Business Forecasting and Analyzing

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Objectives:

❖ Introduce the company overview and its financial overview.

❖ Introduce the variables we used in regression models.

❖ Seasonal Decomposition: Additive and Multiplicative

❖ Multiple Regression

❖ ARIMA Models

❖ Exponential Models

❖ Combinations of ARIMA and Multiple Regression

❖ Analysis and determine the best model

❖ Summary

Company Overview

NVIDIA has been dominating the market of GPUs (Graphics Processing Unit) since 1990s, its rapid and steady technology breakthroughs made other competitors such as AMD gradually shrinking over the years. NVIDIA's GPUs has transformed images in video games from boxy pixels to vivid pictures.
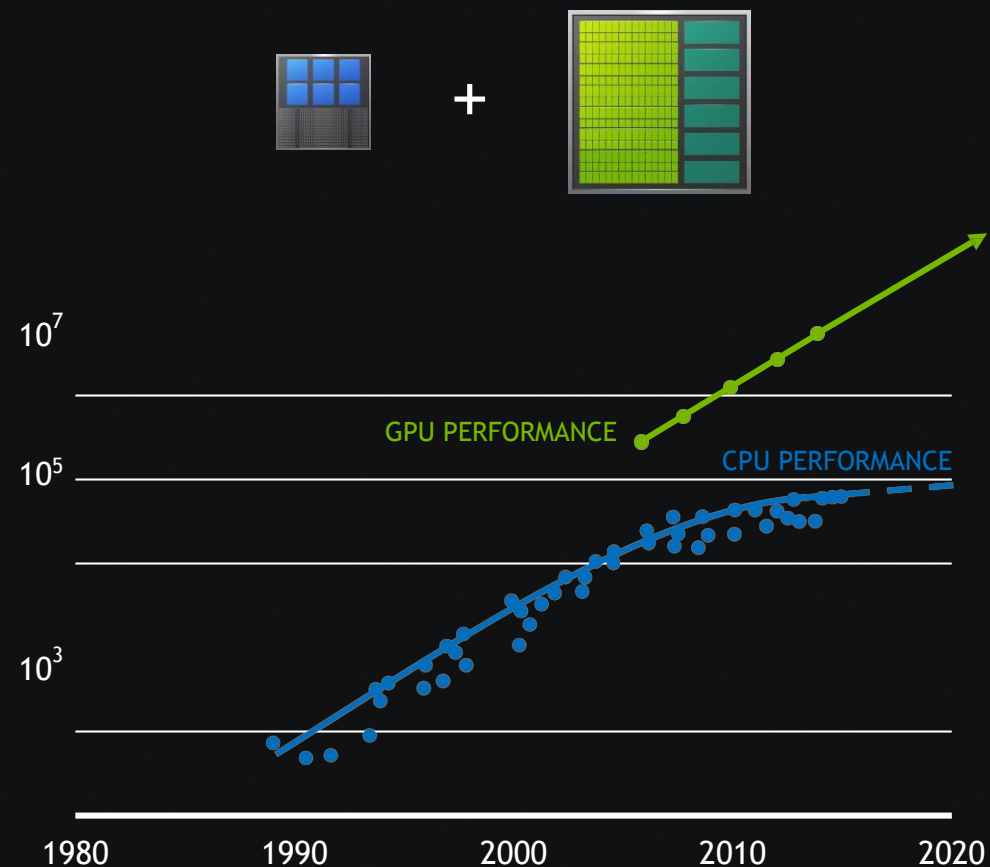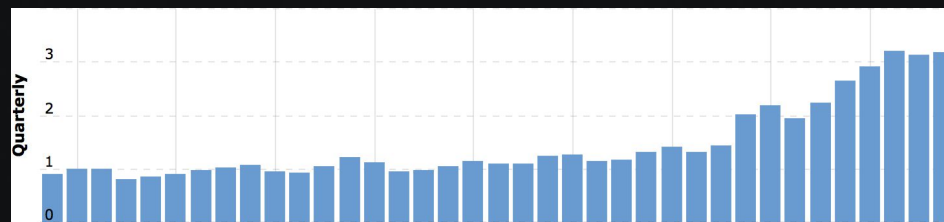
Financial Overview

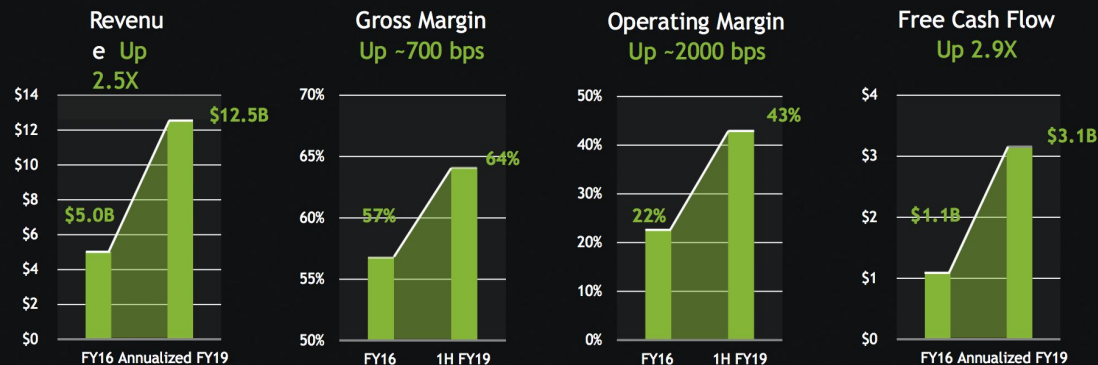Stock price from 2002 to 2018

Quarterly Financial Growth since 2010 (Revenue)
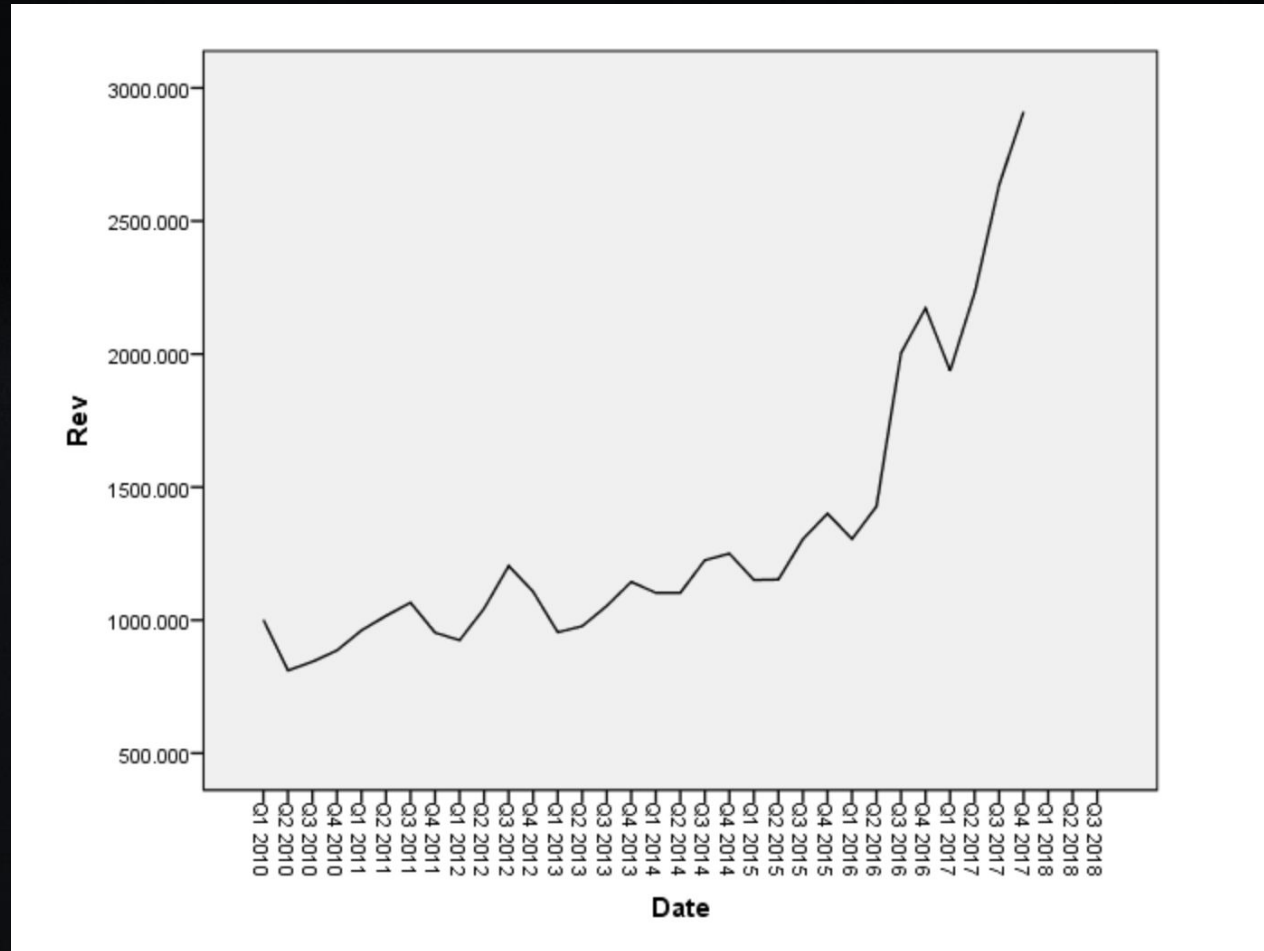
Financial Breakdowns of the Past 3 Years

Revenue Up 2.5X
$5.0B
$12.5B

Gross Margin Up ~700 bps
57%
64%

Operating Margin Up ~2000 bps
22%
43%

Free Cash Flow Up 2.9X
$1.1B
$3.1B

Sequence Chart for NVIDIA Quarterly Revenue

These are the various variables that we've considered to formulate our models:

|		
1	DATE_	String
2	Year	Numeric
3	Rev	Numeric
4	trend	Numeric
5	Q1	Numeric
6	Q2	Numeric
7	Q3	Numeric
8	GDPinbillion	Numeric
9	CPI	Numeric
10	COGSQ	Numeric
11	XRDQ	Numeric
12	Intanq	Numeric
13	AMDREV	Numeric
14	BITCOIN	Numeric
15	IntelRev	Numeric

Bitcoin Price Index:
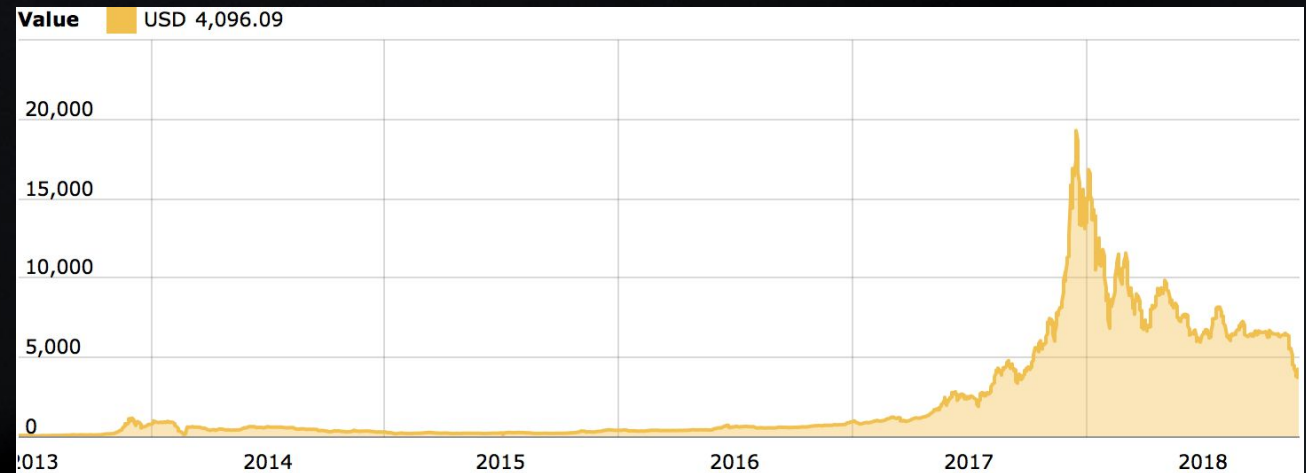
Value   USD 4,096.09

ACF

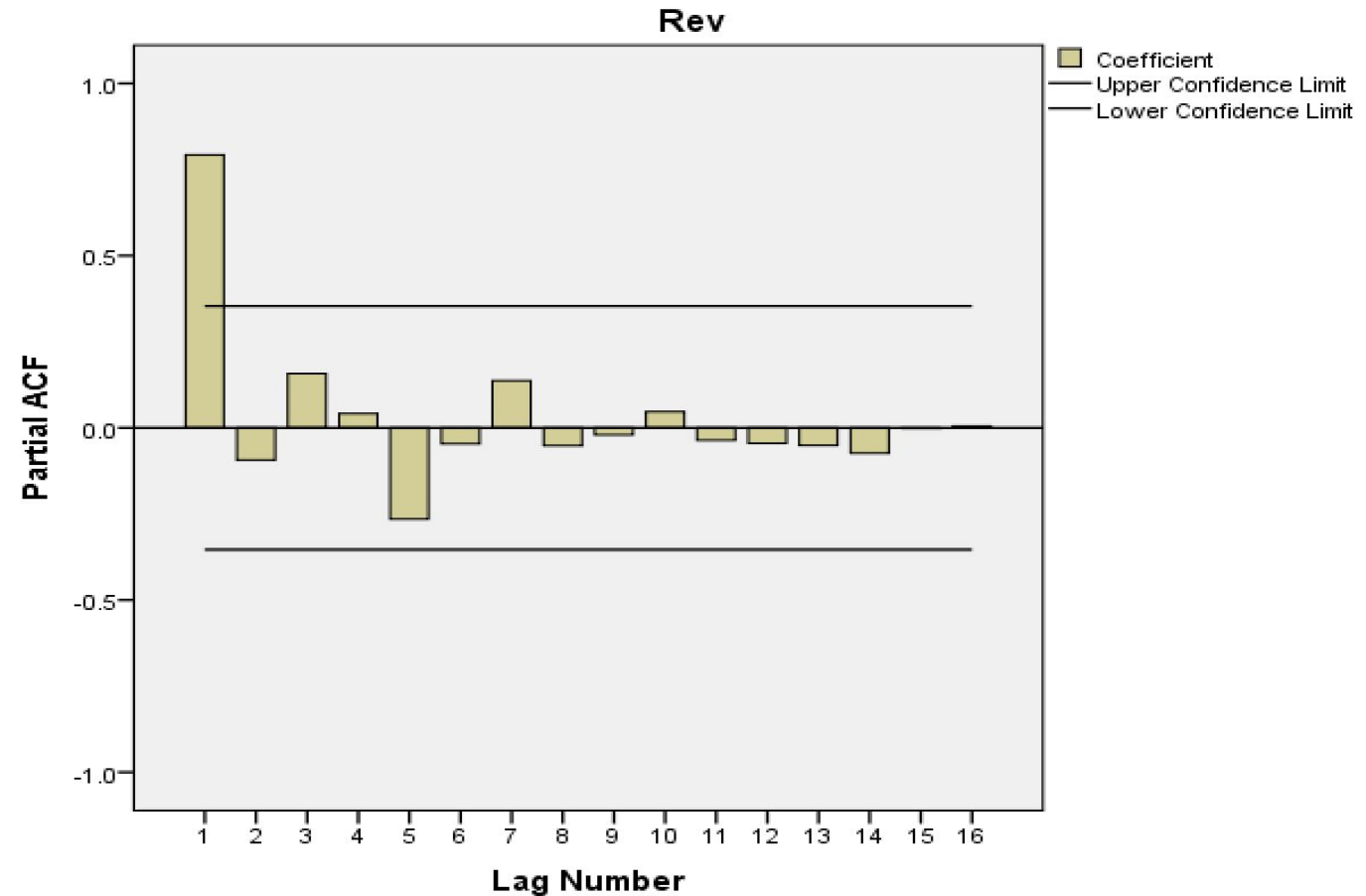This ACF shows a clear trend, however, there is no obvious seasonality.

MA Component:Check
Differencing:Check
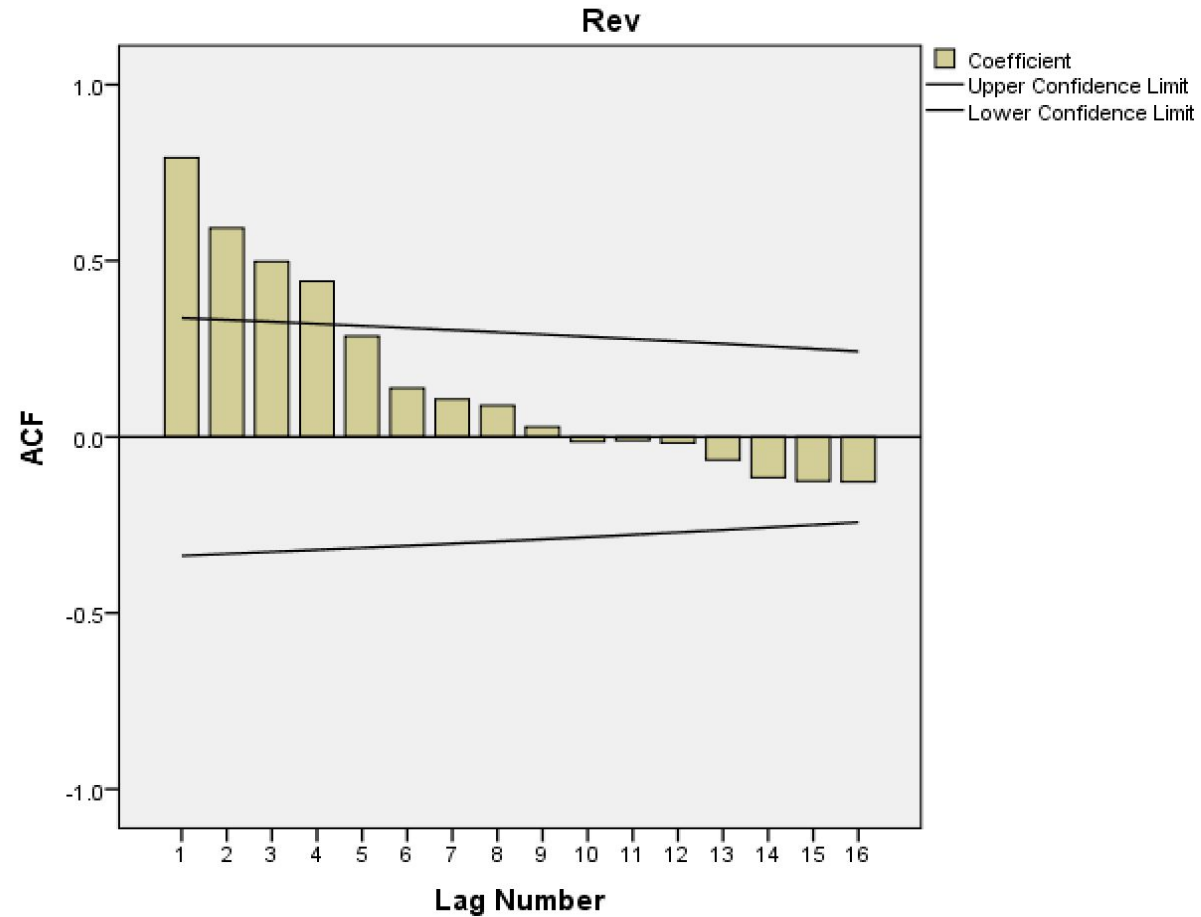
PACF

Note that the PACF plot has one significant spike, and few other spikes indicating there could be more than one lag for autocorrelation.

AR Component: Check

Seasonally differenced ACF
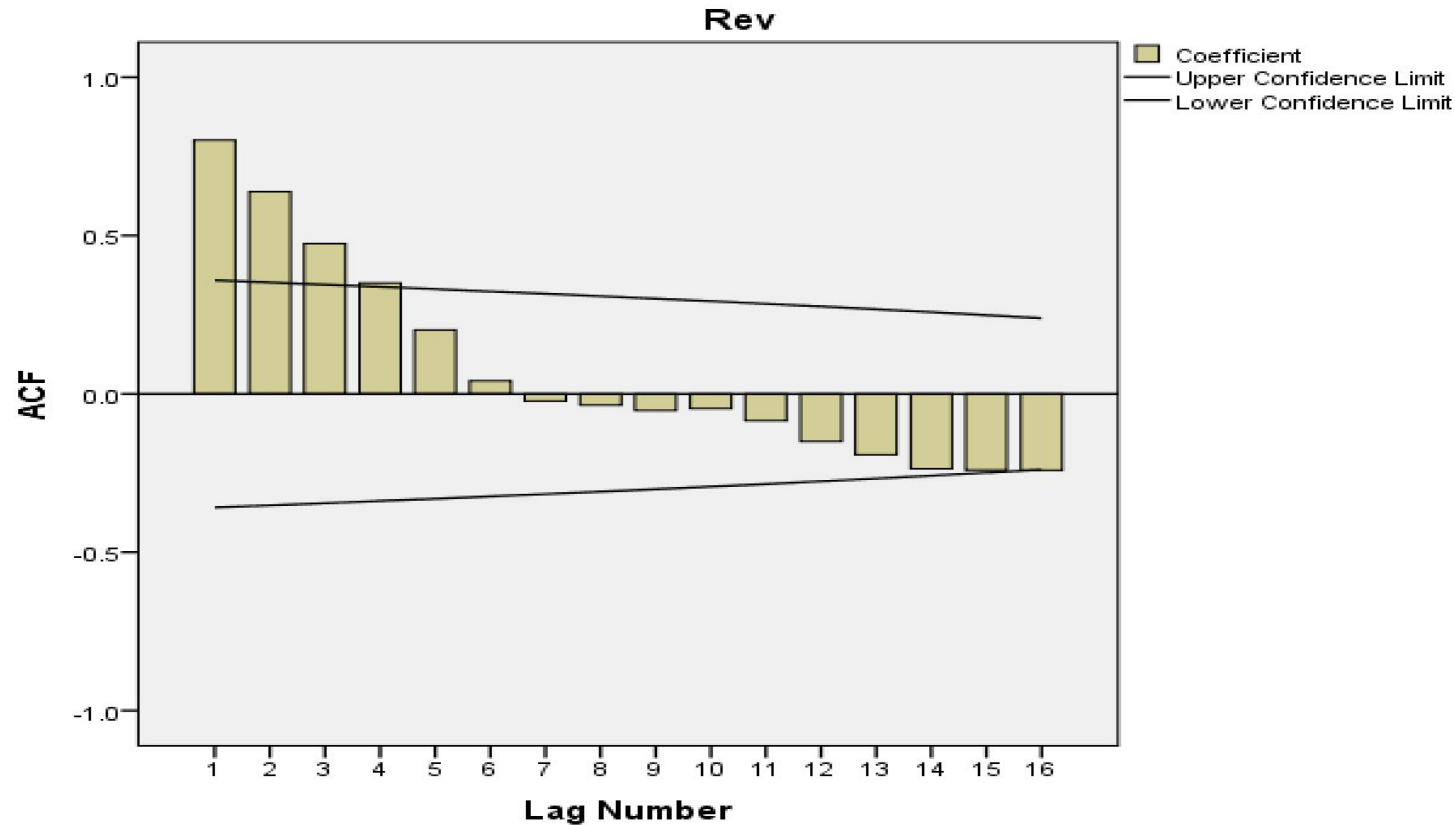
Seasonal Decomposition:
Multiplicative and Additive Model

Multiplicative Model
Y= 578.594 + 44.803*trend

Additive Model
Y= 574.484 + 45.234*trend

Seasonal Factors

Series Name: Rev

Period	Seasonal Factor (%)
1	94.5
2	96.4
3	105.2
4	103.8

Seasonal Factors

Series Name: Rev

Period	Seasonal Factor
1	-77.266990
2	-53.497704
3	74.823113
4	55.941581

Multiple Regression I

From Stepwise, we get:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.997[a]	.994	.994	41.555734	1.600

a. Predictors: (Constant), XRDQ, COGSQ, IntelRev

b. Dependent Variable: Rev

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8639844.056	3	2879948.019	1667.718	.000[b]
	Residual	48352.612	28	1726.879		
	Total	8688196.667	31			

a. Dependent Variable: Rev

b. Predictors: (Constant), XRDQ, COGSQ, IntelRev

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-944.873	80.030		-11.807	.000
	IntelRev	.042	.009	.123	4.655	.000
	COGSQ	2.100	.064	.714	32.954	.000
	XRDQ	1.713	.212	.231	8.069	.000

a. Dependent Variable: Rev

$Y = -944.873 + 0.042*IntelRev + 2.1*COGSQ + 1.713*XRDQ$

Durbin-Watson: 1.6

Forecast:
2018 Q1: 2930.545
2018 Q2: 3051.397
2018 Q3: 3370.138

MAD: 178.3987
MSE: 38858.3292

Correlation Chart : multicollinearity ?

Correlations

		COGSQ	XRDQ	AMDREV	BITCOIN	IntelRev
COGSQ	Pearson Correlation	1	.749**	-.068	.722**	.697**
	Sig. (2-tailed)		.000	.713	.000	.000
	N	32	32	32	32	32
XRDQ	Pearson Correlation	.749**	1	-.417*	.602**	.839**
	Sig. (2-tailed)	.000		.018	.000	.000
	N	32	32	32	32	32
AMDREV	Pearson Correlation	-.068	-.417*	1	.194	-.260
	Sig. (2-tailed)	.713	.018		.287	.150
	N	32	32	32	32	32
BITCOIN	Pearson Correlation	.722**	.602**	.194	1	.503**
	Sig. (2-tailed)	.000	.000	.287		.003
	N	32	32	32	32	32
IntelRev	Pearson Correlation	.697**	.839**	-.260	.503**	1
	Sig. (2-tailed)	.000	.000	.150	.003	
	N	32	32	32	32	32

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Multiple Regression II

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.794[a]	.631	.606	332.509708

a. Predictors: (Constant), AMDREV, BITCOIN

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5481878.197	2	2740939.099	24.791	.000[b]
	Residual	3206318.470	29	110562.706		
	Total	8688196.667	31			

a. Dependent Variable: Rev

b. Predictors: (Constant), AMDREV, BITCOIN

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2163.344	321.281		6.733	.000
	BITCOIN	1692.680	247.547	.786	6.838	.000
	AMDREV	-.707	.237	-.342	-2.977	.006

a. Dependent Variable: Rev

$Y = 2163.344 + 1692.68*BitCoin - 0.707*AMDRev$

Forecast:
2018 Q1: 2691.592
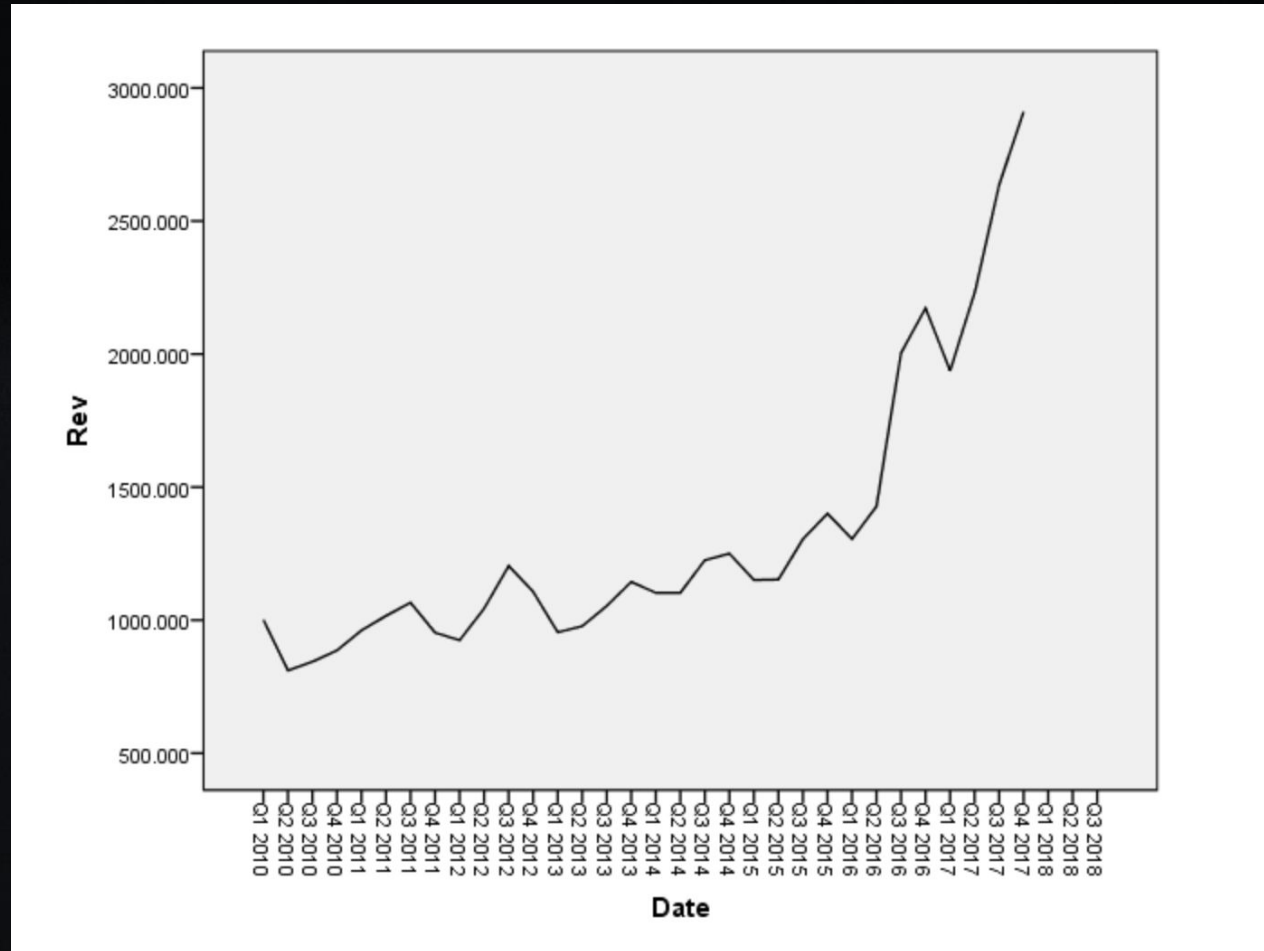2018 Q2: 2614.532
2018 Q3: 2687.353

MAD: 506.5067
MSE: 256615.99

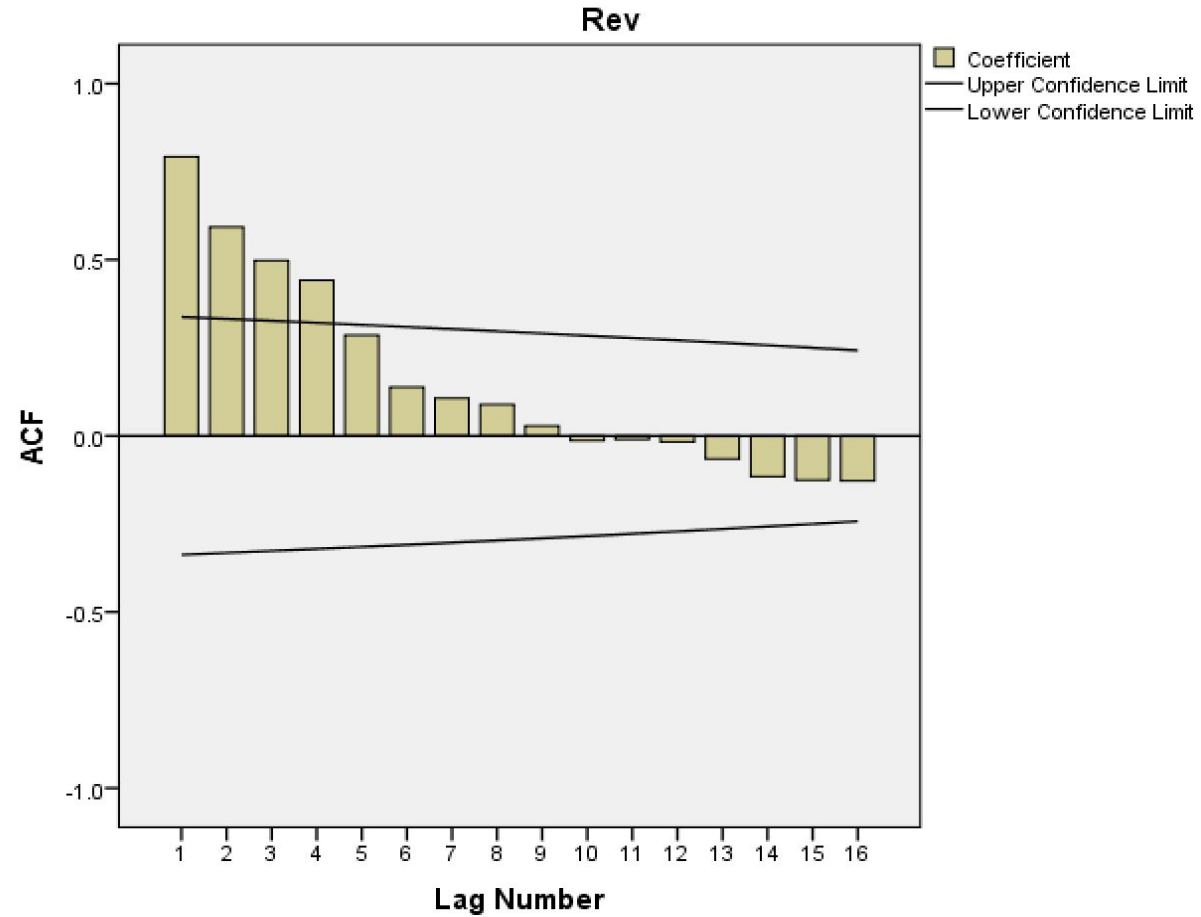Sadly, worse than Expectation
Will not include this in further tests

Sequence Chart for NVIDIA Quarterly Revenue

ACF

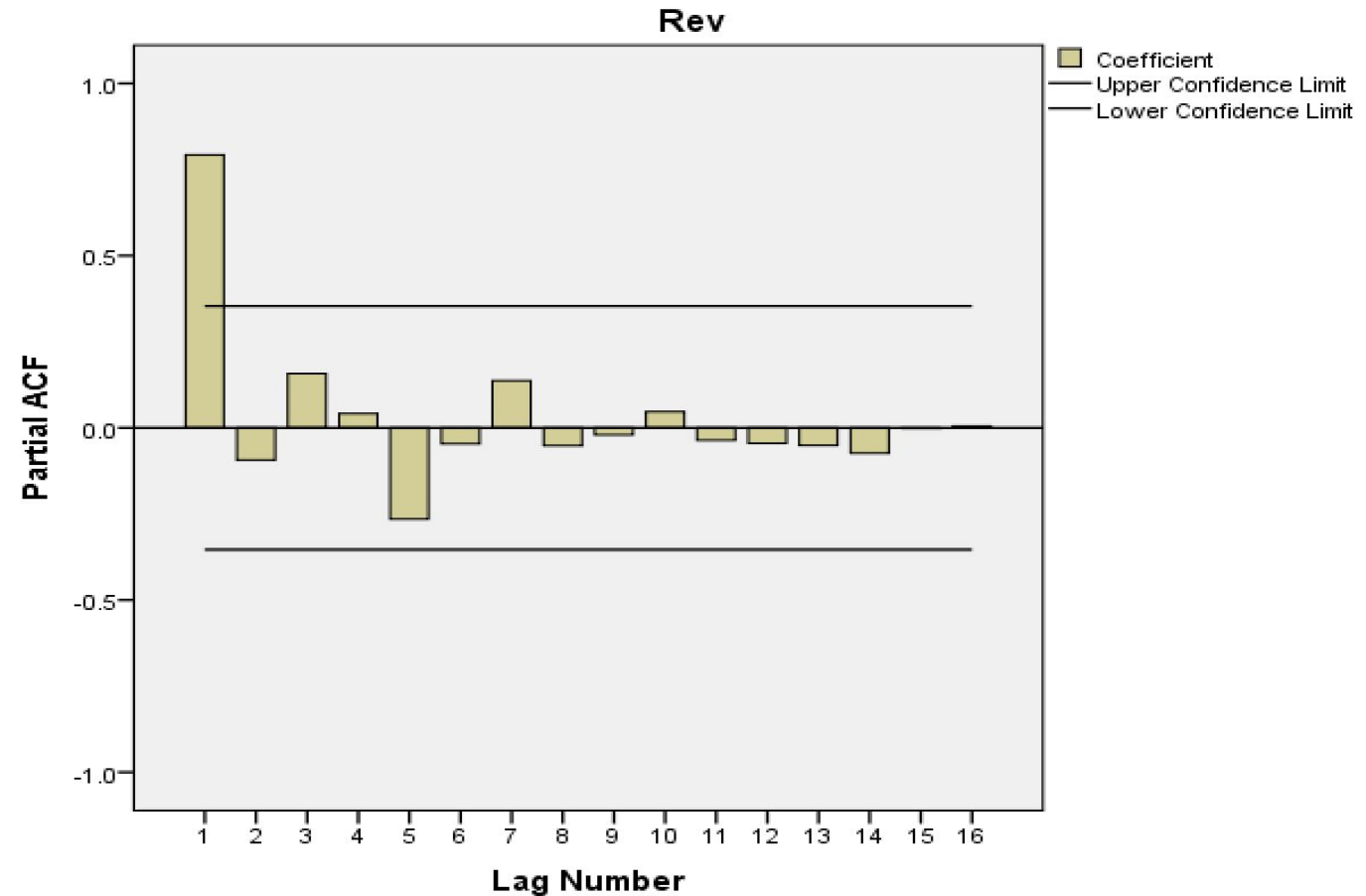This ACF shows a clear trend, however, there is no obvious seasonality.

MA Component:Check
Differencing:Check

PACF

Note that the PACF plot has one significant spike, and few other spikes indicating there could be more than one lag for autocorrelation.

AR Component: Check

ARIMA(3,1,1)(0,0,0)$_4$

ARIMA Model Parameters

						Estimate	SE	t	Sig.
Rev-Model_1	Rev	Natural Logarithm	AR	Lag 1		1.090	.239	4.568	.000
				Lag 2		-.840	.212	-3.969	.000
				Lag 3		.691	.160	4.314	.000
			Difference			1			
			MA	Lag 1		.716	.332	2.160	.040

Model Statistics

Model	Number of Predictors	Model Fit statistics			Ljung-Box Q(18)			Number of Outliers
		Stationary R-squared	MaxAE	Normalized BIC	Statistics	DF	Sig.	
Rev-Model_1	0	.334	389.178	10.148	8.588	14	.857	0

Noise residual from Rev-Model_1
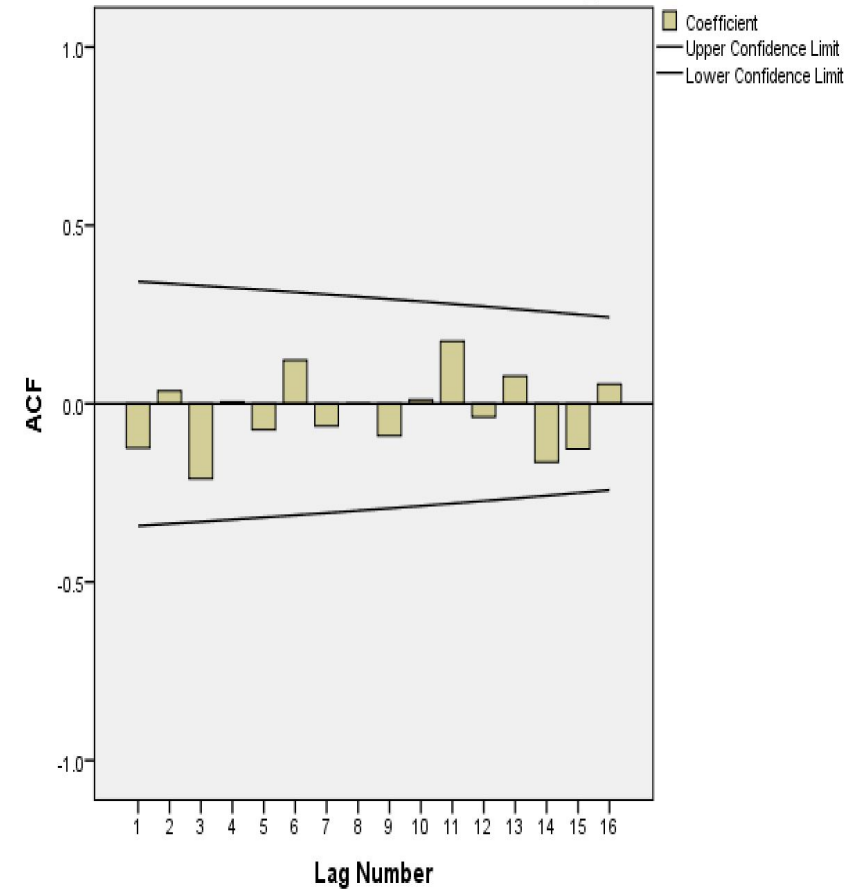
ARIMA(3,1,1)(0,0,0)$_4$

Fit+Forecast graph
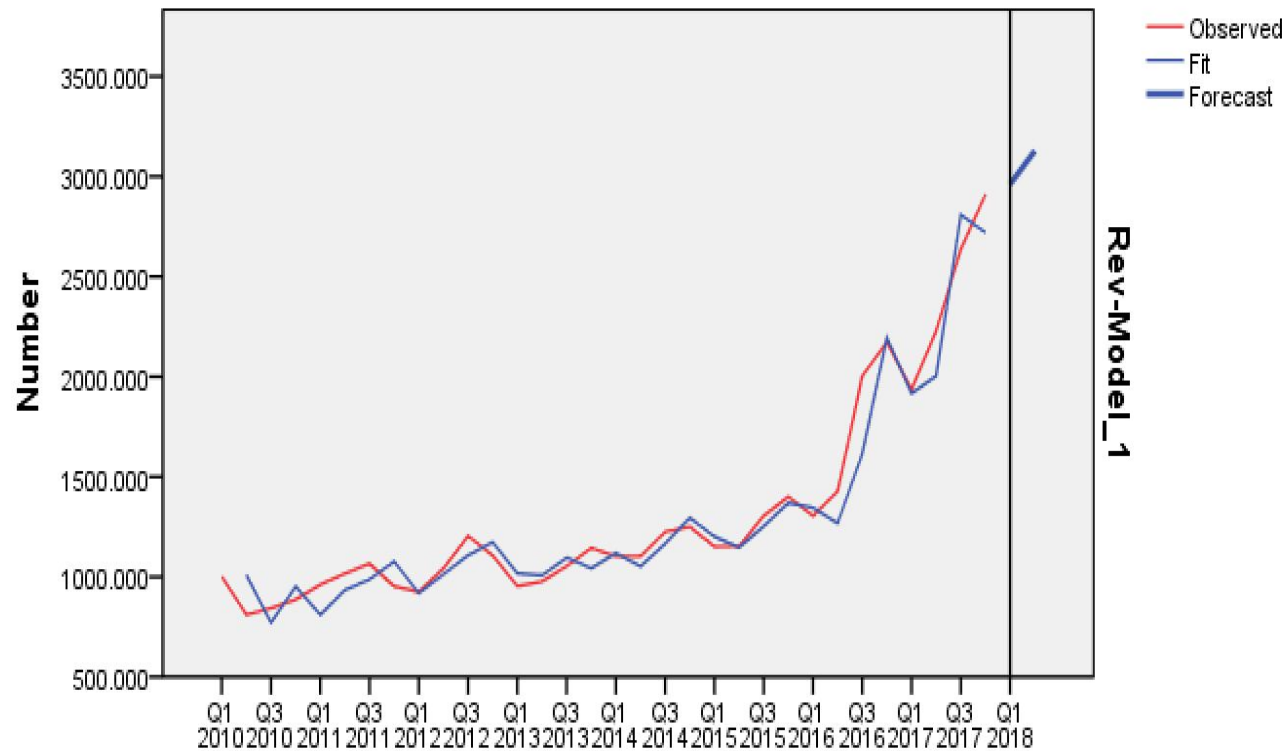
Predicted Value:
Forecast:
2018 Q1: 2962.225
2018 Q2: 3127.524
2018 Q3: 3497.749

MAD:188.01
MSE:35320.1778

# Exponential Smoothing(Holt's With Log transformation)

Model Statistics

Model	Number of Predictors	Model Fit statistics Stationary R-squared	Ljung-Box Q(18) Statistics	DF	Sig.	Number of Outliers
Rev-Model_1	0	.459	34.202	16	.005	0

Exponential Smoothing Model Parameters

Model			Estimate	SE	t	Sig.
Rev-Model_1	Natural Logarithm	Alpha (Level)	1.000	.174	5.753	.000
		Gamma (Trend)	.000	.080	.004	.997

Forecast

Model		Q1 2018	Q2 2018	Q3 2018
Rev-Model_1	Forecast	3020.856	3134.872	3253.203
	UCL	3755.972	4250.950	4708.603
	LCL	2400.612	2256.933	2168.068
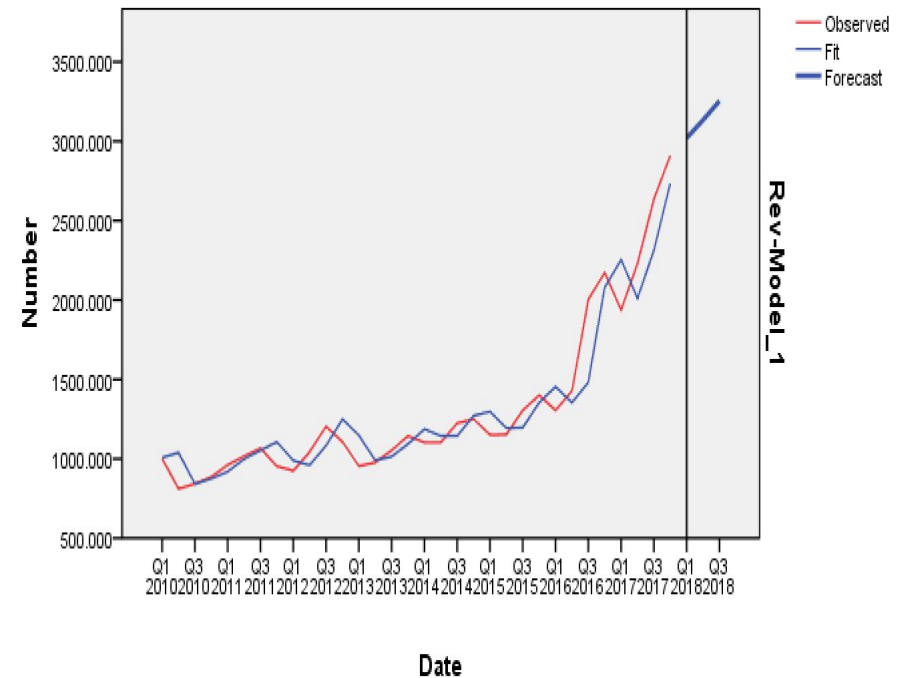
MAD: 90.073
MSE:13334.60211

Combine MR1 + Exponential Smoothing (ES)
Y=0.044F(ES)+0.956F(MR1)

Forecast:
2018 Q1: 2934.5186
2018 Q2: 3055.0699
2018 Q3: 3364.9928

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	Predicted value from Rev-Model_1	.045	.045	.044	1.004	.323
	Unstandardized Predicted Value	.956	.044	.956	21.829	.000

MAD:174.1347
MSE:37237.3224

Combine MR1 + ARIMA
$Y = 0.995F(MR1) + 0.005F(ARIMA)$

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	Unstandardized Predicted Value	.995	.067	.995	14.821	.000
	Predicted value from Rev-Model_1	.005	.069	.005	.070	.945

a. Dependent Variable: Rev

b. Linear Regression through the Origin

Not Statistically Significant

Analysis and Comparison of Different Models to determine which one is the best

Model	Significance	MAD	MSE	Rank
MR1	Yes	178.40	38858.33	
MR2	Yes	506.51	256615.99	
Exponential(Holt's)	**Yes**	**90.07**	**13334.60**	**1**
ARIMA	Yes	188.01	35320.18	
MR1 and Exponential	Yes	174.13	37237.32	
MR1 and ARIMA	No	/	/	

Summary:

In the end, we've determined that...