MS4212 - Group 23

Price of Private Domestic Premises

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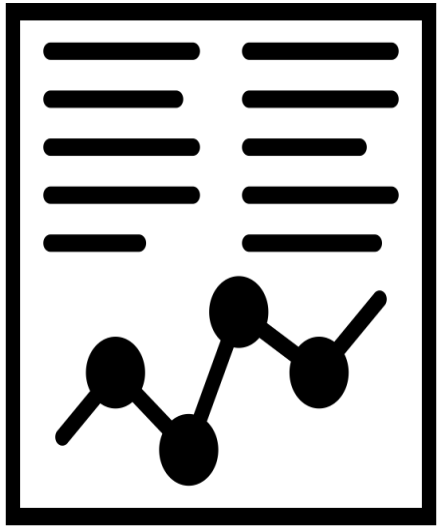
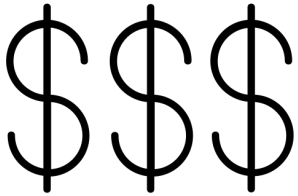
Agenda

- ❏ Introduction
- ❏ Literature Review
- ❏ Methodology
- ❏ Results
- ❏ Conclusion
- ❏ Recommendations

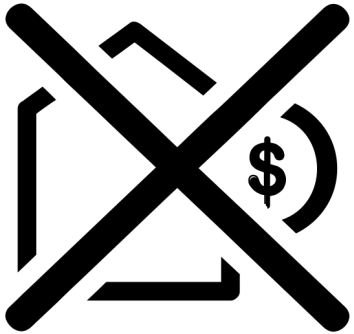


Introduction

Property prices - high & keep surging



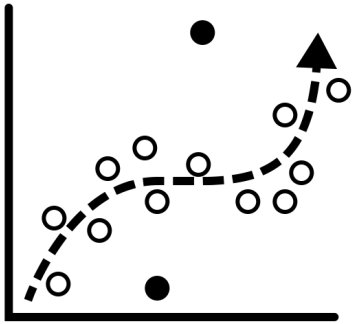
World's Most Unaffordable (consecutive 8-year)



1/4 residents not able to afford a house

Introduction

80% (106 Periods): Analysis	20% (26 Periods): Estimation

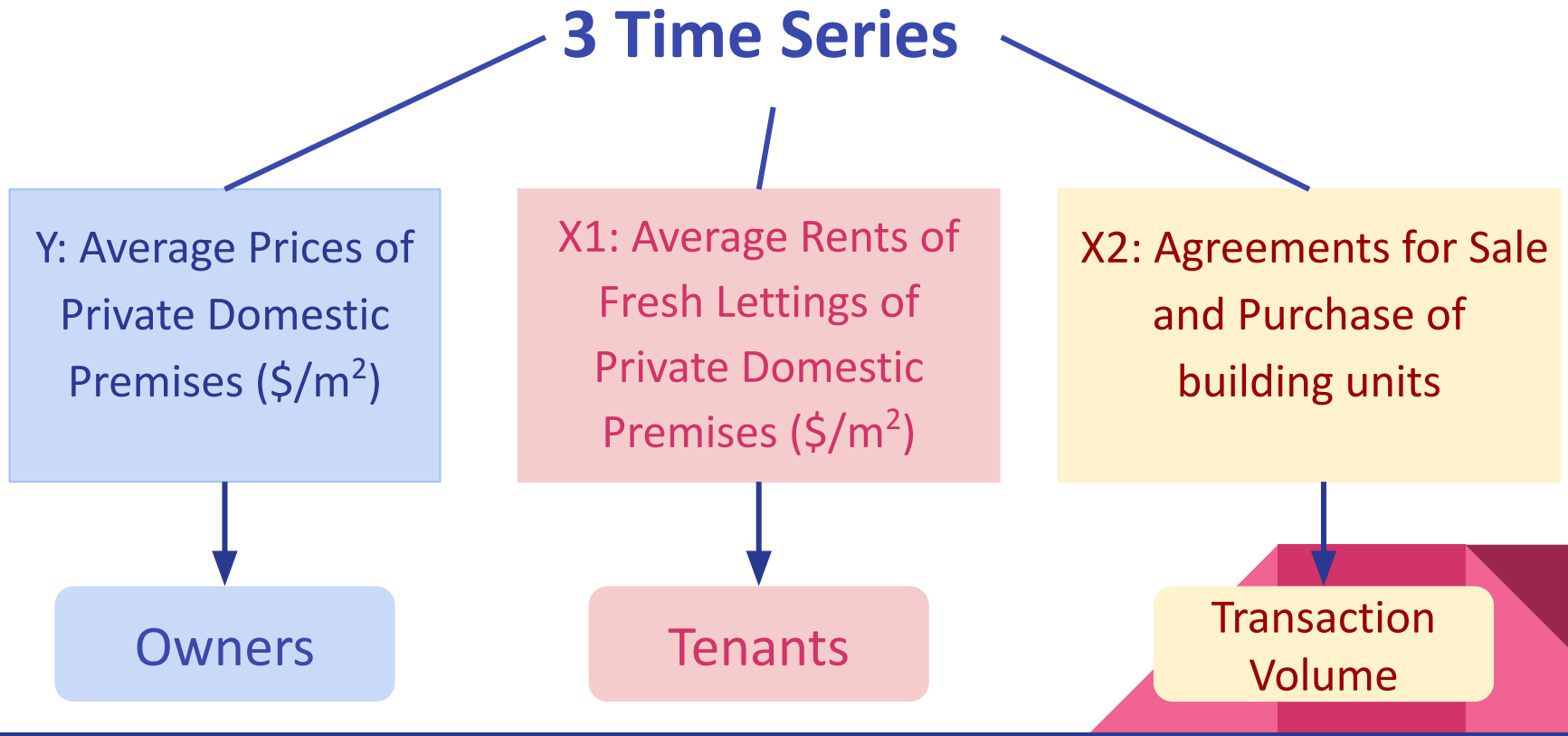


- **Compute error statistics**

→ examine different model's accuracy

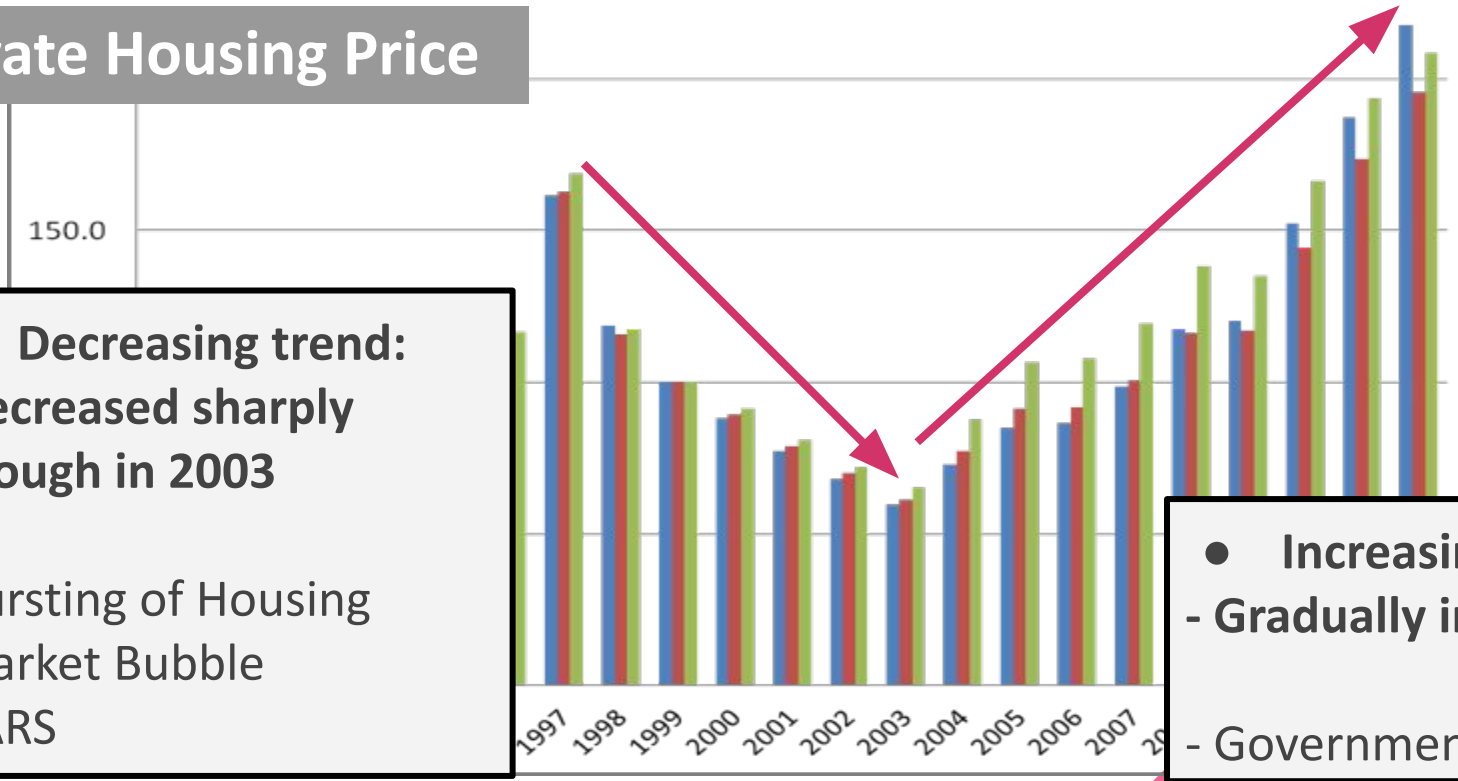
Introduction

- **Focus: Private Housing Market**



Literature Review (1997 and after)

Private Housing Price



- **Decreasing trend:**

- Decreased sharply

- Trough in 2003

- Bursting of Housing Market Bubble
- SARS

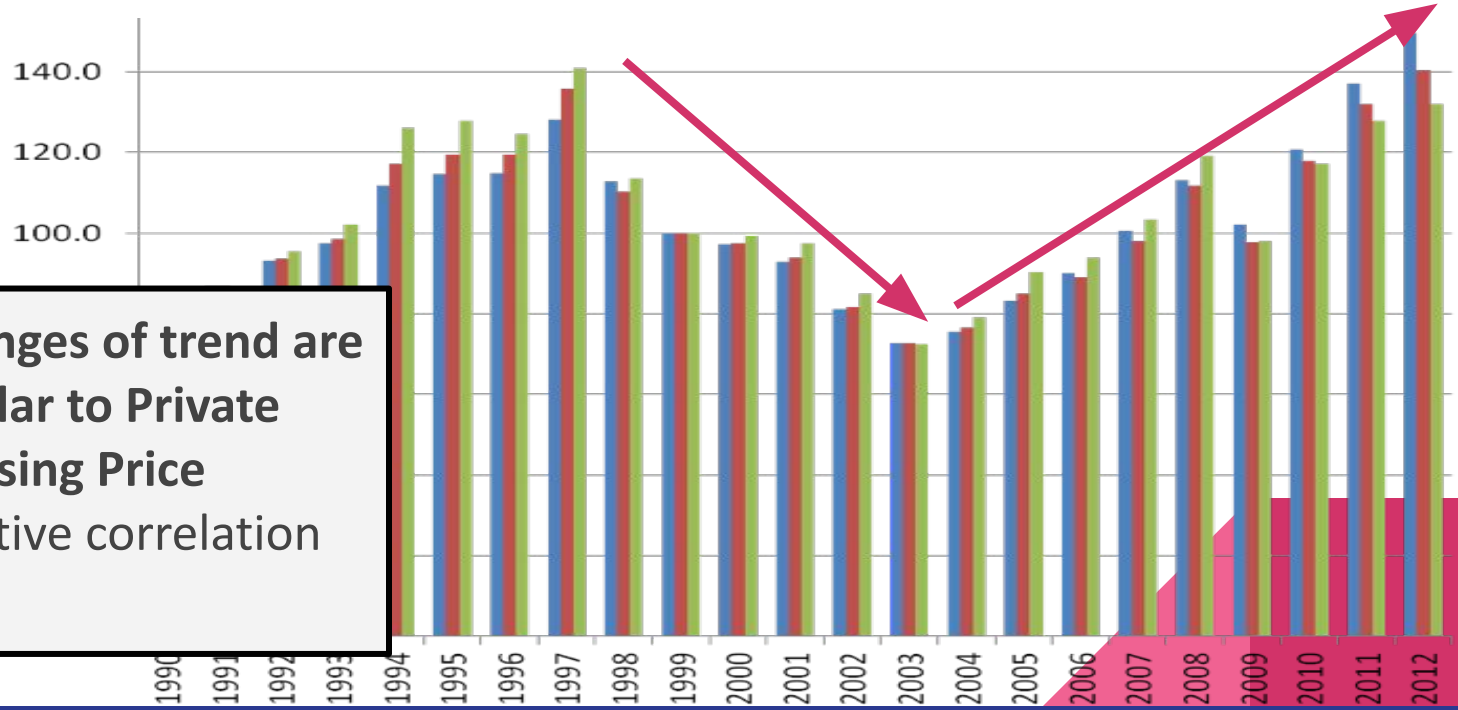
- **Increasing trend:**

- Gradually increased

- Government policies

Literature Review (1997 and after)

Private Housing Rental Price

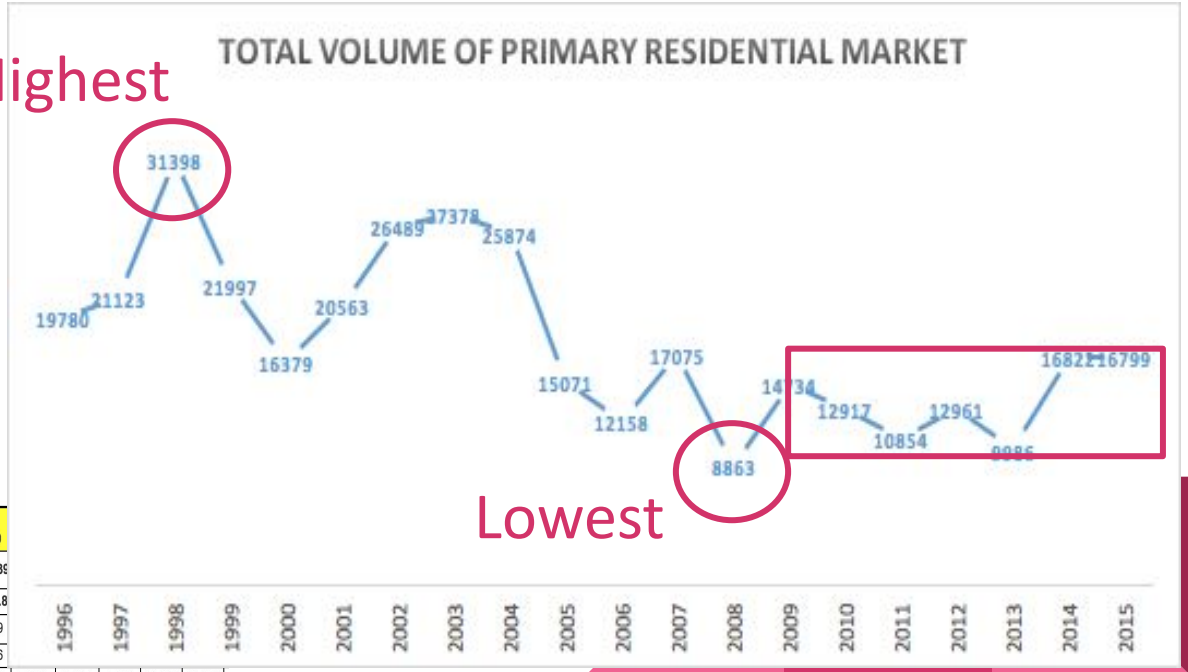


- **Changes of trend are similar to Private Housing Price**
- Positive correlation

Literature Review (1997 and after)

Volume of Primary Residential Transactions

- **Fluctuated**
- 1998: highest
- 2008: lowest
- >2006: less dynamic fluctuations



		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
roperties		147,423	205,461	111,489	98,466	85,744	88,190	85,921	87,309	123,480	123,697	99,087	145,691	113,298	133,962	162,739
operties($100M)		4,746.6	8,680.2	3,409.1	2,566.4	2,225.2	1,928.1	1,853.9	1,894.2	3,517.9	3,955.1	3,152.0	5,256.3	4,131.1	5,157.0	6,894.8
Private	HK	2,314	2,239	1,688	2,653	3,035	3,757	2,231	4,023	4,086	2,922	1,316	2,746	472	1,164	2,019
	KLN	2,259	3,400	6,433	4,443	3,107	4,717	9,387	6,709	7,709	4,421	2,691	4,815	2,839	5,688	3,506
	NT	15,207	15,484	23,277	14,901	10,237	12,089	14,871	16,646	14,079	7,728	8,151	9,514	5,552	7,882	7,392
	Total	19,780	21,123	31,398	21,997	16,379	20,563	26,489	27,378	25,874	15,071	12,158	17,075	8,863	14,734	12,917

		7,333	8,314	6,521	11,840	10,968
		10,854	12,961	9,986	16,822	16,799

Methodology

5 forecasting methods:

1. Naive Method
2. Moving Average Method
3. Exponential Smoothing
4. Decomposition Method
5. Regression A - E

Naive Method

Characteristics

- Rely on the actual values of previous periods
- **Simple**
- Time series data only

- **4 more naive models**:
  - Naive trend
  - Naive seasonal
  - Naive trend & seasonal
  - Naive rate of change

→ **Find out seasonal/trend/ both patterns**

Moving Average Method

Characteristics

- Average of any subset of number
- **Smooth out** short-term fluctuations
- **Highlight** long-term trends or cycles

- Short term MA

→ **Sensitive to changes**

- Long term MA

→ **Less sensitive**

→ **Larger smoothing effect**

Moving Average Method

Simple Moving Average	Double Moving Average
● Reduce variability and illuminate systematic patterns	● Further amplify the effects
● Disadvantage: Problem of lagging behind	

Exponential Smoothing

Characteristics	
• **Heavier weights to recent observations** • Weight: 3 smoothing constants (α, β, γ) $\Rightarrow 0 < \alpha, \beta, \gamma < 1$ $\Rightarrow \sum \alpha \cong 1, \quad \sum \beta \cong 1, \quad \sum \gamma \cong 1$	α: Level of the series β: Trend γ: Seasonality

Exponential Smoothing

Simple Exponential Smoothing (α)	Double Exponential Smoothing	Triple Exponential Smoothing (α, β, γ)
• No trend data	• Linear trend data ➔ Brown's method (α) ➔ Holt's method (α, β) • **Different weights** for actual data & trend • Disadvantage: hard to specify 2 parameters	• Trend & seasonal data ➔ Winter's **multiplicative** method ➔ Winter's **additive** method

Decomposition Method

Characteristics

- Decompose the time series into 4 components:

  Trend, Seasonal, Cyclical, Irregular terms

- **2 types:**
  - Additive Decomposition
  - Multiplicative Decomposition

Regression Model

Characteristics

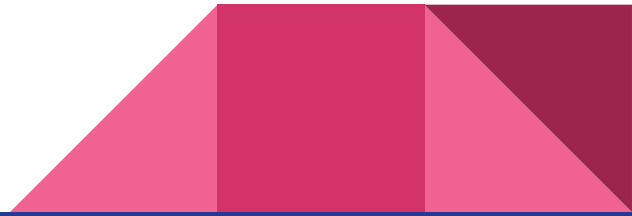
- Consider the lagged independent variable
- Suit in different types of data
- **Identifies autocorrelation**
- **Recognize multicollinearity**

- **Durbin-Watson test statistic**

→ Test for autocorrelation

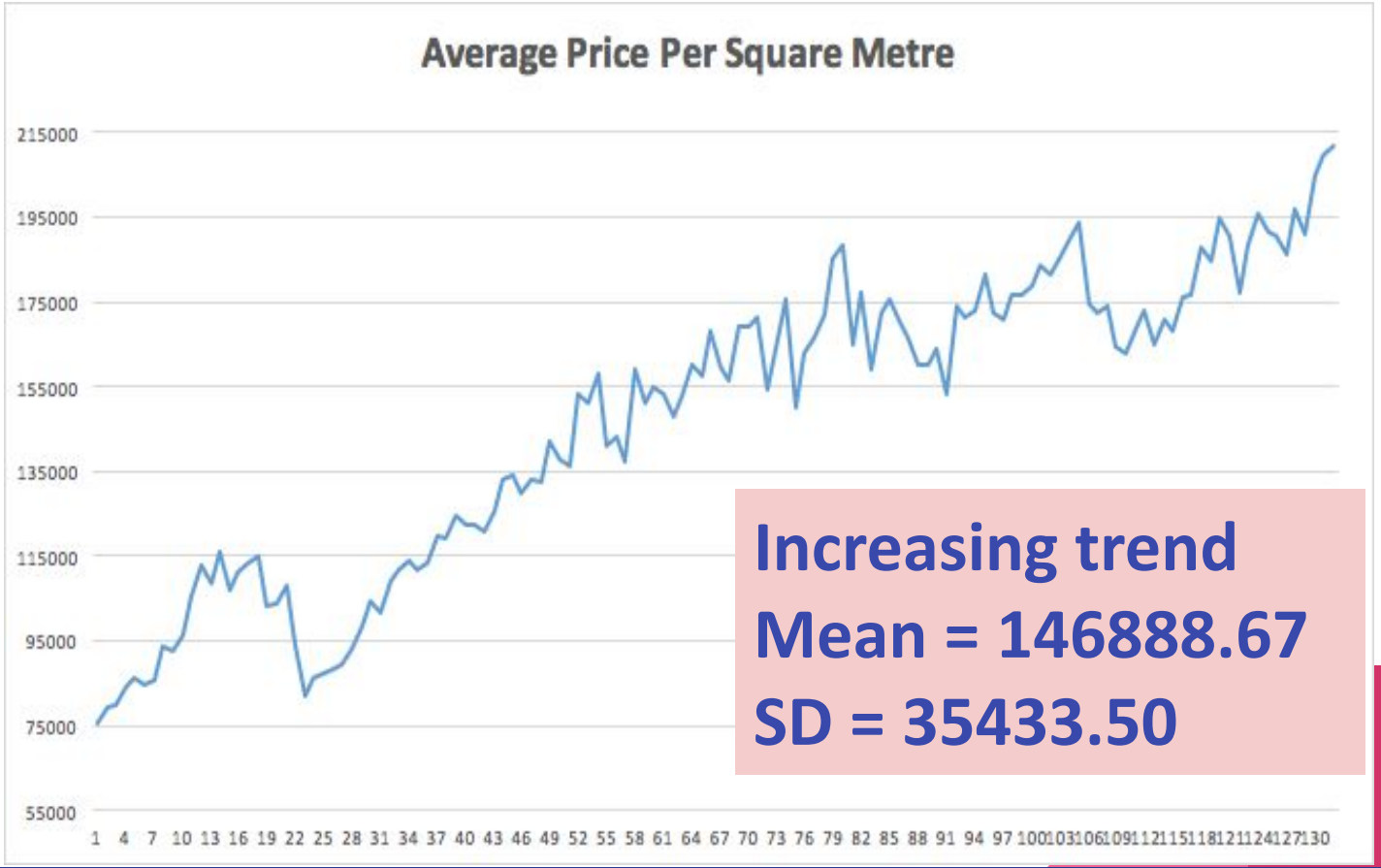
(1) Omission of important variable

(2) Incorrect functional form



Time Series 1 (Y) Model & Forecast

Actual Data:

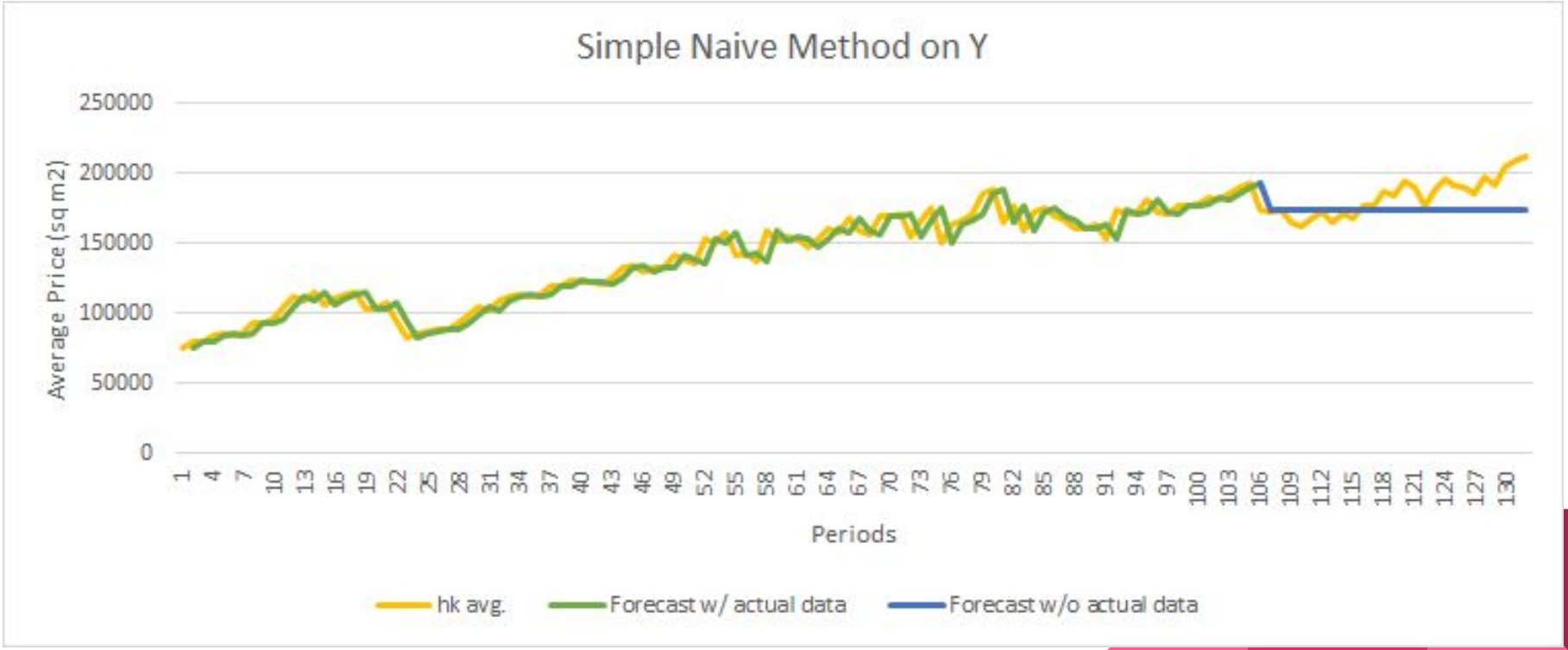


Increasing trend

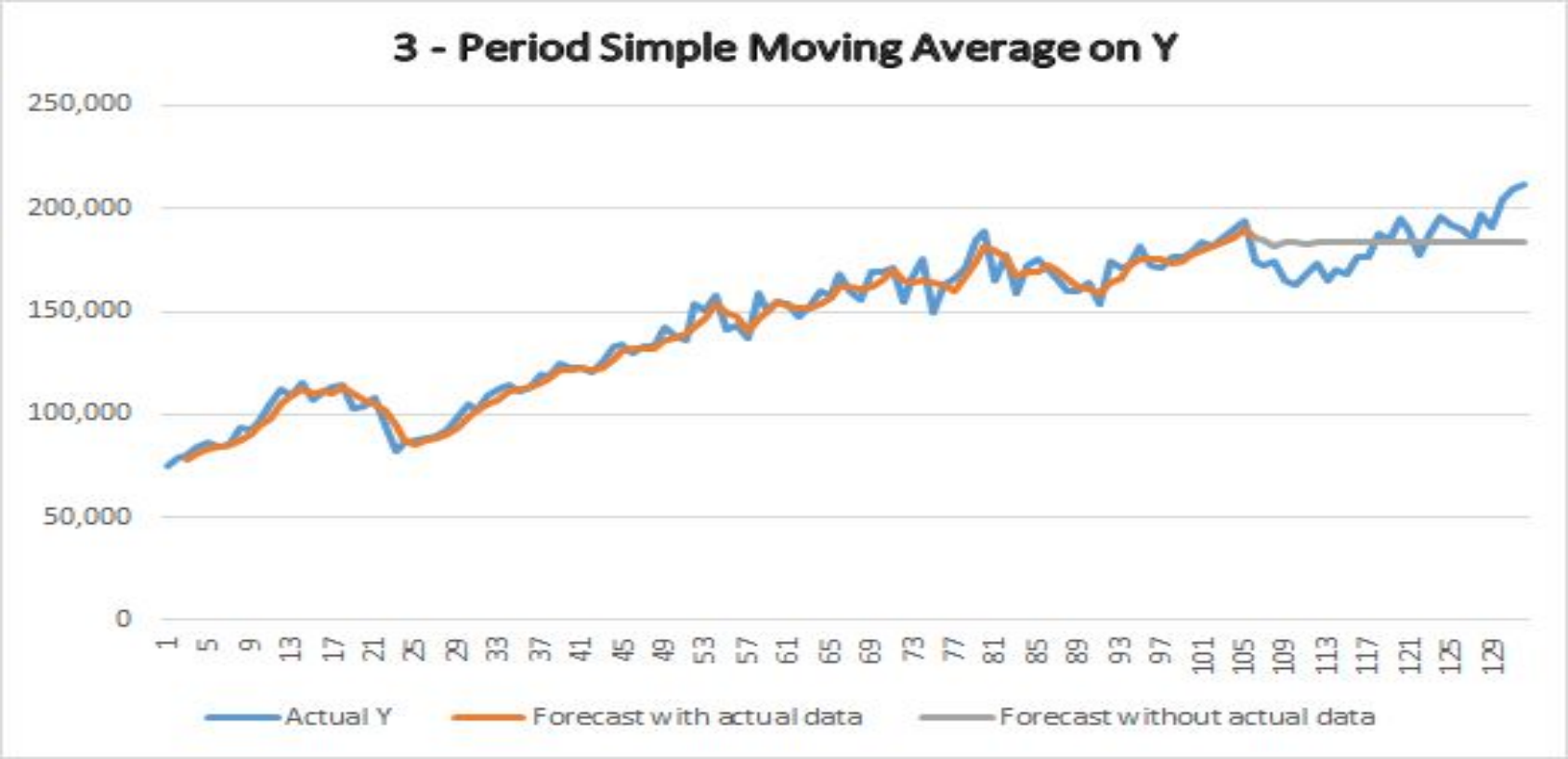
Mean = 146888.67

SD = 35433.50

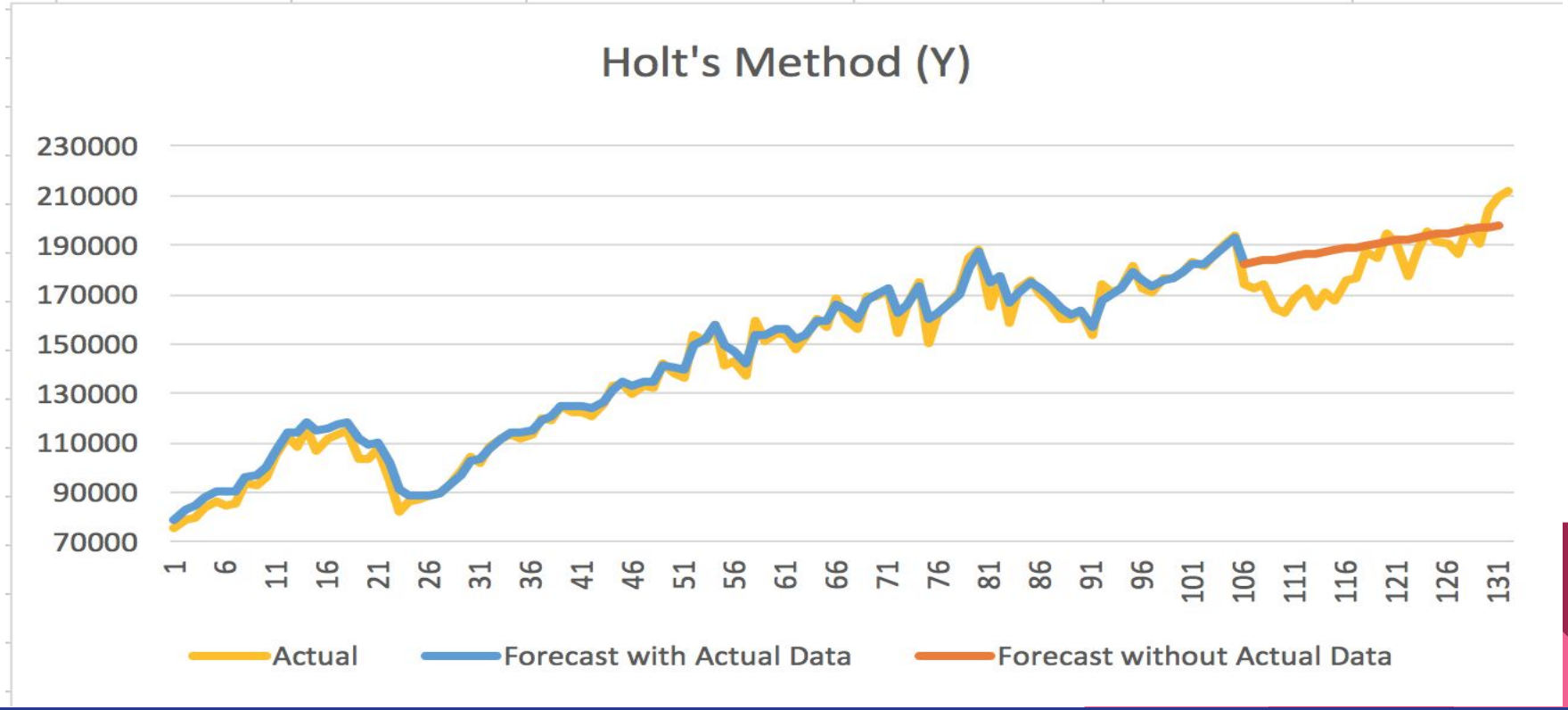
Result: Naive Method



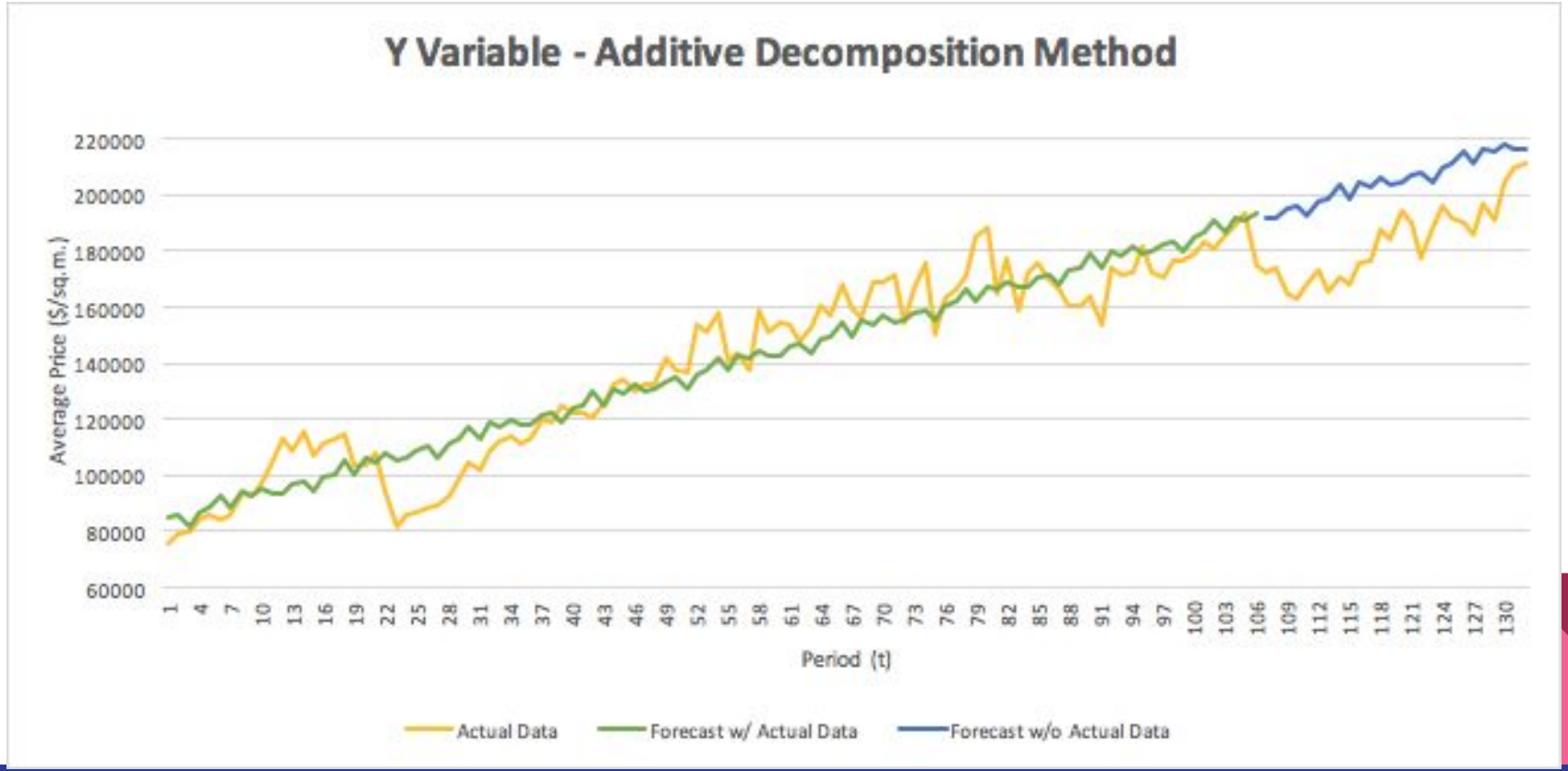
Results: Moving Average Method



Results: Exponential Smoothing



Results: Decomposition Method

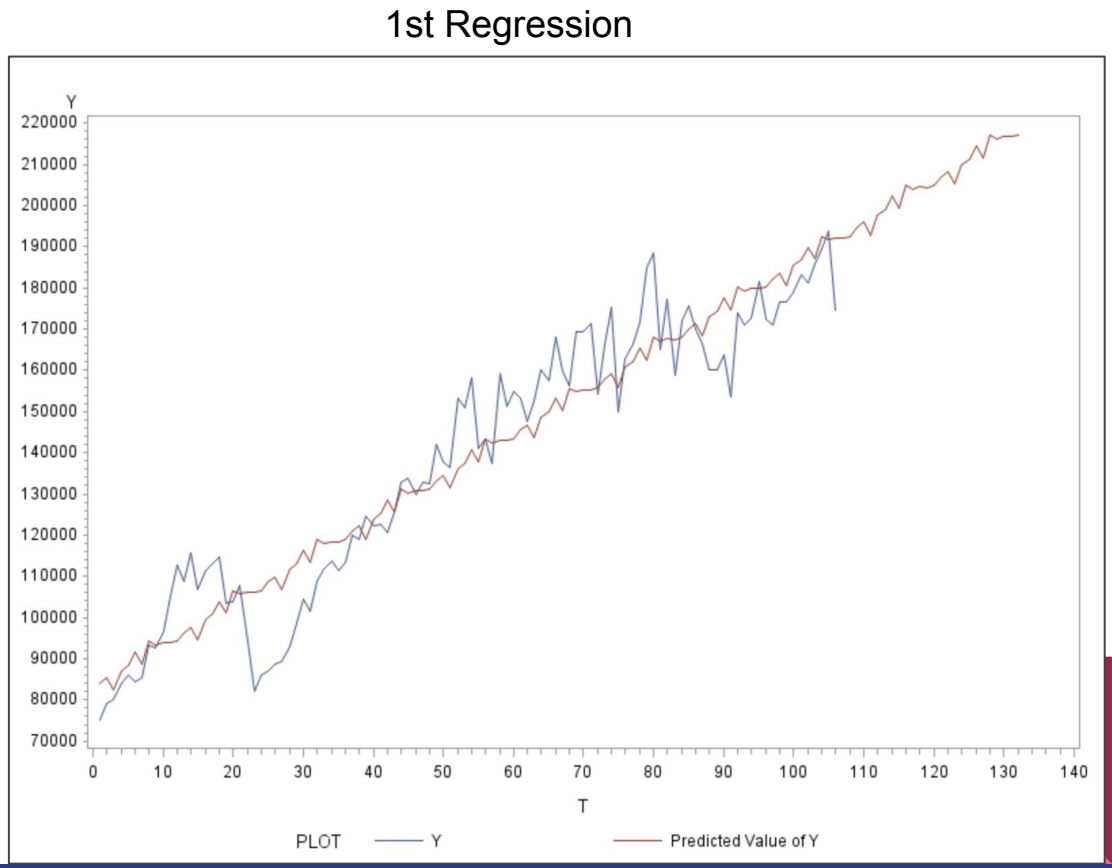


Results: Regression A for Y on Time & Dummy Variables

Variables:

1. T
2. Q1 - Q11

(dummy variables for Jan to Nov)



Results: Regression A for Y on Time & Dummy Variables

The SAS System

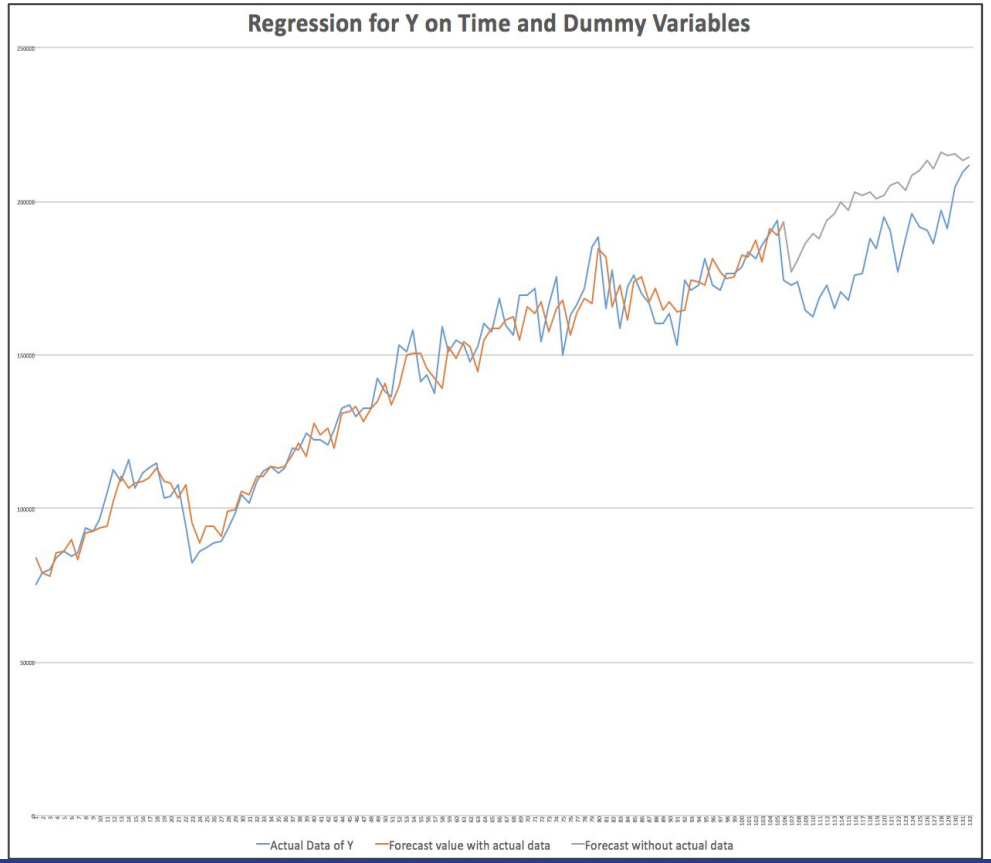
The AUTOREG Procedure

Unconditional Least Squares Estimates			
SSE	5479319650	DFE	92
MSE	59557822	Root MSE	7717
SBC	2249.53128	AIC	2212.24313
MAE	5481.16852	AICC	2216.85852
MAPE	3.9827051	HQC	2227.35622
Durbin-Watson	2.2779	Transformed Regression R-Square	0.6178
		Total R-Square	0.9528

Durbin-Watson Statistics			
Order	DW	Pr < DW	Pr > DW
1	2.2779	0.9111	0.0889

Autoregressive parameters assumed given					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	80761	6031	13.39	<.0001
T	1	1011	86.5776	11.67	<.0001
Q1	1	2175	2889	0.75	0.4534
Q2	1	2581	3697	0.70	0.4869
Q3	1	-1349	4165	-0.32	0.7468
Q4	1	2566	4445	0.58	0.5651
Q5	1	2944	4597	0.64	0.5235
Q6	1	5167	4648	1.11	0.2692
Q7	1	1269	4607	0.28	0.7835
Q8	1	5721	4465	1.28	0.2033
Q9	1	3768	4198	0.90	0.3717
Q10	1	3223	3746	0.86	0.3918
Q11	1	319.5177	2893	0.11	0.9123

Results: Regression A for Y on Time & Dummy Variables



Regression equation for Y after Autoregression :

Y = 80574 + 1011*t + 2104*Q1 +2410*Q2 -1563*Q3 +2322*Q4 + 2685*Q5 + 4903*Q6 +1008*Q7 + 5470*Q8 + 3536*Q9 + 3027*Q10 + 648.0259*Q11

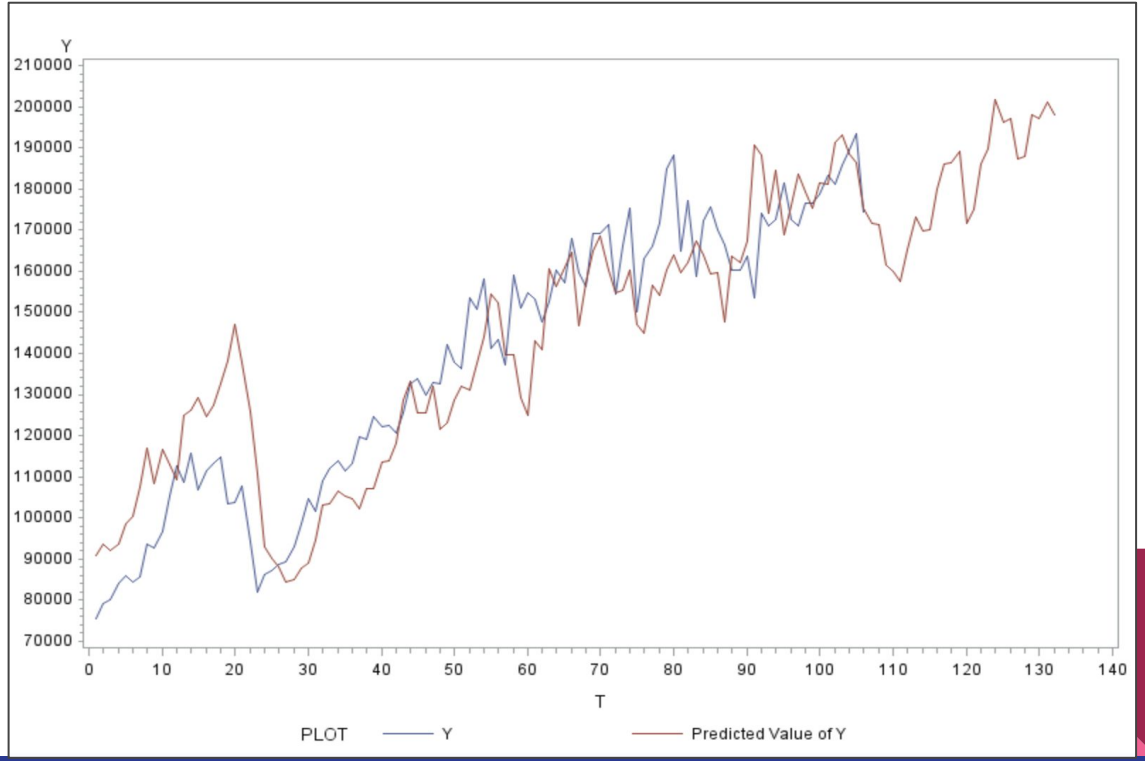
Results: Regression B for Y on X1 and X2

- Regression of Y on X1 X2

Variables:

1. X1
2. X2

1st Regression



Results: Regression B for Y on X1 and X2

The SAS System

The AUTOREG Procedure

Unconditional Least Squares Estimates			
SSE	7027345213	DFE	102
MSE	68895541	Root MSE	8300
SBC	2231.84127	AIC	2221.18752
MAE	6102.01412	AICC	2221.58356
MAPE	4.40934776	HQC	2225.50554
Durbin-Watson	2.2621	Transformed Regression R-Square	0.0171
		Total R-Square	0.9395

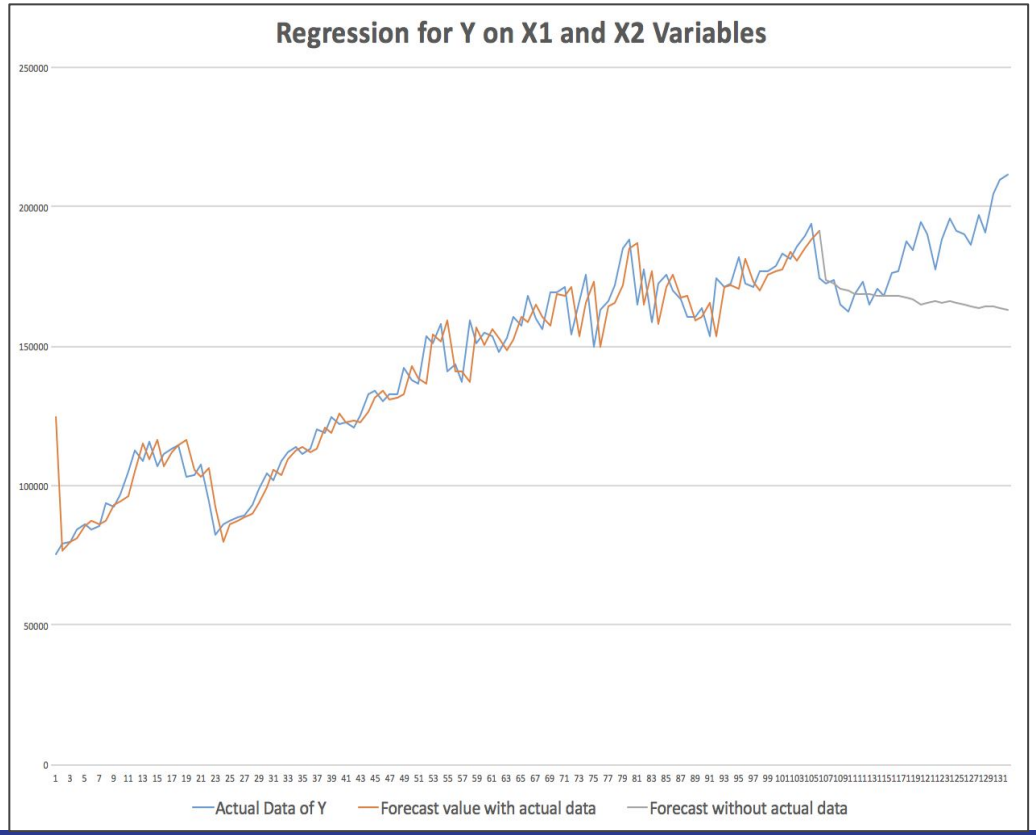
Durbin-Watson Statistics			
Order	DW	Pr < DW	Pr > DW
1	2.2621	0.9097	0.0903

NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.

Parameter Estimates					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	102606	41901	2.45	0.0160
X1	1	79.1372	62.3148	1.27	0.2070
X2	1	0.0411	0.1078	0.38	0.7040
AR1	1	-0.9823	0.0224	-43.80	<.0001

Autoregressive parameters assumed given					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	102606	38642	2.66	0.0092
X1	1	79.1372	61.3642	1.29	0.2001
X2	1	0.0411	0.1078	0.38	0.7039

Results: Regression B for Y on X1 and X2



Regression equation for Y after Autoregression :

Y = 102606 + 79.1372*X1 +

0.0411*X2

Results: Regression C for Y on All Variables

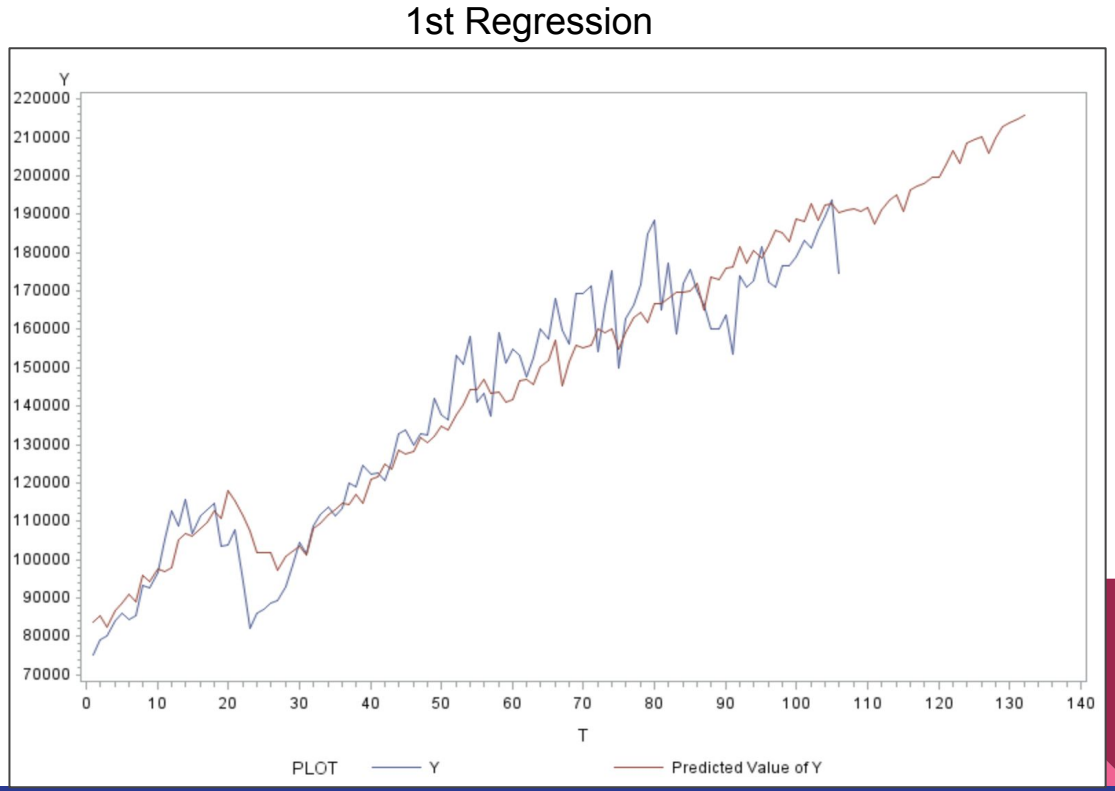
- Regression of Y on all variables

Variables:

1. T
2. Q1 - Q11

(dummy variables for Jan to Nov)

3. X1
4. X2



Results: Regression C for Y on All Variables

The AUTOREG Procedure

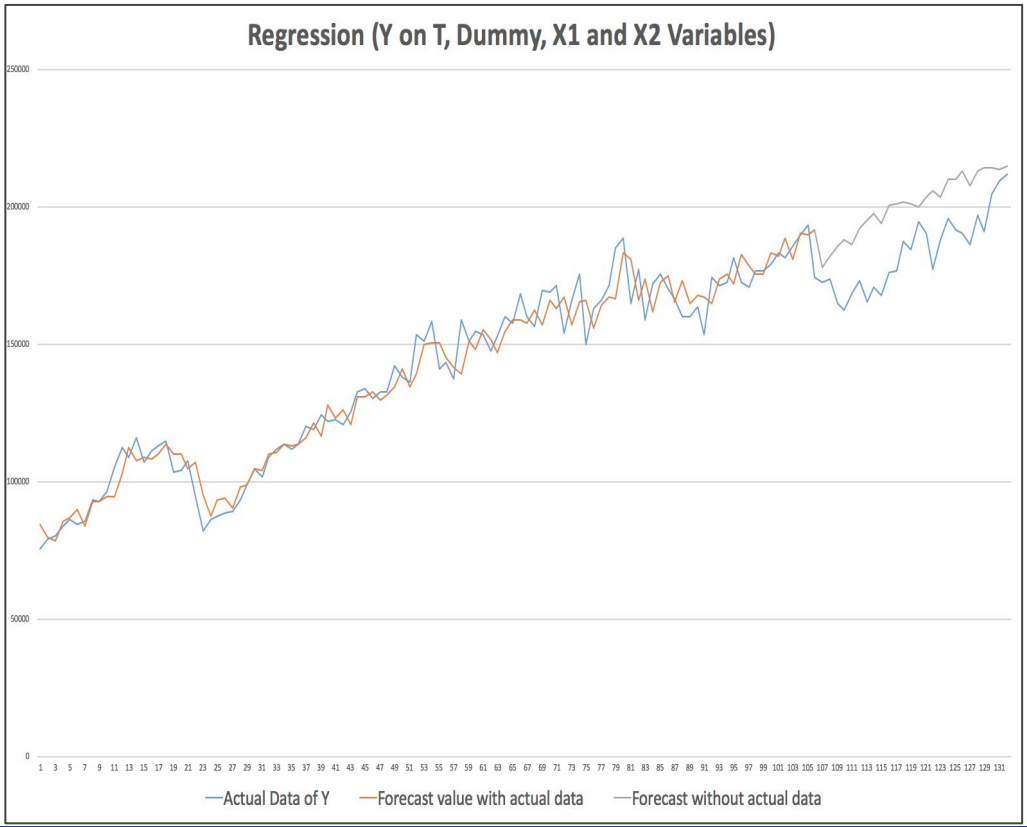
Unconditional Least Squares Estimates			
SSE	5390324969	DFE	90
MSE	59892500	Root MSE	7739
SBC	2256.9897	AIC	2214.37468
MAE	5431.30421	AICC	2220.48704
MAPE	3.91422256	HQC	2231.64678
Durbin-Watson	2.2745	Transformed Regression R-Square	0.6854
		Total R-Square	0.9536

Durbin-Watson Statistics			
Order	DW	Pr < DW	Pr > DW
1	2.2745	0.9016	0.0984

NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrel

Autoregressive parameters assumed given					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	60002	18538	3.24	0.0017
T	1	887.8747	119.2713	7.44	<.0001
Q1	1	1613	2967	0.54	0.5879
Q2	1	1941	3752	0.52	0.6061
Q3	1	-1712	4194	-0.41	0.6841
Q4	1	1967	4440	0.44	0.6588
Q5	1	1945	4611	0.42	0.6741
Q6	1	3641	4720	0.77	0.4426
Q7	1	-1010	4840	-0.21	0.8351
Q8	1	2908	4928	0.59	0.5565
Q9	1	1936	4404	0.44	0.6612
Q10	1	1430	3982	0.36	0.7203
Q11	1	-504.9944	3005	-0.17	0.8669
X1	1	76.0484	64.6351	1.18	0.2425
X2	1	0.0818	0.1099	0.74	0.4591

Results: Regression C for Y on All Variables



Regression equation for Y after Autoregression :

Y =60002 + 887.8747*t + 1613*Q1 + 1941*Q2 -1712*Q3 + 1967*Q4 + 1945*Q5 + 3641*Q6 -1010*Q7 + 2908*Q8 + 1936*Q9 + 1430*Q10 -887.8747*Q11 + 76.0484*X1 +0.0818*X2

Comparison Statistics

In Sample (106 obs)

Forecasting Methods	MSE	MAE	MAPE	SSE	Theil's U
Simple Naive Method	68109521.81	6133.02	4.41%	7151499790	1
Naive Trend Method	68109521.81	6133.017	4.41%	7151499790	1.013473
Naive Seasonal Method	393013394.6	17138.12	12.87%	36943259093	2.671953
Naive Trend and Seasonal Meth	336611611.2	15889.08	11.83%	31304879845	2.438013
Naive Rate of Change Method	179727785.6	9939.8	6.98%	18691689702	1.581092
Simple Moving Average (n=3)	65574190.94	6513.26	4.81%	6754141668	1.05258275
Simple Moving Average (n=12)	144049754.4	10422.56	7.82%	13540676911	1.64137042
Double Moving Average (n=3)	87433411.18	6823.75	4.94%	8830774530	1.12714616
Double Moving Average (n=12)	111903031.8	8575.69	6.31%	9287951642	1.42403184
Simple Exponential Smoothing	59357670.41	5913.8	4.32%	6232555393	0.97738
Brown's Method	62920989.21	5971.87	4.44%	6606703867	1.011503
Holt's Method	60535692.73	5755.34	4.25%	6356247736	0.982684
Winter's Multiplicative Method	68399174.87	9067.45	6.81%	12859044869	1.549508
Winter's Additive Method	61720493.12	8506.21	6.44%	12859044869	1.465022
Additive Decomposition	108734383.2	8375.01	6.59%	11525844622	1.540352
Multiplicative Decomposition	109047395.8	8390.4	6.60%	11559023958	1.541099
Regression (Y on T)	48,939,871.68	5,282.83	3.86%	5,187,626,398.32	0.87537304
Regression (Y on X1 & X2)	88,502,384.85	6,480.73	4.91%	9,381,252,794.29	0.98009443
Regression (Y on All)	51196598.24	5454.18	3.94%	5426839414	1.09475687

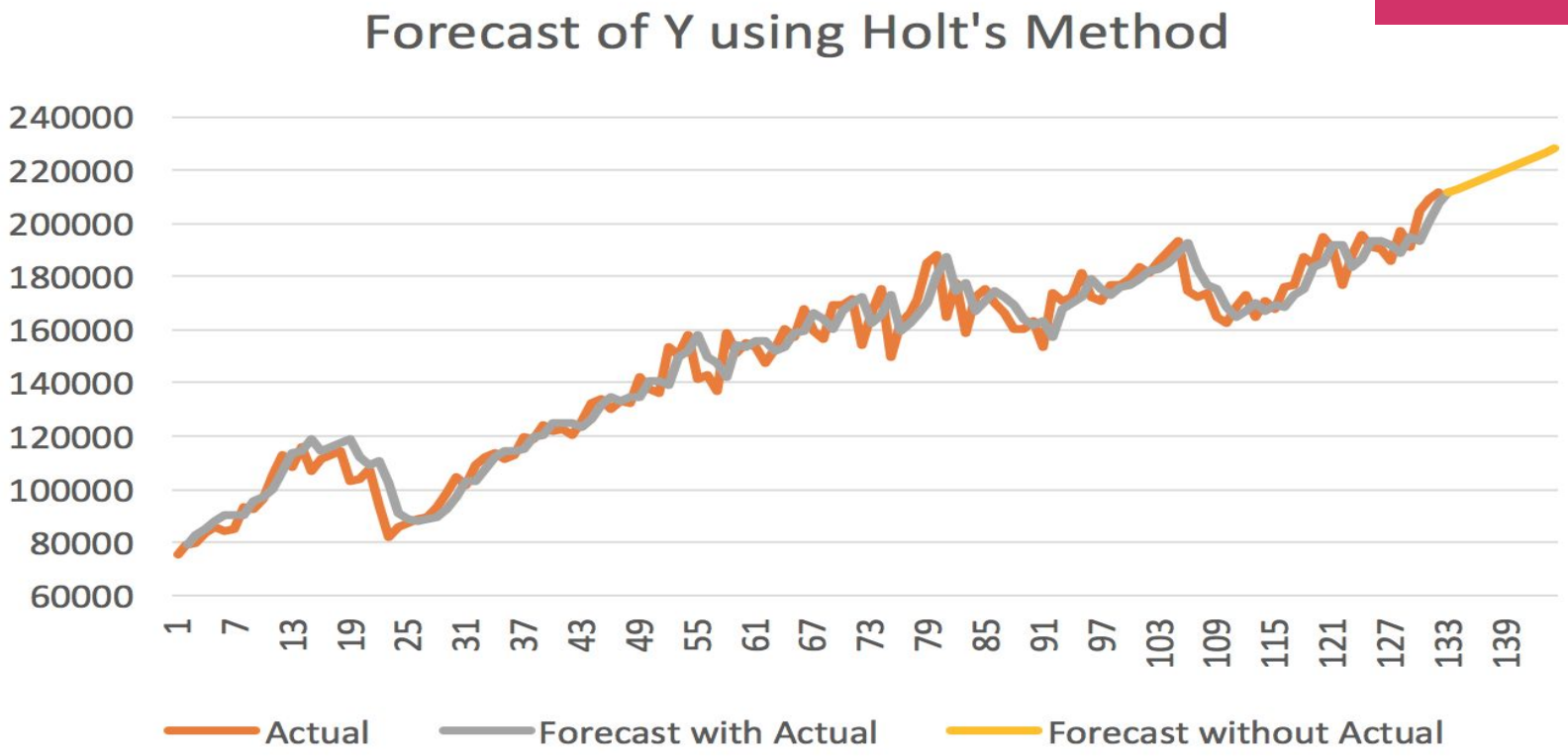
Out Sample (26 obs)

Forecasting Methods	MSE	MAE	MAPE	SSE	Theil's U
Simple Naive Method	267139706.3	12983.53	6.78%	6945632365	2.15167
Naive Trend Method	27580451073	156015.11	83.73%	7.17092E+11	22.772691
Naive Seasonal Method	266290667.8	13344.43	7.11%	6923557362	2.186295
Naive Trend and Seasonal Meth	251288584.1	12820.11	6.85%	6533503185	2.120887
Naive Rate of Change Method	18783711237	126086.69	67.15%	4.88376E+11	18.540642
Simple Moving Average (n=3)	188842645.5	11915.84	6.50%	4909908784	1.86841752
Simple Moving Average (n=12)	194868160.6	12056.17	6.48%	5066572175	1.87917531
Double Moving Average (n=3)	651767394.3	21035.81	11.03%	16945952252	3.3489887
Double Moving Average (n=12)	529097339.7	22058.08	12.28%	13756530832	3.25696183
Simple Exponential Smoothing	194061093.5	12010.31	6.46%	5045588431	1.875352
Brown's Method	159896217.2	10575.42	5.98%	4157301646	1.815666
Holt's Method	140204471.8	9975.21	5.83%	3645316266	1.70687
Winter's Multiplicative Method	349565443.3	16677.51	9.37%	9088701525	2.693137
Winter's Additive Method	354812792.2	16664.75	9.39%	9225132597	2.697728
Addictive Decomposition	537440545.1	21785.65	12.20%	13973454172	3.301743
Multiplicative Decomposition	541397623.1	21672.71	12.14%	14076338199	3.320528
Regression (Y on T)	368,599,599.69	17,575.64	9.83%	9,583,589,591.96	2.7436196
Regression (Y on X1 & X2)	529740089.8	18032.9	9.33%	13773242334	3.02580906
Regression (Y on All)	367830167.1	17538.55	9.80%	9563584344	2.74718157

Final Model Chosen - Holt's Method

α: 0.601603708

β: 0.054623534



Fitted Values - Holt's Method

α: 0.601603708

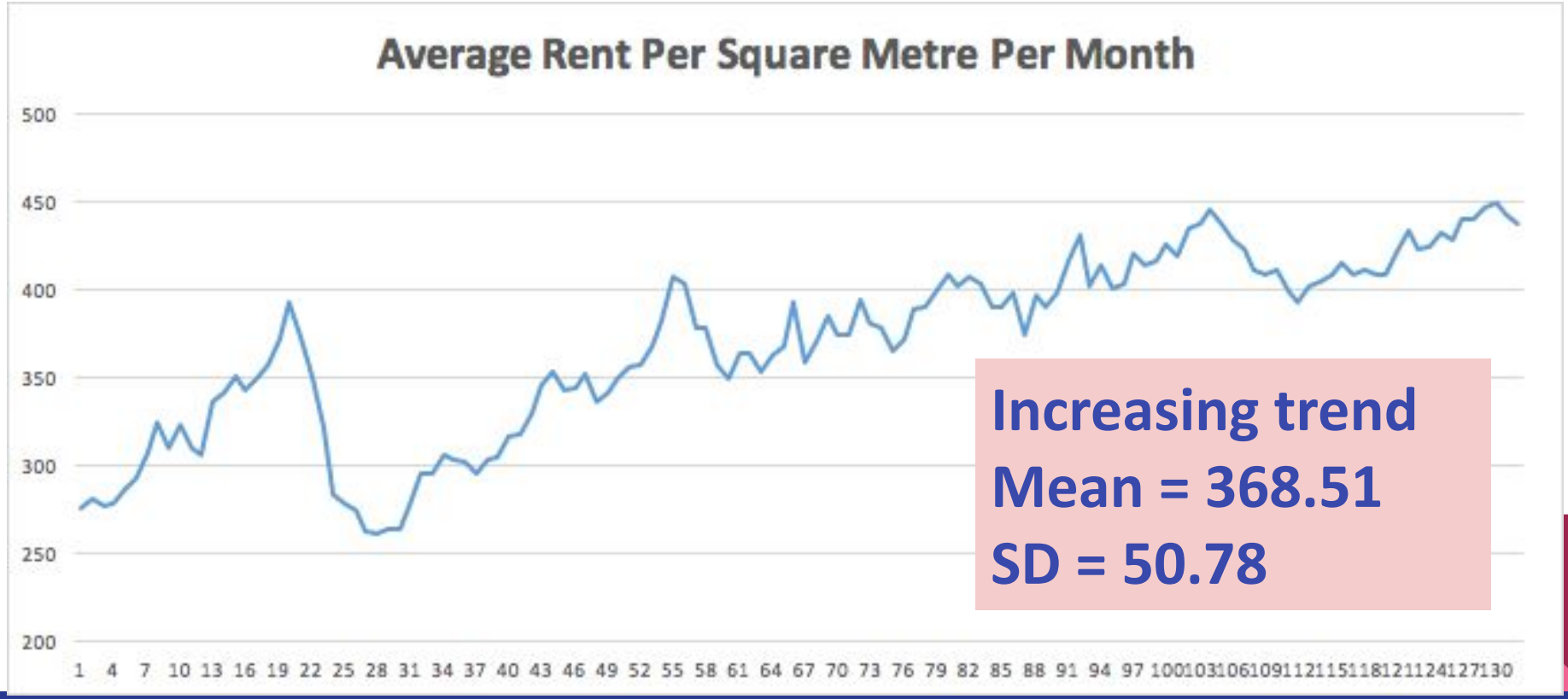
β: 0.054623534

$F_{t+m} = 209{,}959.4288 + 1{,}500.7737 * m$ $\quad m = 1, 2, 3, \ldots, 12$

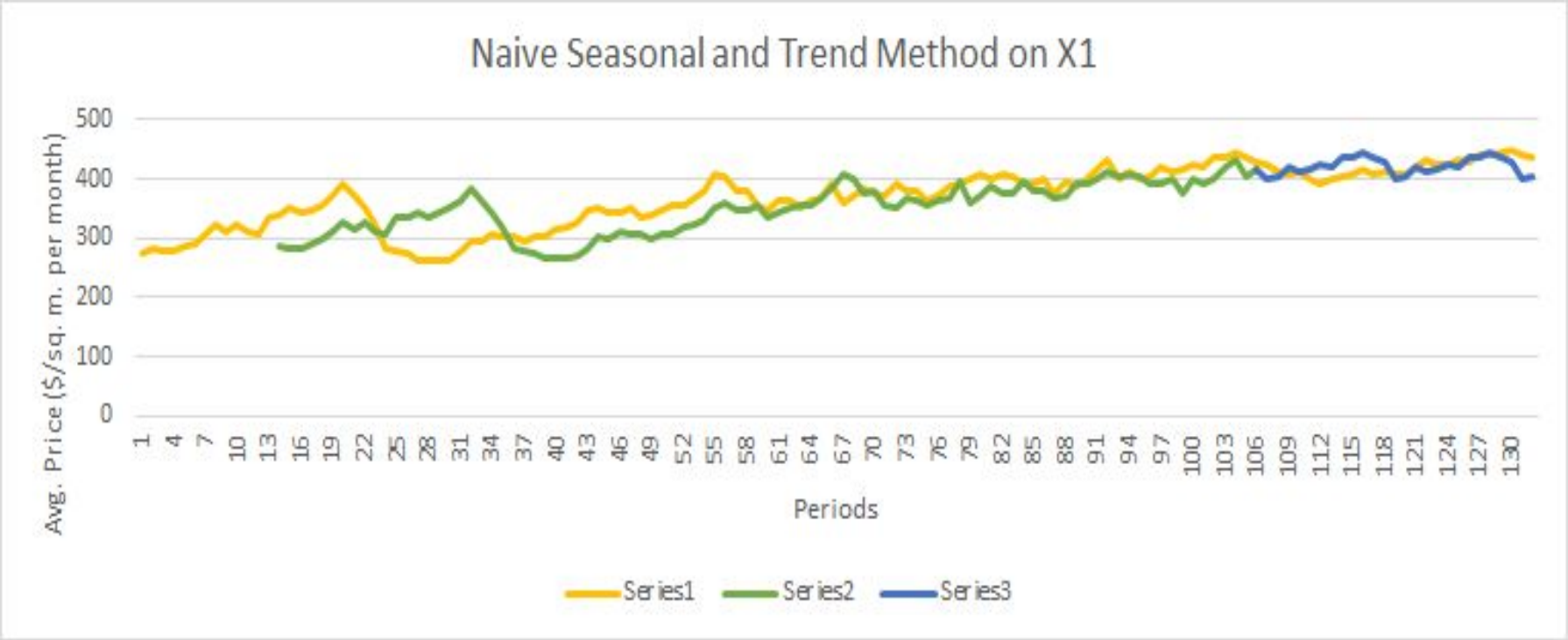
2018	*Fitted Values*		*Fitted Values*
January	211,460.20	*July*	220,464.84
February	212,960.98	*August*	221,965.62
March	214,461.75	*September*	223,466.39
April	215,962.52	*October*	224,967.17
May	217,463.30	*November*	226,467.94
June	218,964.07	*December*	227,968.71

Time Series 2 (X1) Model & Forecast

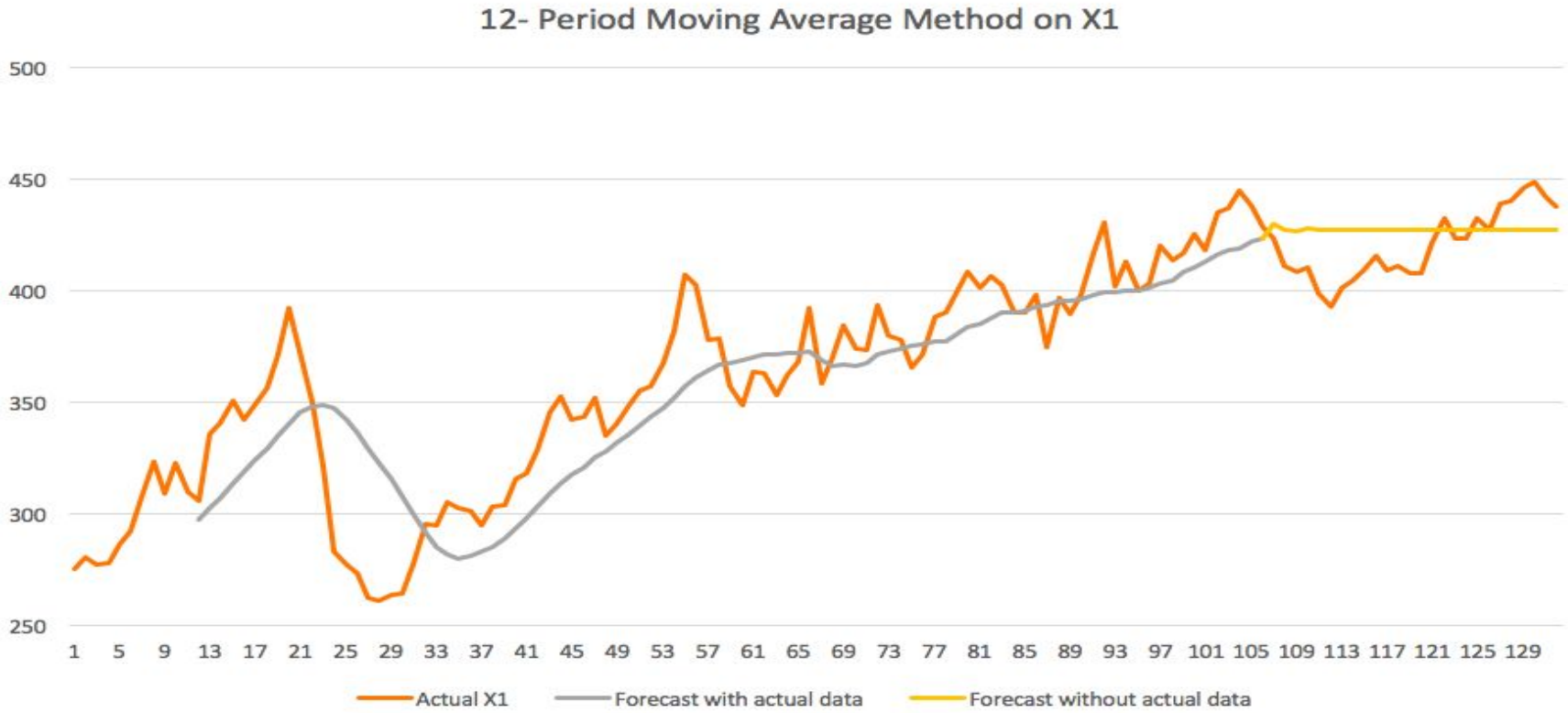
Actual Data:


Average Rent Per Square Metre Per Month
500
450
400
350
300
250
200
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 82 85 88 91 94 97 100 103 106 109 112 115 118 121 124 127 130
Increasing trend
Mean = 368.51
SD = 50.78

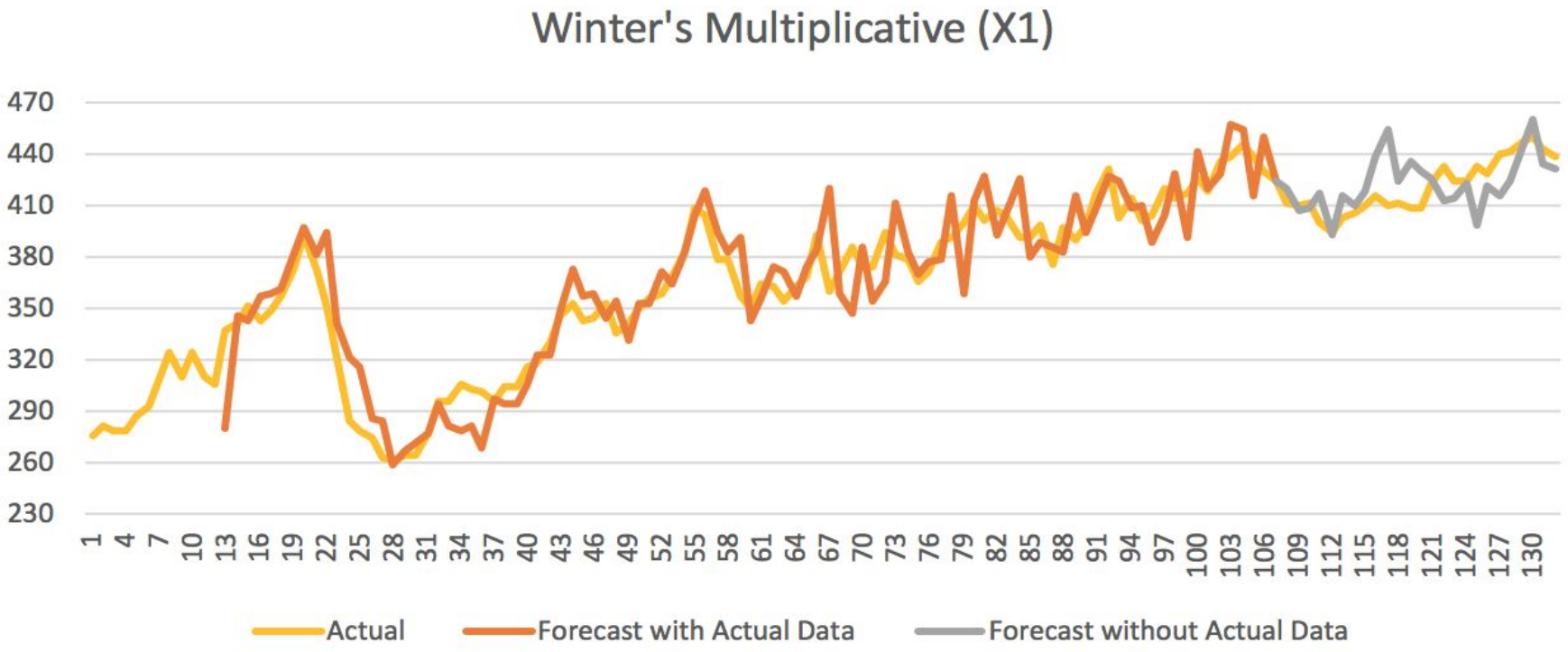
Results: Naive Method



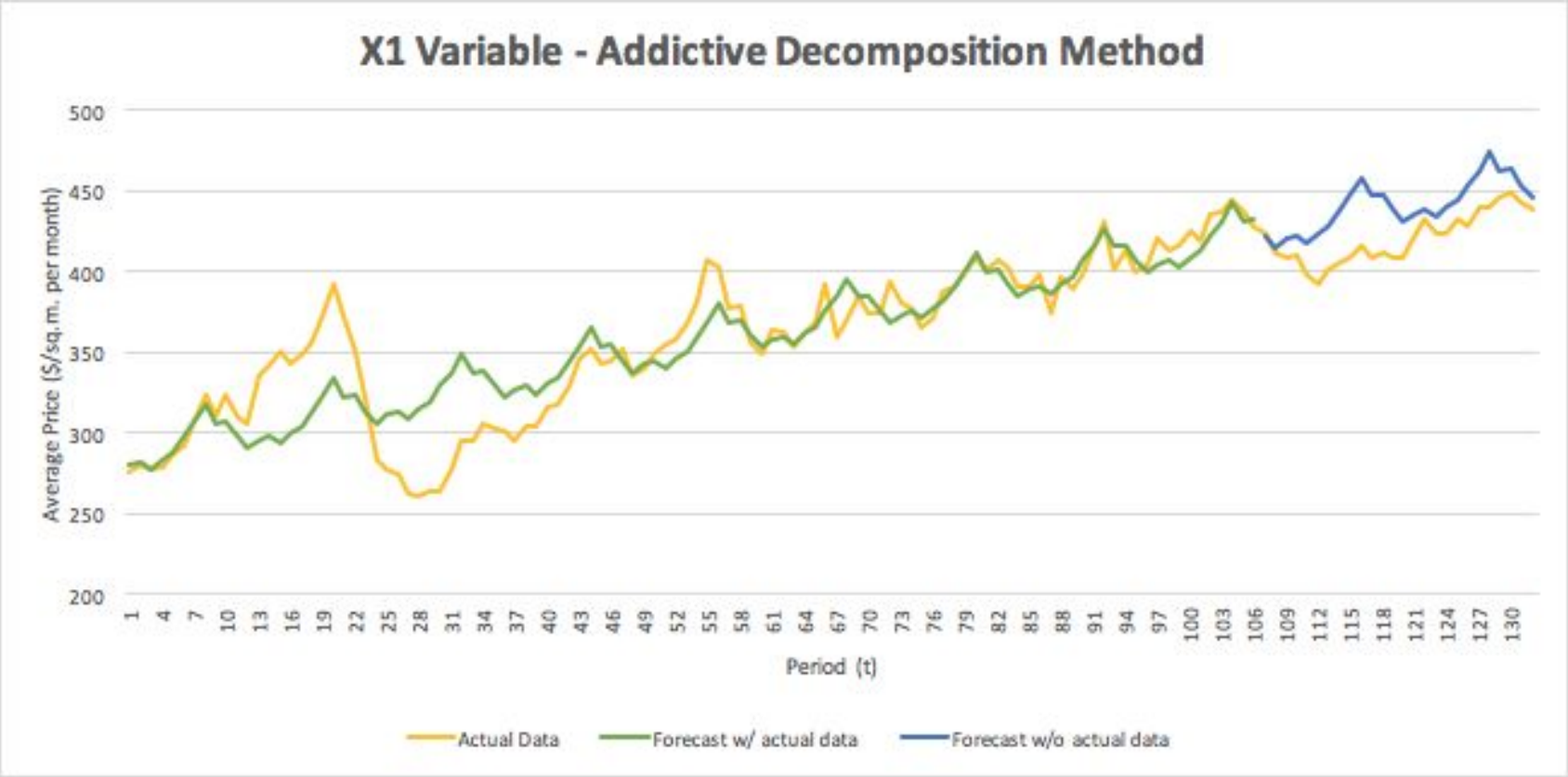
Results: Moving Average Method



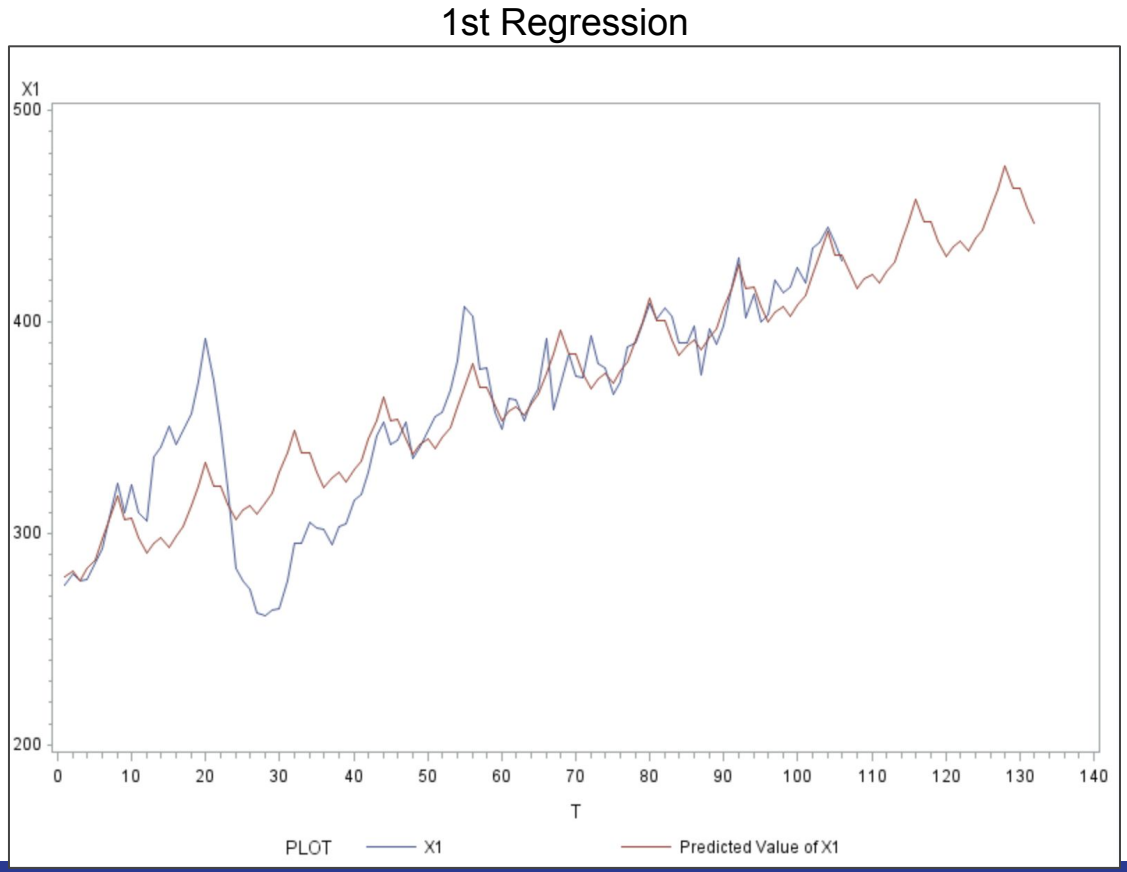
Results: Exponential Smoothing



Results: Decomposition Method



Results: Regression D for X1 on Time & Dummy Variables



Variables:

1. T
2. Q1 - Q11 (Dummy variables for Jan to Nov)

Results: Regression D for X1 on Time & Dummy Variables

The AUTOREG Procedure

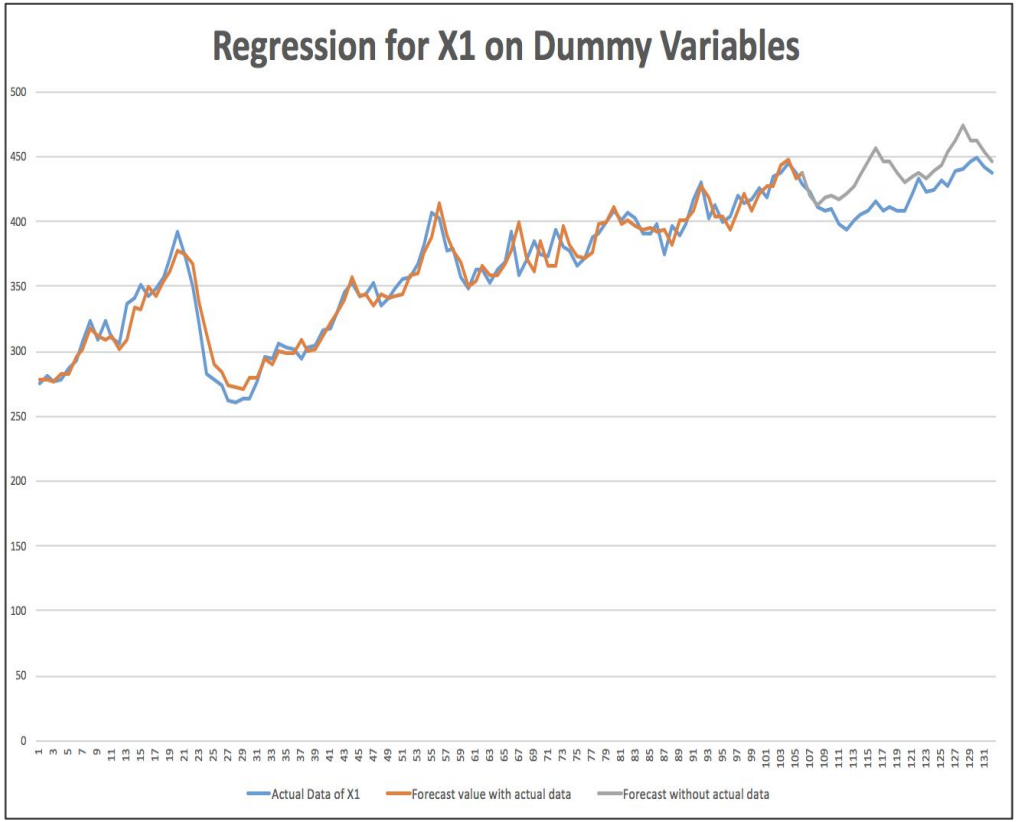
Unconditional Least Squares Estimates			
SSE	11872.0161	DFE	92
MSE	129.04365	Root MSE	11.35974
SBC	867.882351	AIC	830.594204
MAE	7.98753087	AICC	835.209589
MAPE	2.27357529	HQC	845.707293
Durbin-Watson	2.0083	Transformed Regression R-Square	0.4128
		Total R-Square	0.9514

Durbin-Watson Statistics			
Order	DW	Pr < DW	Pr > DW
1	2.0083	0.5117	0.4883

NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.

Autoregressive parameters assumed given					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	273.8434	18.1168	15.12	<.0001
T	1	1.3063	0.2769	4.72	<.0001
Q1	1	3.7705	4.0160	0.94	0.3503
Q2	1	4.9235	5.2493	0.94	0.3507
Q3	1	-0.7732	6.0247	-0.13	0.8982
Q4	1	3.4584	6.5184	0.53	0.5970
Q5	1	6.4849	6.7993	0.95	0.3427
Q6	1	15.2175	6.8974	2.21	0.0299
Q7	1	22.9895	6.8217	3.37	0.0011
Q8	1	32.7117	6.5645	4.98	<.0001
Q9	1	20.4285	6.0978	3.35	0.0012
Q10	1	19.2507	5.3572	3.59	0.0005
Q11	1	8.5434	4.0168	2.13	0.0361

Results: Regression D for X1 on Time & Dummy Variables



Regression equation for X1 after Autoregression :

X1 = 273.8434 + 1.3063*t + 3.7705*Q1 + 4.9235*Q2 -0.7732*Q3 + 3.4584*Q4 + 6.4849*Q5 + 15.2175*Q6 + 22.9895*Q7 + 32.7117*Q8 + 20.4285*Q9 + 19.2507*Q10 + 8.5434*Q11

Comparison Statistics

In Sample (106 obs)

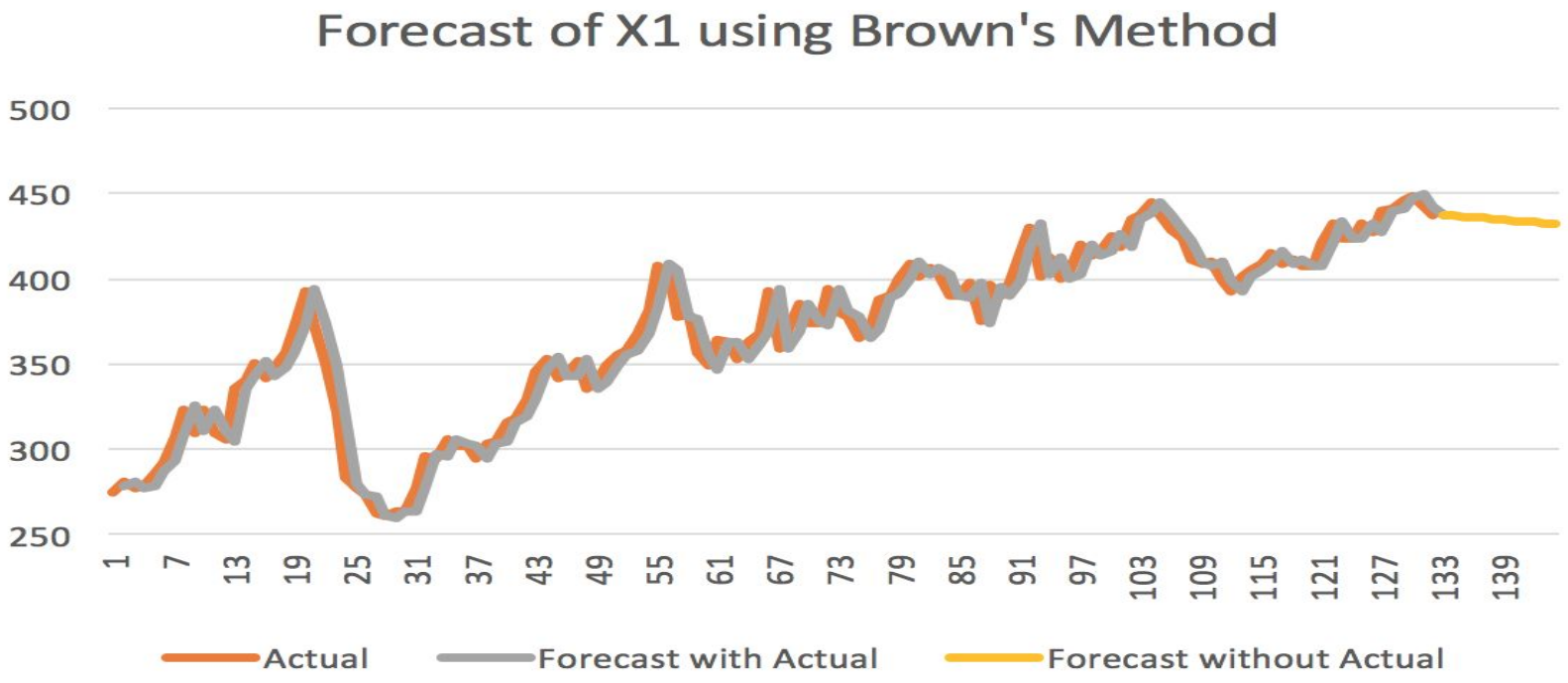
Forecasting Methods	MSE	MAE	MAPE	SSE	Theil's U
Simple Naive Method	174.87	10.61	2.98%	18360.92	1
Naive Trend Method	174.87	10.61	2.98%	18360.92	0.99967
Naive Seasonal Method	1900.41	35.72	10.55%	178638.64	3.773851
Naive Trend and Seasonal Method	1603.72	32.8	9.68%	149145.72	3.453836
Naive Rate of Change Method	344.51	14.69	4.10%	35829.16	1.359946
Simple Moving Average (n=3)	291.14	12.89	3.71%	29987.54	1.337527
Simple Moving Average (n=12)	800.91	22.27	6.59%	75285.14	2.449634
Double Moving Average (n=3)	274.94	13.3	3.80%	27768.98	1.244023
Double Moving Average (n=12)	857.94	20.75	6.42%	71208.67	2.796392
Simple Exponential Smoothing	174.87	10.61	2.98%	18360.92	1
Brown's Method	173.45	10.47	2.94%	18212.19	0.991812
Holt's Method	175.44	10.32	2.92%	18421.61	0.994129
Winter's Multiplicative Method	178.15	14.44	4.05%	33487.56	1.377077
Winter's Additive Method	358.35	20.33	5.71%	67364.47	2.03286
Addictive Decomposition	563.94	16.62	5.05%	59778.08	2.068655
Multiplicative Decomposition	570.3	16.91	5.13%	60451.07	2.073737
Regression	112.09	8.01	2.28%	11881.89	0.811796

Out Sample (26 obs)

Forecasting Methods	MSE	MAE	MAPE	SSE	Theil's U
Simple Naive Method	309.97	15.35	3.71%	8059.12	2.567067
Naive Trend Method	18471.14	110.4	25.69%	7.1709E+11	18.83867
Naive Seasonal Method	395.28	16.16	3.86%	10277.16	2.765944
Naive Trend and Seasonal Method	387.77	16	3.82%	10082	2.748395
Naive Rate of Change Method	12211.39	90.68	21.12%	317496.26	15.34024
Simple Moving Average (n=3)	435.96	17.85	4.34%	11,335.00	3.045747
Simple Moving Average (n=12)	293.35	14.81	3.57%	7,627.15	2.494218
Double Moving Average (n=3)	746.44	23.21	5.45%	19407.53	3.795093
Double Moving Average (n=12)	1970.078	43.41	10.36%	51222.04	6.365981
Simple Exponential Smoothing	309.97	15.35	3.71%	8059.12	2.567067
Brown's Method	424.65	18.14	4.29%	11040.8	0.042893
Holt's Method	1863.06	41.87	9.98%	48439.48	6.177607
Winter's Multiplicative Method	284.69	12.78	3.05%	7401.84	2.424645
Winter's Additive Method	2318.6	46.47	11.10%	60283.69	6.856175
Addictive Decomposition	566.65	20.73	4.98%	14732.88	3.458894
Multiplicative Decomposition	612.14	20.66	4.95%	15915.64	3.58568
Regression	525.42	19.85	4.76%	13660.85	3.458044

Final Model Chosen - Brown's Method

α: 0.776124783



Fitted Value - Brown's Method

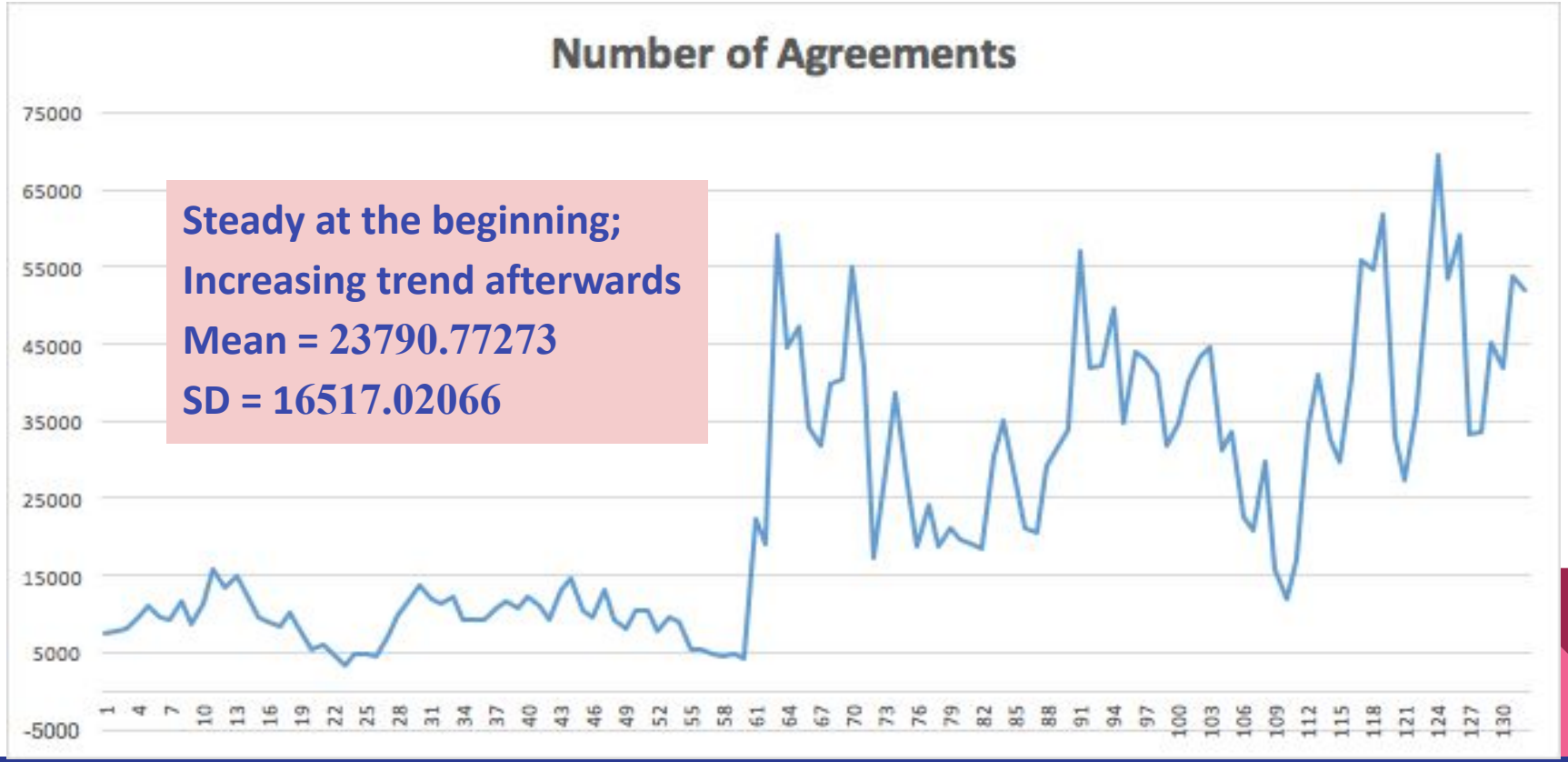
α: 0.776124783

$F_{t+m} = 438.1169 + (-0.4842)*m$ $\quad m = 1, 2, 3, \ldots, 12$

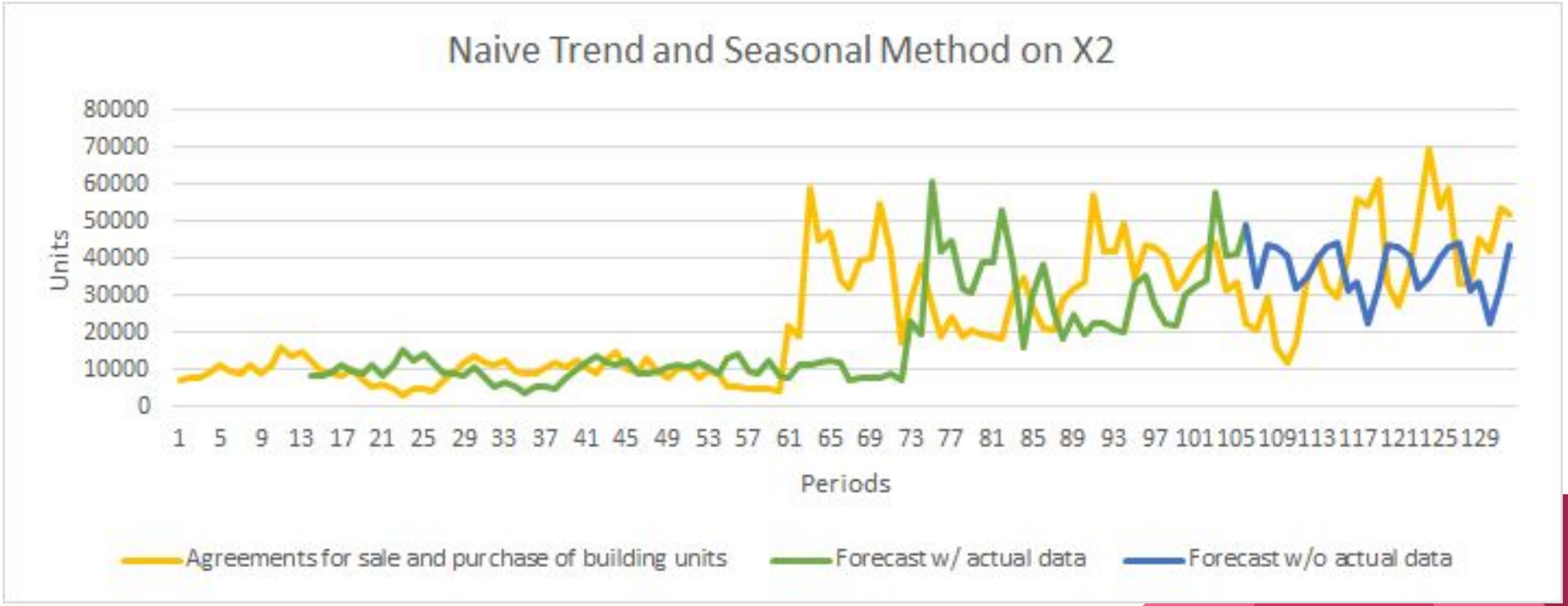
2018	*Fitted Values*		*Fitted Values*
January	437.63	*July*	434.73
February	437.15	*August*	434.24
March	436.66	*September*	433.76
April	436.18	*October*	433.27
May	435.70	*November*	432.79
June	435.21	*December*	432.31

Time Series 3 (X2) Model & Forecast

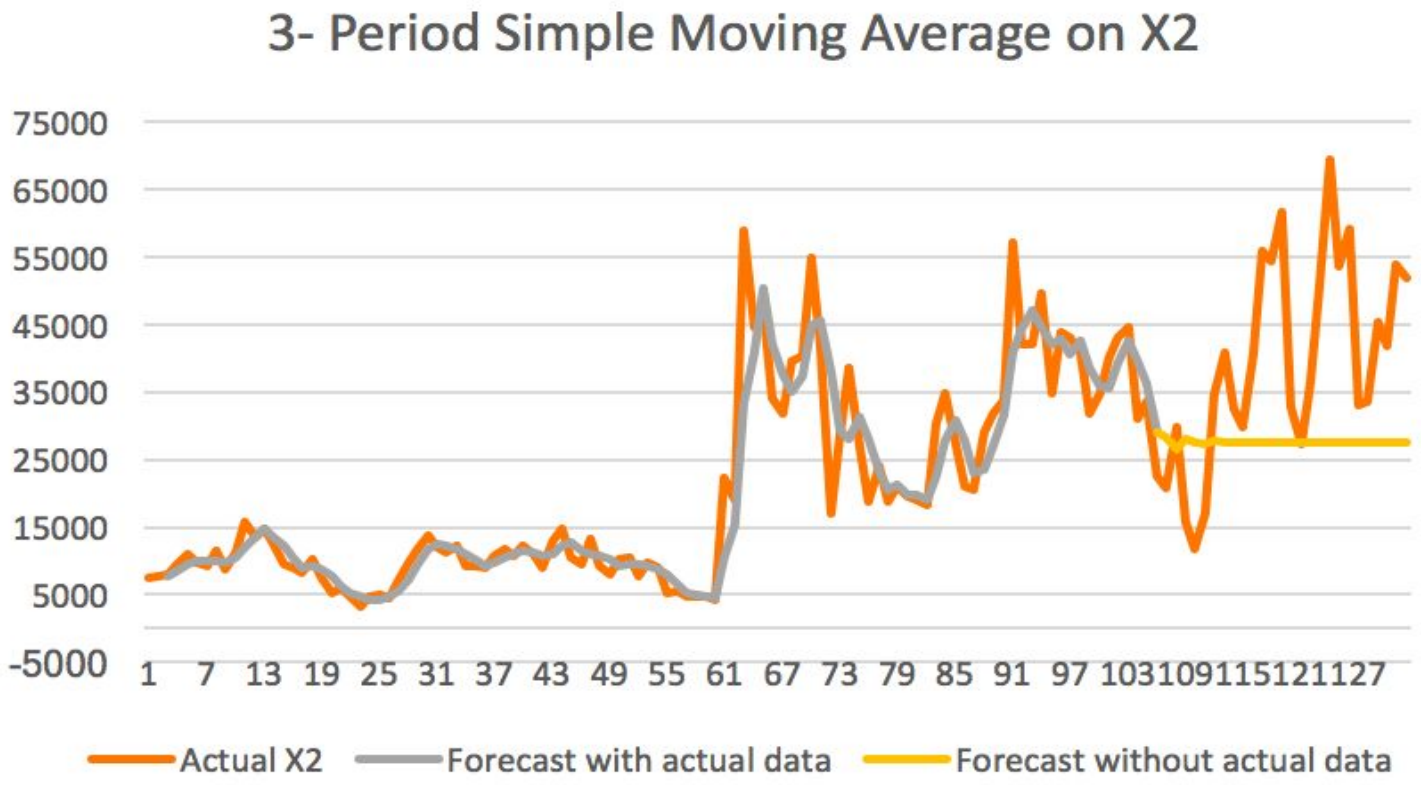
Actual Data:


Number of Agreements
75000
65000
55000
45000
35000
25000
15000
5000
-5000
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79
82
85
88
91
94
97
100
103
106
109
112
115
118
121
124
127
130
Steady at the beginning;
Increasing trend afterwards
Mean = 23790.77273
SD = 16517.02066

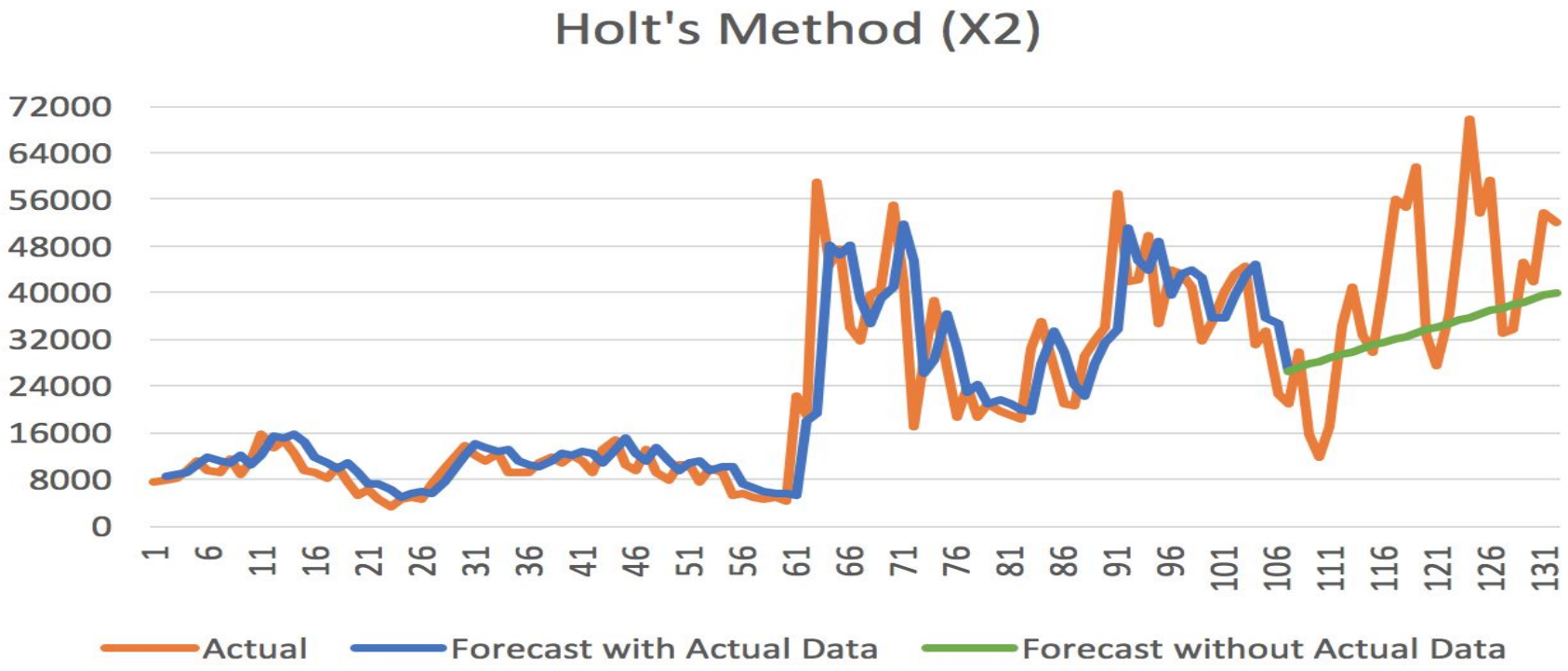
Results: Naive Method



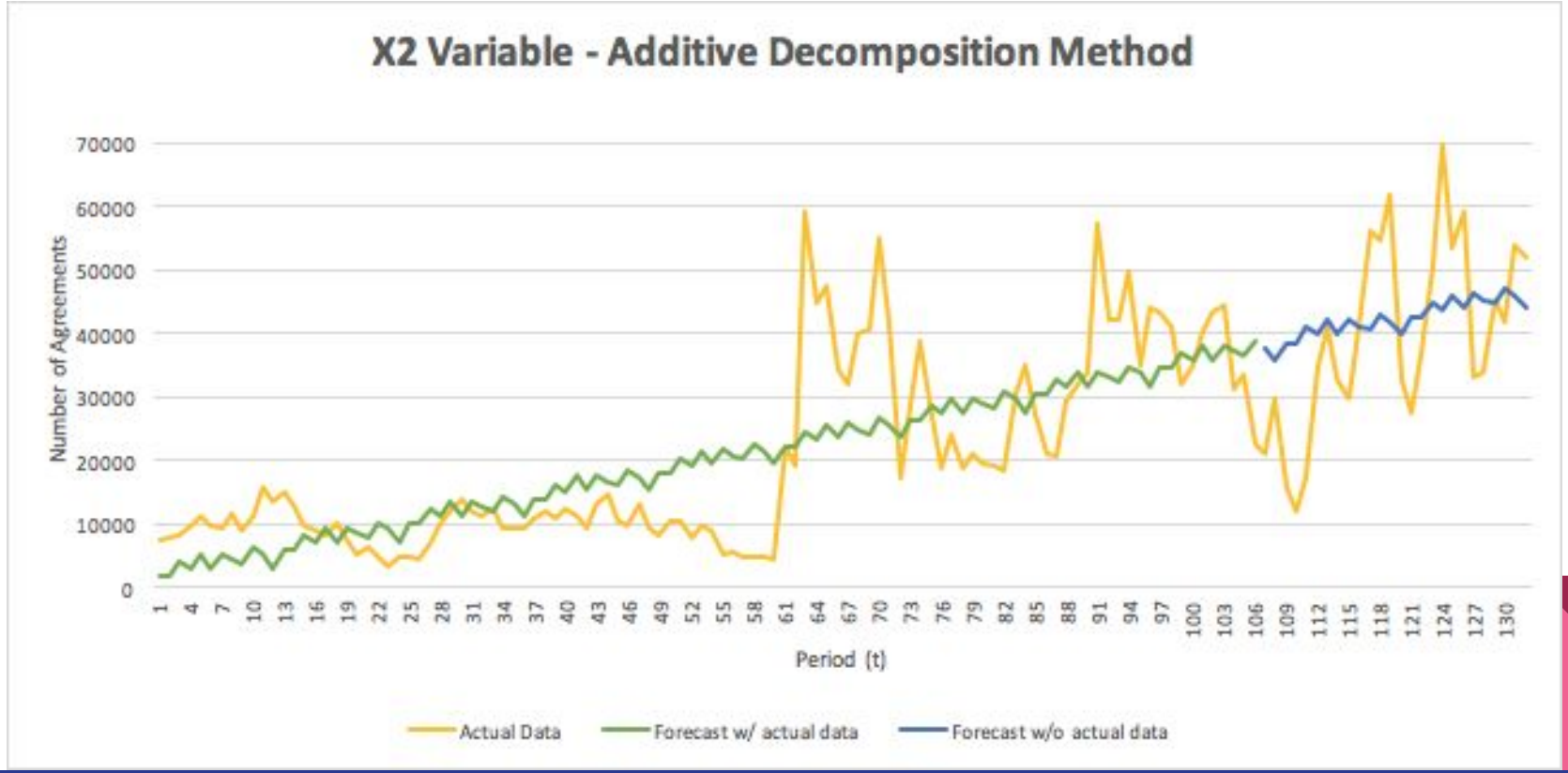
Results: Moving Average Method



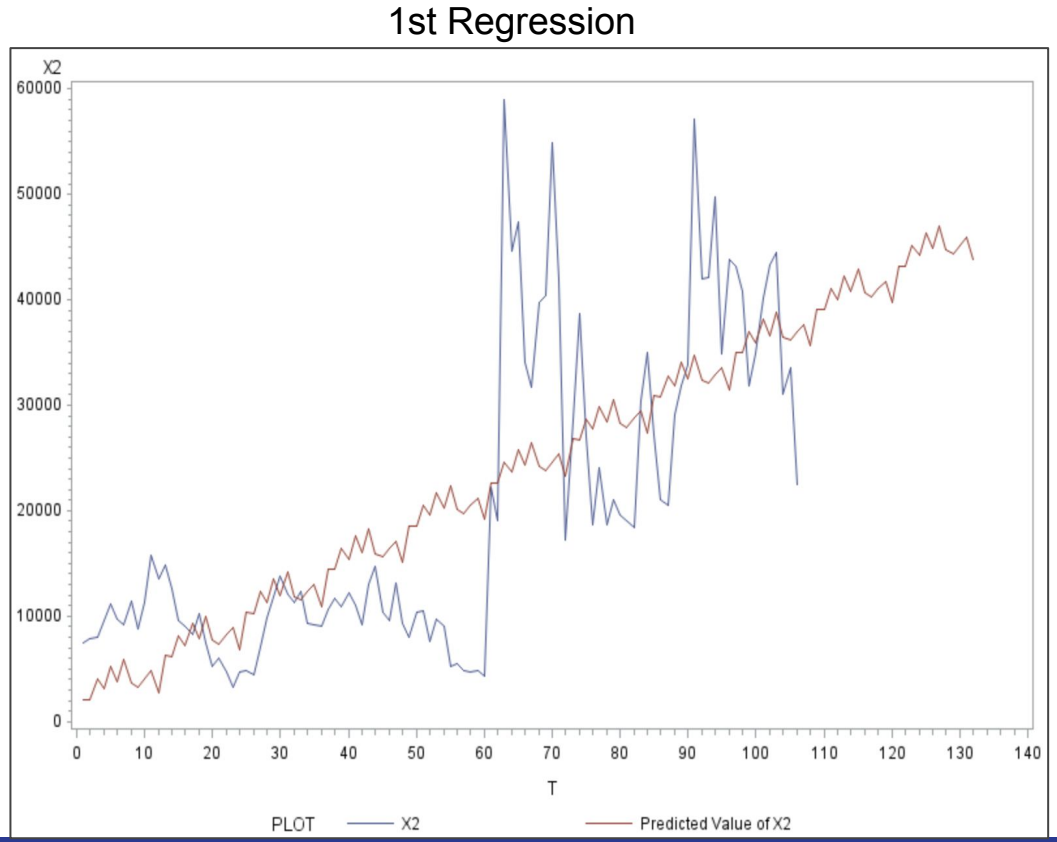
Results: Exponential Smoothing



Results: Decomposition Method



Results: Regression E for X2 on Time & Dummy Variables



Variables:

1. T
2. Q1 - Q11 (Dummy variables for Jan to Nov)

Results: Regression E for X2 on Time & Dummy Variables

The AUTOREG Procedure

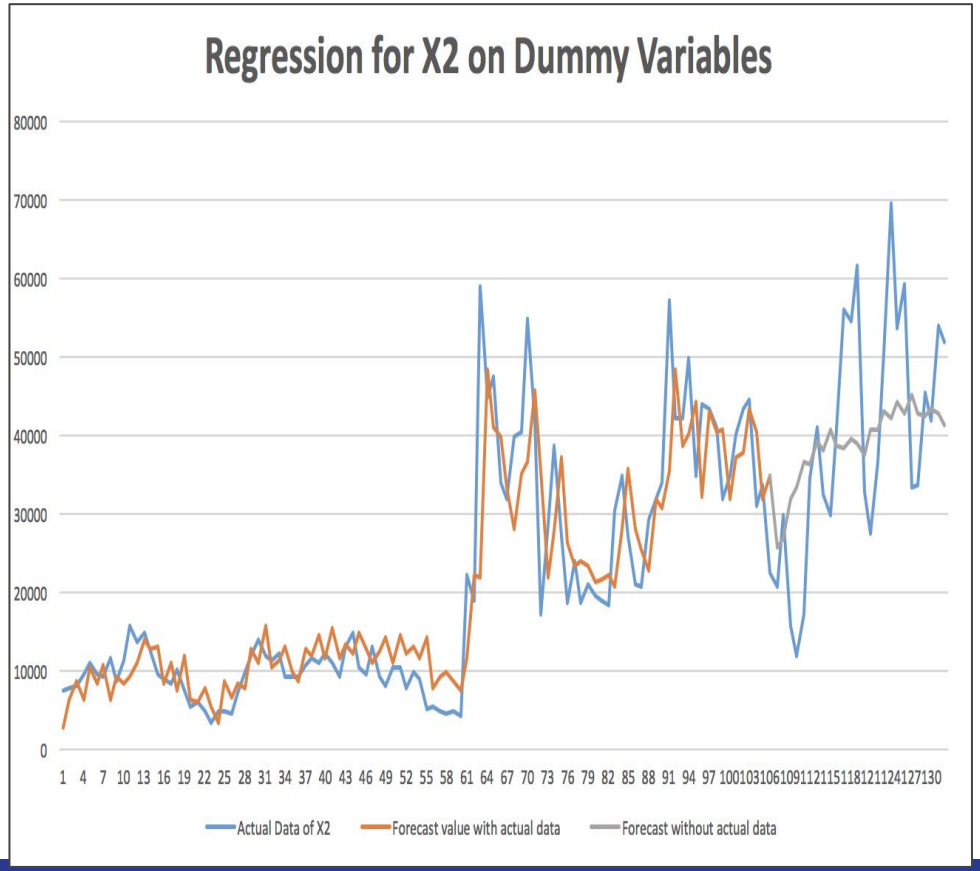
Unconditional Least Squares Estimates			
SSE	4955499309	DFE	92
MSE	53864123	Root MSE	7339
SBC	2238.82675	AIC	2201.53861
MAE	4585.83653	AICC	2206.15399
MAPE	28.7113863	HQC	2216.6517
Durbin-Watson	2.1182	Transformed Regression R-Square	0.1856
		Total R-Square	0.7719

Durbin-Watson Statistics			
Order	DW	Pr < DW	Pr > DW
1	2.1182	0.7137	0.2863

e p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing nega

Autoregressive parameters assumed given					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-389.7720	5481	-0.07	0.9435
T	1	315.6598	77.7763	4.06	0.0001
Q1	1	2925	2762	1.06	0.2924
Q2	1	2732	3523	0.78	0.4400
Q3	1	4518	3958	1.14	0.2566
Q4	1	3316	4215	0.79	0.4334
Q5	1	5248	4353	1.21	0.2311
Q6	1	3480	4400	0.79	0.4310
Q7	1	5388	4362	1.24	0.2199
Q8	1	2819	4233	0.67	0.5071
Q9	1	2214	3987	0.56	0.5800
Q10	1	2795	3567	0.78	0.4353
Q11	1	1916	2767	0.69	0.4905

Results: Regression E for X2 on Time & Dummy Variables



Regression equation for X2 after Autoregression :

X2 = -389.7720 + 315.6598*t + 2925*Q1 + 2732*Q2 + 4518*Q3 + 3316*Q4 + 5248*Q5 + 3480*Q6 + 5388*Q7 + 2819*Q8 + 2214*Q9 + 2795*Q10 + 1916*Q11

Comparison Statistics

In Sample (106 obs)

Forecasting Methods	MSE	MAE	MAPE	SSE	Theil's U
Simple Naive Method	57503334.9	4517.64	21.54%	6037850164	1
Naive Trend Method	57503334.9	4517.64	21.54%	6037850164	1.002919
Naive Seasonal Method	281327363	11983.81	108.46%	25705856655	1.679726
Naive Trend and Seaonal Method	249918950	11213.05	81.05%	22542189598	1.590054
Naive Rate of Change Method	392231498	8894.85	39.27%	40605807470	1.475268
Simple Moving Average (n=3)	64195531.8	4734.63	23.62%	6612139771	1.02603427
Simple Moving Average (n=12)	119901878	7286.85	39.12%	11270776557	1.18028224
Double Moving Average (n=3)	89641055.5	5846.72	26.48%	9053746601	1.03631632
Double Moving Average (n=12)	160136937	8,413.58	37.44%	13291365803	1.24797189
Simple Exponential Smoothing	79200156.9	5470.08	27.66%	8316016479	1.079212
Brown's Method	55087516.9	4403.5	21.45%	5784189273	0.99406
Holt's Method	54121098.2	4412.84	24.35%	5682715314	0.971379
Winter's Multiplicative Method	99016387.5	6151.32	31.87%	9307540427	1.166917
Winter's Additive Method	240176029	10128.19	46.88%	22576546728	1.350682
Addictive Decomposition	94636215.9	7570.36	60.27%	10031438887	1.767463
Multiplicative Decomposition	95240890.4	7552.92	59.45%	10095534386	1.729588
Regression	46854879.9	4599.19	28.89%	5682715314	0.971379

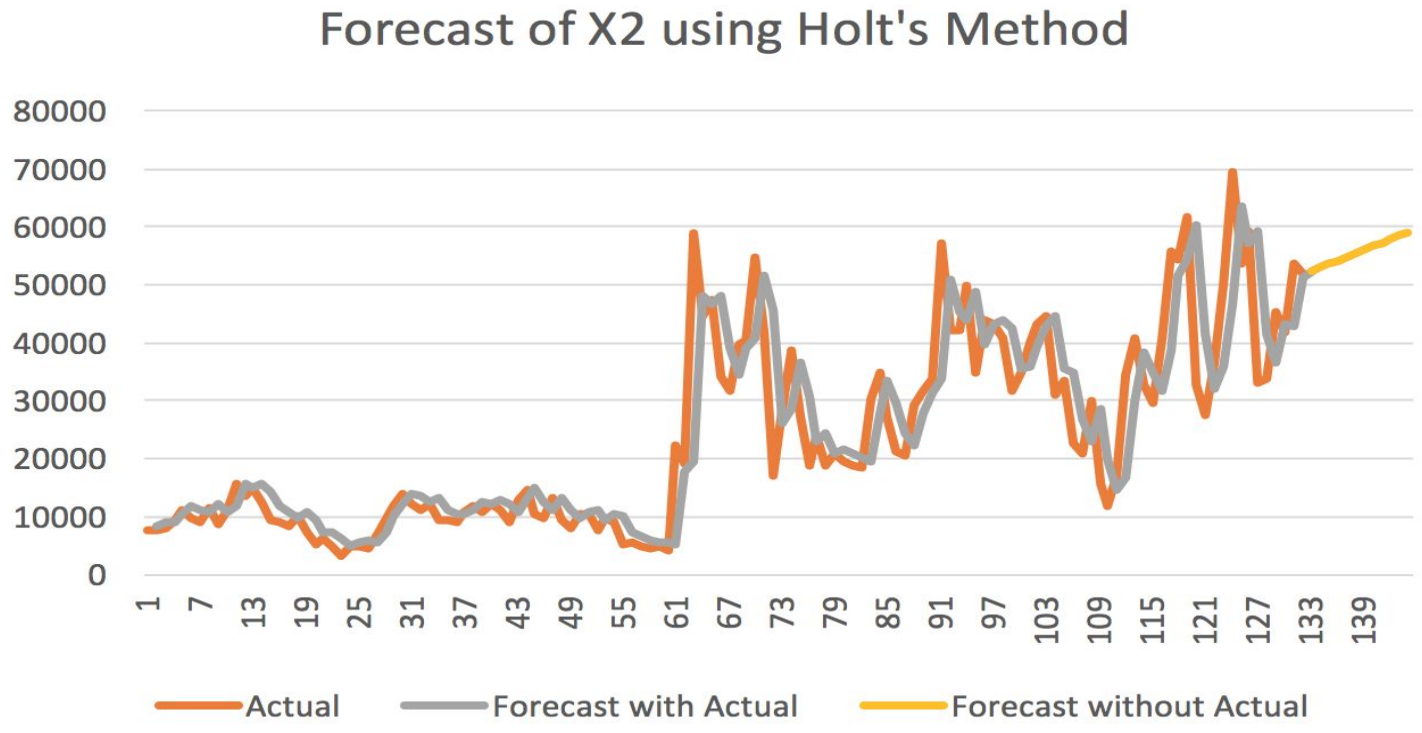
Out Sample (26 obs)

Forecasting Methods	MSE	MAE	MAPE	SSE	Theil's U
Simple Naive Method	518440895	19180.23	44.87%	13479463276	1.551052
Naive Trend Method	1789761626	39344.73	97.80%	46533802279	3.203373
Naive Seasonal Method	319994252	15478.15	44.56%	8992766673	1.698333
Naive and Trend Method	325833068	15556.71	45.28%	9102830323	1.705743
Naive Rate of Change Method	1737911771	38034.49	778851.93%	42672727910	3.051283
Simple Moving Average (n=3)	368759546	15679.25	39.50%	9587748190	1.40638694
Simple Moving Average (n=12)	291995530	13652.523	38.05%	7591883779	1.41176404
Double Moving Average (n=3)	1.2515E+10	97421.44	230.66%	3.254E+11	7.75330003
Double Moving Average (n=12)	373797660	15837.28	43.59%	9718739155	1.58194677
Simple Exponential Smoothing	246696871	12585.57	37.75%	6414118654	1.473429
Brown's Method	479275797	18380.63	44.10%	12461170710	1.511385
Holt's Method	206040149	11307.31	30.88%	5357043883	1.180812
Winter's Multiplicative Method	381461815	16225.24	40.53%	9918007186	1.327528
Winter's Additive Method	416459803	16276.82	36.67%	10827954869	1.374131
Addictive Decomposition	94636215.9	7570.35603	60.27%	10031438887	1.682922
Multiplicative Decomposition	95240890.4	7552.92429	59.45%	10095534386	1.76117
Regression	161844213	10476.84	34.06%	4207949540	1.368076

Final Model Chosen - Holt's Method

α: 0.7046522

β: 0.005921666



Fitted Value - Holt's Method

α: 0.7046522

β: 0.005921666

$$F_{t+m} = 51{,}736.212 + 618.5929 * m \qquad m = 1, 2, 3, \ldots, 12$$

2018	*Fitted Values*		*Fitted Values*
January	52354.80	*July*	56066.36
February	52973.40	*August*	56684.96
March	53591.99	*September*	57303.56
April	54210.58	*October*	57922.14
May	54829.18	*November*	58540.73
June	55447.77	*December*	59159.33

Conclusion

Best Model for each variable:

Y variable	**Holt's Method**
X1 variable	**Brown's Method**
X2 variable	**Holt's Method**

For Y variable - Holt's Method

- Linear trend series
- Beyond sample: Smallest MSE/MAE/MAPE

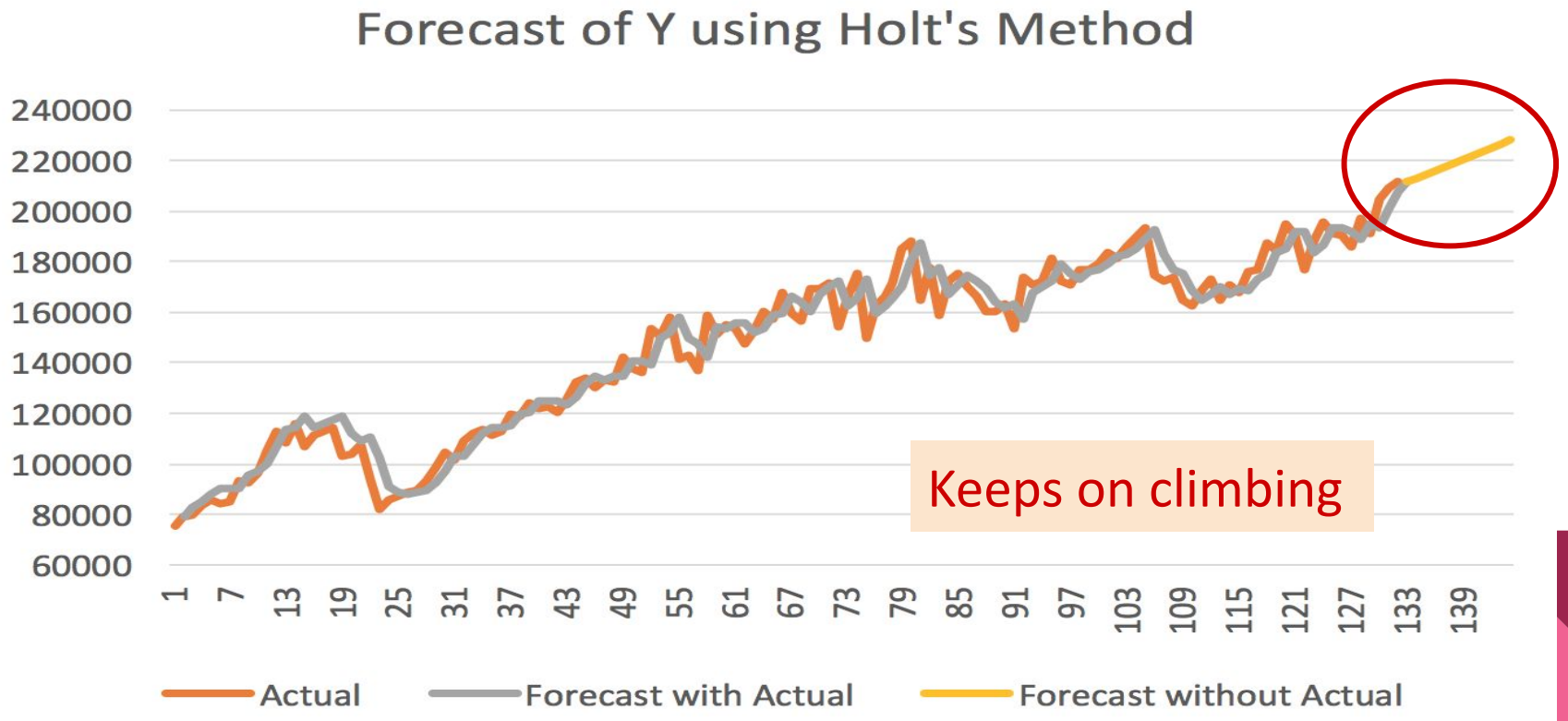
For X1 variable - Brown's Method

- Linear trend series
- Both samples: relatively small MSE/MAE/MAPE
- Theil's U: smaller than 1

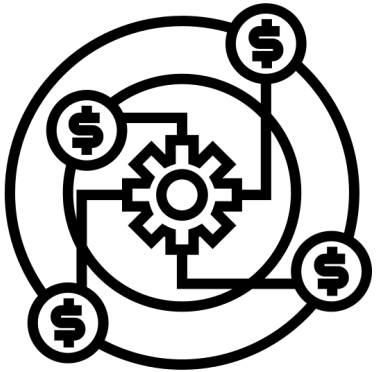
For X2 variable - Holt's Method

- Linear trend series
- Apply different weights to actual data & trend
- MAPE: smallest in beyond sample
- Theil's U: smallest in both samples
- MSE: relatively small in both samples

Recommendations(Price of private housing)

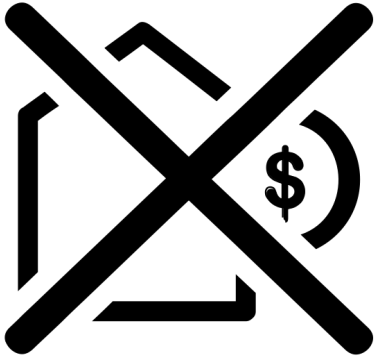


Recommendations



Pros:

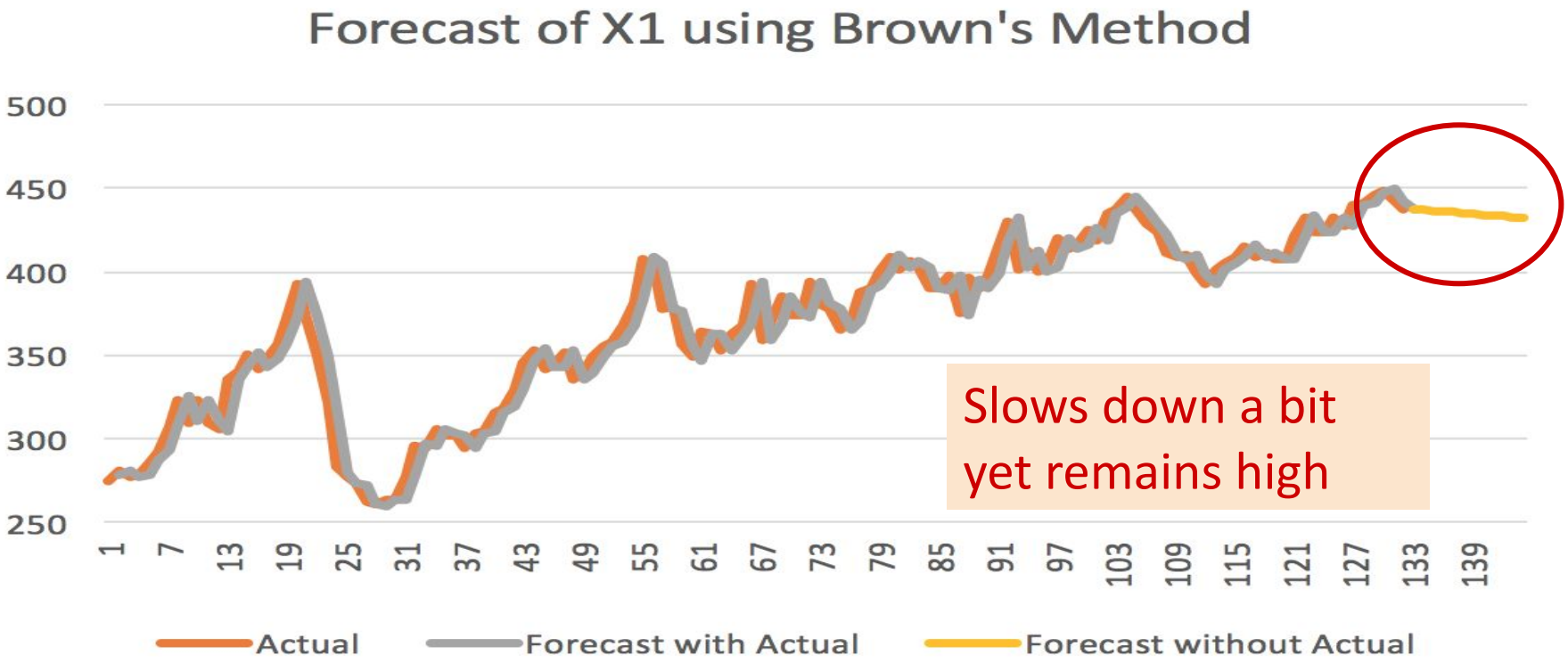
Investment potential



Cons:

More unaffordable

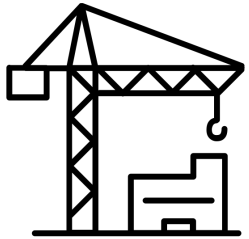
Recommendations(Rental Price)



Recommendations

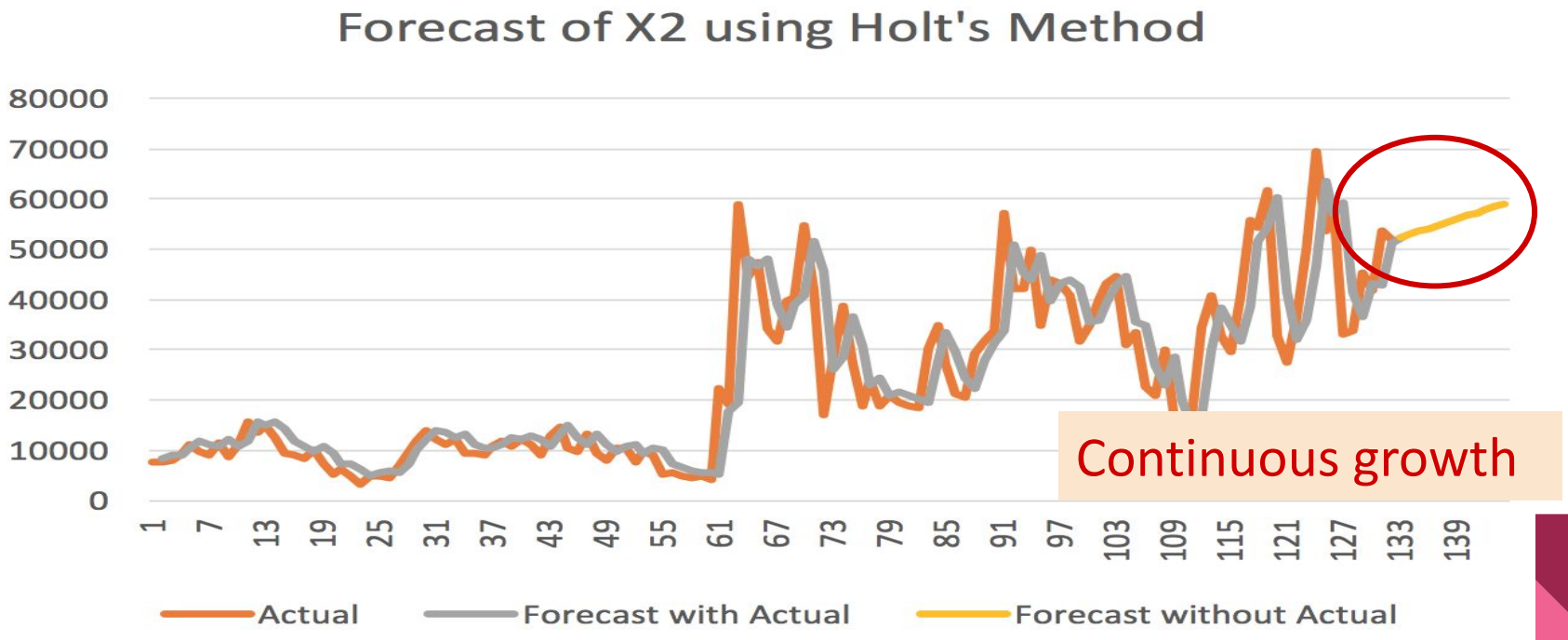
Government policies & measures

- Counter speculations



- Increase land supply

Recommendations(Number of private housing unit's transaction)



Recommendations

- Impose regulations to enhance transparency of transactions

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