8	2015-07-01	2015	7	406.393	7	0		
9	2015-08-01	2015	8	404.729	8	0		
10	2015-09-01	2015	9	382.02	9	0		
11	2015-10-01	2015	10	392.545	10	0		
12	2015-11-01	2015	11	396.49	11	0		
13	2015-12-01	2015	12	464.962	12	0		
14	2016-01-01	2016	1	351.89	13			

Fitting Linear Trend Models with OLS

	A	B	C	D	E	F	G	H
1	date	year	month	advance_retail_sales	Time	Spring	Summer	Fall
2	2015-01-01	2015	1	350.067	1	0	0	
3	2015-02-01	2015	2	341.459	2	0	0	
4	2015-03-01	2015	3	392.848	3	0	0	
5	2015-04-01	2015	4	387.352	4	1	0	
6	2015-05-01	2015	5	409.376	5	1	0	
7	2015-06-01	2015	6	397.752	6	1	0	
8	2015-07-01	2015	7	406.393	7	0	1	
9	2015-08-01	2015	8	404.729	8	0	1	
10	2015-09-01	2015	9	382.02	9	0	1	
11	2015-10-01	2015	10	392.545	10	0	0	
12	2015-11-01	2015	11	396.49	11	0	0	
13	2015-12-01	2015	12	464.962	12	0	0	
14	2016-01-01	2016	1	351.89	13			

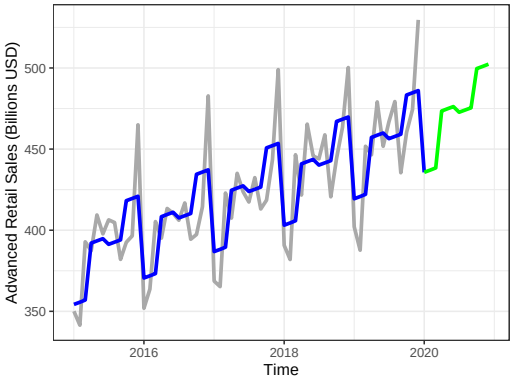
Fitting Linear Trend Models with OLS

	A	B	C	D	E	F	G	H
1	date	year	month	advance_retail_sales	Time	Spring	Summer	Fall
2	2015-01-01	2015	1	350.067	1	0	0	0
3	2015-02-01	2015	2	341.459	2	0	0	0
4	2015-03-01	2015	3	392.848	3	0	0	0
5	2015-04-01	2015	4	387.352	4	1	0	0
6	2015-05-01	2015	5	409.376	5	1	0	0
7	2015-06-01	2015	6	397.752	6	1	0	0
8	2015-07-01	2015	7	406.393	7	0	1	0
9	2015-08-01	2015	8	404.729	8	0	1	0
10	2015-09-01	2015	9	382.02	9	0	1	0
11	2015-10-01	2015	10	392.545	10	0	0	1
12	2015-11-01	2015	11	396.49	11	0	0	1
13	2015-12-01	2015	12	464.962	12	0	0	1
14	2016-01-01	2016	1	351.89	13			

Model 2: Regress advanced retail sales on time period and season dummies

1. Fit the model
    - Time period = 1:60
    - Spring = '1' if Apr, May, Jun
    - Summer = '1' if Jul, Aug, Sep
    - Fall = '1' if Oct, Nov, Dec
2. Visualize the model (line plot)
3. Predict the next 12 months

	Retail Sales
Time	1.36*
	(0.17)
Spring	33.73*
	(8.43)
Summer	28.89*
	(8.47)
Fall	51.73*
	(8.56)
Constant	352.90*
	(7.49)
Observations	60
Adjusted R^2	0.66
Residual Std. Error	23.03 (df = 55)
F Statistic	29.70* (df = 4; 55)
Note:	*p<0.05

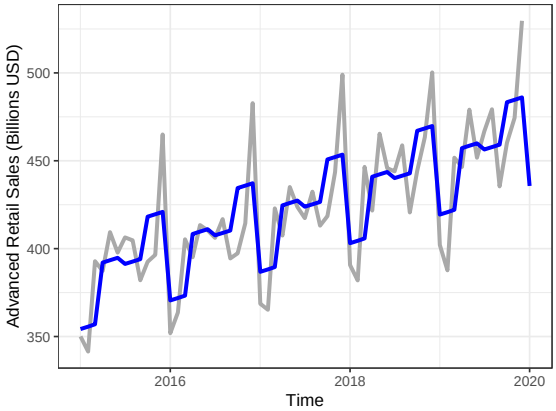


Predictions

c(436, 437, 438, 473, 475, 476, 473, 474, 475, 500, 501, 502)

Fitting Linear Trend Models with OLS

Tools	MSE
Naive	1629
WMA-3	1310
MA-3	1289
ExpSmth (.2)	1075
OLS Time	820
OLS Time and Season	486



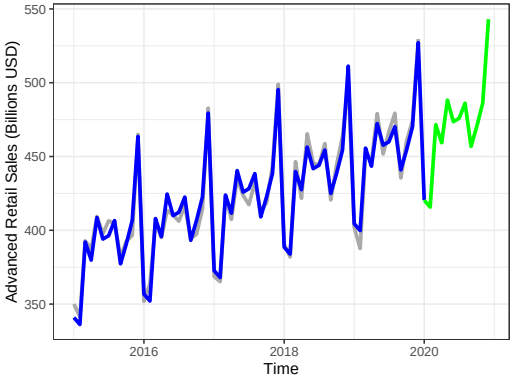
Model 3: Regress advanced retail sales on time period and monthly dummies

1. Fit the model
    - Time period = 1:60
    - Month dummies (x 11)
2. Visualize the model (line plot)
3. Predict the next 12 months

Fitting Linear Trend Models with OLS

	A	B	C	D	E	F	G	H	I
1	date	year	month	advance_retail_sales	Time	Feb	Mar	Apr	May
2	2015-01-01	2015	1	350.067	1	0	0	0	0
3	2015-02-01	2015	2	341.459	2	1	0	0	0
4	2015-03-01	2015	3	392.848	3	0	1	0	0
5	2015-04-01	2015	4	387.352	4	0	0	1	0
6	2015-05-01	2015	5	409.376	5	0	0	0	1
7	2015-06-01	2015	6	397.752	6	0	0	0	0
8	2015-07-01	2015	7	406.393	7	0	0	0	0
9	2015-08-01	2015	8	404.729	8	0	0	0	0
10	2015-09-01	2015	9	382.02	9	0	0	0	0
11	2015-10-01	2015	10	392.545	10	0	0	0	0
12	2015-11-01	2015	11	396.49	11	0	0	0	0
13	2015-12-01	2015	12	464.962	12	0	0	0	0
14	2016-01-01	2016	1	351.89	13				

	Retail Sales
Time	1.33*
	(0.05)
Constant	339.55*
	(3.31)
Observations	60
Adjusted R^2	0.97
Residual Std. Error	6.81 (df = 47)
F Statistic	161.59* (df = 12; 47)
Note:	*p<0.05

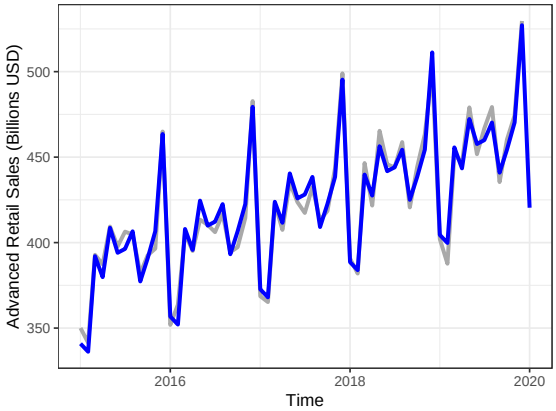


Predictions = 420, 416, 472, 459, 488, 474, 476, 486, 457, 470, 486, 543

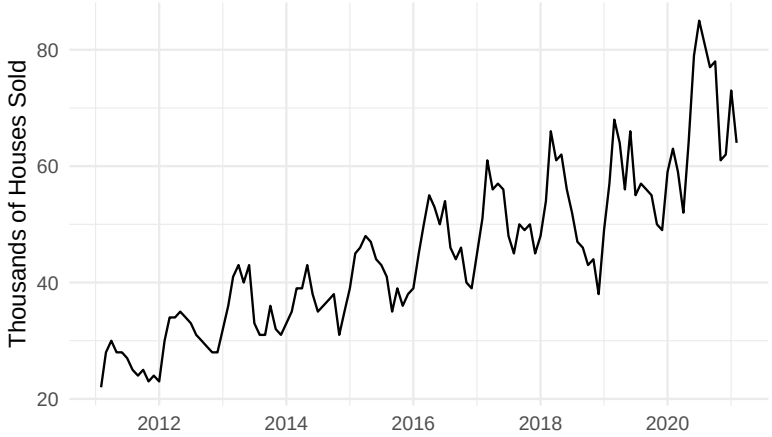
- Month coefficients omitted from the table.

Fitting Linear Trend Models with OLS

Tools	MSE
Naive	1629
WMA-3	1310
MA-3	1289
ExpSmth (.2)	1075
OLS Time	820
OLS Time and Season	486
OLS Time and Month	36

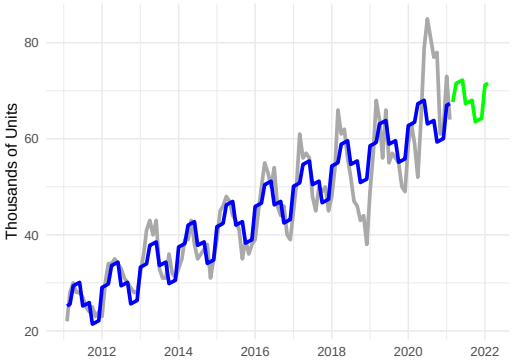


Predict the next 12 months of new home sales



Regress new home sales on time and season dummies

	New Home Sales
Time	0.35*
	(0.01)
Spring	3.50*
	(1.44)
Summer	−1.76
	(1.44)
Fall	−6.58*
	(1.44)
Constant	24.84*
	(1.35)
Observations	121
Adjusted R^2	0.83
Residual Std. Error	5.62 (df = 116)
F Statistic	151.41* (df = 4; 116)
Note:	*p<0.05



	New Home Sales
Time	0.35*
	(0.01)
Spring	3.50*
	(1.44)
Summer	−1.76
	(1.44)
Fall	−6.58*
	(1.44)
Constant	24.84*
	(1.35)
Observations	121
Adjusted R^2	0.83
Residual Std. Error	5.62 (df = 116)
F Statistic	151.41* (df = 4; 116)
Note:	*p<0.05

Time	Date	Predictions
122	2021-03-01	68
123	2021-04-01	72
124	2021-05-01	72
125	2021-06-01	72
126	2021-07-01	67
127	2021-08-01	68
128	2021-09-01	68
129	2021-10-01	64
130	2021-11-01	64
131	2021-12-01	64
132	2022-01-01	71
133	2022-02-01	72