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MSIM 3103:
Business Forecasting

Report Title:
Forecast of the cargo flow in Hong Kong International Airport

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1. Introduction

Hong Kong International Airport(usually called HKIA) is one of the world's busiest international cargo airports. The location of the airport is in Chek Lap Kok, which first opened in 1998 and relocated from Kai Tak Airport. HKIA had moved 4.8 million cargo and airmail. In 2020, HKIA handled 4.5 million tonnes of the total cargo throughput as well. The cargo accounted for about forty-three per cent of the total value of Hong Kong's external trade. There are fifty-five packing stands for the cargo aircraft, that's the reason why HKIA can hold the process efficiency. HKIA had won many awards in cargo, for example, 2021 Top Asian Airport Efficiency Excellence (Awarding from Air Transport Research Society) and 2019 Freighter Hub of the Year 2019 (Awarding from Air Cargo News).

Under the COVID-19 effect, the HKIA total cargo throughout did not reduce by a large portion. There are fewer people on the flight, cargo would not stop for no reason. Since vaccines need to be transported in a limited time, the government can only choose air cargo to supply this service. HKIA became a preferred hub for vaccine transport, transporting the vaccine and providing 50 live shipments of the trial run.

HKIA is one of the famous airports in cargo efficiency, as they set the target mostly to finish each process within thirty minutes and above ninety-six per cent. In this project, we would forecast the cargo throughout HKIA and other factors that may affect cargo transportation from 2016-to 2021. The forecast model contains the value before the Anti-Extradition Law Amendment Bill Movement, during the movement and the COVID-19 pandemic.

2. Objective

The objective of the analysis is to consider all factors that may affect the goods of Hong Kong International Airport. We will use linear regression to choose the independent variables on the change of the (total) goods flow. Next, we will base on the function, time series, and the ARIMA to select the most suitable method to forecast the HKIA goods flow a few months later. By finishing the model, we very much hope that it can help HKIA to forecast the goods flow and continuously effectively control the volume of the goods in HKIA in the future.

3. Data Source

There are a total of 12 variables(x) that can be classified into 3 important data source types taken into the discussion in the analysis. They include the Weather factor, Economic factor and Covid factor.

We also consider shipping fees and total GDP for other variables in this study. However, there is no data about previous shipping fees after we search for a bunch of websites. It seems the previous shipping fee would not show to the public. And the reason why we do not consider total GDP is that total GDP was not suitable for our study. The total GDP was collected by year but we are using monthly data.

Weather is one of our factors as it is an important factor to decide whether the airplane can land or take off. It included Pressure, Temperature, Cloud, Rainfall and Wind speed. If there is bad weather, it is common to delay the airplane and also the cargo. We can see that the weather affects the airplane and affects the cargo volume indirectly.

The CPI(A), CPI(B) and CPI(C) respectively cover some 50%, 30% and 10% of households in Hong Kong. The average monthly household expenditures (in HK\$) of these groups were \$6,500 - \$27,999, \$28,000 - \$48,499 and \$48,500 - \$91,999 respectively during October 2019 - September 2020, which is the base period. Within consideration of the influence of price changes since the base period, the monthly household expenditure ranges of the CPI(A), CPI(B) and CPI(C) adjusted to the price level of 2021 are broadly equal to \$6,600 - \$28,200, \$28,200 - \$48,700 and \$48,700 - \$92,500 respectively, and that of the Composite CPI is equivalent to \$6,600 - \$92,500. (Census and Statistics Department, 2021)

Variables	Reason
1. Year	Time series data
2. Month	
3. Mean Pressure (hPa)	Could affect the airplane landing and take off then affect the number of cargo
4. Mean Air Temperature (Deg. C)	
5. Mean Amount of Cloud (%)	
6. Total Rainfall (mm)	
7. Mean Wind Speed (km/h)	
8. Consumer Price Index	Reflect on people's ability to send cargo by air transport
9. Consumer Price Index (A)	
10. Consumer Price Index (B)	
11. Consumer Price Index (C)	
12. Covid case (number)	Could affect the number of airplanes

4. Correlation Analysis

Let p denote the correlation between the variables.

$$H_0 : p = 0$$

$$H_1 : p \neq 0$$

From the correlation coefficient table (Appendix 1), there are 12 variables that show a significant relationship

($\alpha < 0.05$) to the throughput of airport control point passenger flow.

1. Year with the correlation coefficient of 0.0439 shows a weak positive relationship with airport control point passenger flow.
2. Month with the correlation coefficient of 0.6637 shows a strong positive relationship with airport control point passenger flow.
3. Composite CPI with the correlation coefficient of 0.0685 shows a weak positive relationship with airport control point passenger flow.
4. CPI (A) with the correlation coefficient of 0.0722 shows a weak positive relationship with airport control point passenger flow.
5. CPI (B) with the correlation coefficient of 0.0533 shows a weak positive relationship with airport control point passenger flow.
6. CPI (C) with the correlation coefficient of 0.0733 shows a weak positive relationship with airport control point passenger flow.
7. Covid's case with the correlation coefficient of -0.0176 shows a weak negative relationship with airport control point passenger flow.
8. Total rainfall with a correlation coefficient of 0.0417 shows a weak positive relationship with airport control point passenger flow.
9. Mean amount of Cloud with a correlation coefficient of -0.1528 shows a weak negative relationship with airport control point passenger flow.
10. Mean pressure with the correlation coefficient of -0.1209 shows a weak negative relationship with airport control point passenger flow.
11. Mean wind speed with the correlation coefficient of 0.2103 shows a weak positive relationship with airport control point passenger flow.
12. Mean air temperature with the correlation coefficient of 0.2278 shows a weak positive relationship with airport control point passenger flow.

5. Regression Analysis

Data selection

Regression analysis for Hong Kong International Airport cargo volume flow is generated by twelve independent variables which are expected to have some relationship among them. The reason why we do not consider GDP and shipping fees in the regression is that no monthly GDP statistics are provided and no trace of the changes in the shipping fees can be found on the internet.

Dependent variable (y)

1. Airport total cargo volume

Independent variable (x)

1. HK Covid cases
2. Time
3. Total Rainfall
4. Mean Wind Speed
5. Mean Pressure
6. Mean amount of Cloud
7. Mean Air Temperature
8. Composite CPI (Consumer Price Level)
9. CPI (A)
10. CPI (B)
11. CPI (C)
12. 11 dummy variables
13. $Y(t-1)$

Scatterplot

According to the scatter plot diagram (Appendix 2), from 2016 to 2021, there is a positive trend in cargo volume flow in HKIA with a seasonal pattern and few outliers indicated in the plot. It shows that cargo volume is subject to seasonality. For instance, volume flow rises when a new phone model launches. For the past 2 years, the air cargo volume has a steady increasing trend as medical supplies such as vaccines are in high demand and acted as a transshipment hub under a privileged geographical location to facilitate international trade. In addition, 11 dummy variables will be added to address the seasonal pattern.

Multiple Regression Analysis with Time Series

After investigating all of the above variables for the model, the multiple regression models can be generated by using Minitab to fit all the independent variables.

1st Regression Model (Appendix 3)

$$\begin{aligned}\text{Cargo_volume} = & 5407163 + 1724 \text{ Time (x)} + 111422 \text{ Composite CPI} - 27474 \text{ CPI (A)} \\ & - 127550 \text{ CPI (B)} + 32337 \text{ CPI (C)} - 20.53 \text{ Covid case} - 2.8 \text{ total rainfall} \\ & - 609 \text{ Mean amount of Cloud} - 3787 \text{ mean pressure} - 452 \text{ Mean wind speed} \\ & - 4551 \text{ mean air temperature} - 93300 \text{ Q2} + 32051 \text{ Q3} + 1207 \text{ Q4} + 17237 \text{ Q5} \\ & + 12401 \text{ Q6} + 15696 \text{ Q7} + 5112 \text{ Q8} + 24822 \text{ Q9} + 52164 \text{ Q10} + 66732 \text{ Q11} \\ & + 58182 \text{ Q12}\end{aligned}$$

However, there are some non-significant variables in the model even if the four assumptions of linear regression are satisfied. In order to ensure the accuracy of the regression model. The least significant variables have to be dropped one at a time until every variable is within the significant level ($p\text{-value} < 0.05$) under the stepwise procedure. (Appendix 4 -12)

11th Regression Model (Appendix 13)

After re-conducting the regression analysis 10 times and eliminating 10 non-significant variables, the next step is to remove the multicollinearity to ensure no correlation between explanatory variables. Thus, variables which have a VIF value larger than 5 will be dropped one at a time until all the variables are significant and have no multicollinearity.

14th Regression (Appendix 16)

After re-conducting the regression and eliminating 3 variables that have multicollinearity, we found that the $p\text{-value}$ of some variables is larger than 0.05, so they should be dropped.

19th Regression (Appendix 21)

After re-conducting the regression and eliminating 5 non-significant variables, the variables in the model are all significant and no multicollinearity existed. However, the value of the adjusted R-square is 72.89%, which is not ideal in multiple regression. Therefore, we would like to add one independent variable to the regression model to check if any transformation is made and examine the result. (Appendix 22)

Examination

The p-value of the whole regression model is smaller than 0.05, which indicates that the regression model is significant in predicting the cargo volume flow. Besides, the R-sq (Adj) equals 75.85% which implies that 75.85% of the variation can be explained by the model. Although it is less than 80%, a 2.96% increase has occurred after adding the new variables and it is a fair model to predict.

As per the residual plot, the three assumptions of linear regression are satisfied.

1. The relation is linear.
2. The errors have constant variance
3. The errors are normally distributed

For the assumption of independent errors, it is hard to tell whether the independence of residuals exists from the residual plot, thus we need to check Durbin-Watson's statistics for further analysis.

Durbin-Watson Statistic

H0: $\rho=0$

H1: $\rho>0$

Durbin-Watson Statistic = 1.12452

With $k=5$, $n=72$ and $\alpha=0.01$, we find that $L=1.313$, $U=1.611$

Since the value of DW falls below $L=1.313$, we reject the null hypothesis and conclude that the error terms are positively autocorrelated. Assumption 2 is not satisfied after adding an independent variable.

Regression Equation

$\text{Cargo_volume} = 324477 - 113749 Q2 + 27515 Q10 + 46290 Q11 + 38050 Q12 + 0.1852 Y(t-1)$

Forecasting

To examine the accuracy of the regression model, the cargo flow in Hong Kong International Airport in Feb 2022 is predicted. By inputting the real data of independent variables,

Variables	Setting
Y(t-1)	388,000
Q2	1
Q3	0
Q10	0
Q11	0
Q12	0

The fitted value is 282,585.6, while the actual value is 270,000,

The percentage error:

$$= \frac{270,000 - 282,585.6}{270,000} \times 100\%$$

$$= -4.66\%$$

Therefore, we can conclude that the regression model is fair to predict the cargo volume flow.

6. ARIMA

Autoregressive Integrated Moving Average models (ARIMA models) in the early 1970s, this model is a class of linear models that is capable of representing stationary as well as non-stationary time series. This model relies heavily on autocorrelation patterns in the data.

First, as the result of the ACF total plot SAR1, SD1, and SMA1 (Appendix 25-27), the data show it is the seasonal pattern and trend pattern, we saw that r1 and r2 are above the value, and r3 have just touched the value. There are two significant values. The p-value is less than the α value(0.05), so the ARIMA is significant.

While we run the ARIMA models, the non-seasonal pattern is not suitable for the data we input, so we try to run it in seasonal-patterns AR1. Besides, we set the moving average and difference in 1, as if we didn't set ARIMA cannot run probably.

For the double moving average, the result of the ACF total plot AR1, Double MA (Appendix 28-31) shows that the r1, r2, r3, and r4 are above the value, and the r5 just touched the value. There are five significant values in the ACF total plot. Also, the Constant type p-value is about 0.000, it is smaller than the α value(0.05), so the ARIMA is significant.

7. Time Decomposition

Time decomposition is the analysis of time-series data to separate the underlying pattern in the data series from randomness. The underlying pattern can also break down into sub-patterns. We use Minitab for finding out the pattern and the relevant data.

After the Time decomposition function in Minitab, we find that the result is good. Since the value of MAPE is 9 per cent (<10%), which means the average percentage error between forecast data and actual data is only 9 per cent.

The forecasting value of the following 5 months:(start from 2022 January)

409782.5321, 410128.375, 410474.218, 410820.061, 411165.9039

We are using the following formula and data to do forecasting:

$$\hat{y} = b_0 + b_1x$$

n	b0	b1
72	384535.9957	345.8429642
Sum of X	Sum of Y	sum of X^2
2628	28595467	127020
Sum of X*Y		
1054489570		

X = time series

Y = total goods flow

8. Suggestion

The above forecasting trend demonstrates the cargo volume flow in HKIA is increasing with the seasonal fluctuations. HKIA is located in an advanced geographical location that serves as a gateway for Asia to travel to other regions. Amid the COVID-19 effects, the cargo traffic continued to increase. The cargo throughput rose 8.3% to 4.9 million tons in 2021, concerning the HKIA press release. The three cargo terminal operators are reaching their capacity. To stay competitive in the region, and accurate cargo volume forecast should be established with continuous review and improvement. Thus, here are some suggestions for the HKIA to consider.

For short term suggestions, a well-structured forecast model should be developed and utilized for the application of digital twins. In our regression model, it is reflected that the assumption of independent error is not satisfied with the reference of Durbin Watson's Statistics even if an independent variable ($Y(t-1)$) is added. To improve the model accuracy and total variation explained by the model, more relevant independent variables should be added to satisfy assumption 2, for example, average crude oil price, exchange rate, and no. of aircraft used. Besides, we understood that the airport authority implemented digital twin to help them make better-informed decisions based on the analyzed data. To maximize the usage, the digital twin can simulate different scenarios that happened in the air cargo terminals and find the optimal solution for various situations. For example, how to deal with continuously changing government policy.

As for the long-term suggestions, operators can invest more capital in digital transformation. It is estimated that the demand for air cargo increases continuously as the COVID situation is more manageable and the delivery from e-commerce rises. Therefore, operators can install sensors and RFID applications within the terminal to track the real-time data. These data are crucial in measuring the cargo handling efficiency and are highly relevant to the regression model. Furthermore, it facilitates the model to break down the time frame in more detail, from monthly data collection to hourly data collection. The air cargo business requires high accuracy in a fast-paced environment, so operators can better understand the demand of air cargo handling in the different timelines and adjust to fit the demand. In addition, the operators need to negotiate with the cargo terminal operators to discuss the future development of the business and ensure the capacity can meet the demand so the international status of the HKIA can be maintained. New operators may join the workforce and provide more handling capacity.

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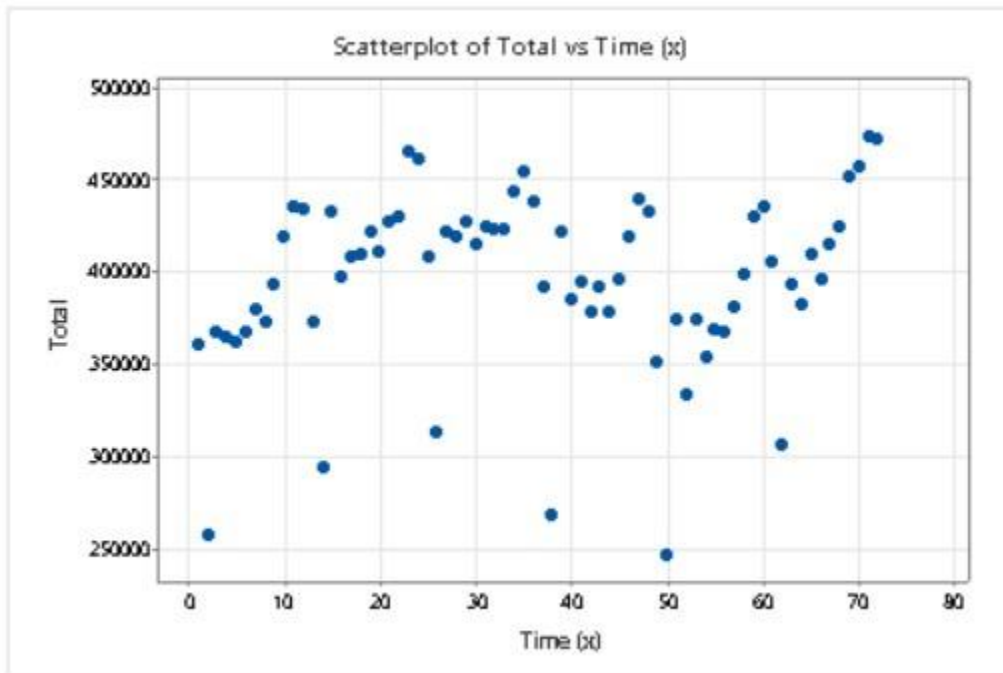
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10. Appendix

Appendix 1 (Correlation)

	Total
Total	1
t	0.1535633934
Year	0.04391951625
Month	0.6637688945
Composite CPI	0.0685708133
CPI (A)	0.07220900988
CPI (B)	0.05339209212
CPI (C)	0.07331983456
Covid case	-0.01769130416
total rainfall	0.04170677584
Mean amount of Cloud	-0.1528704101
mean pressure	-0.1209020709
Mean wind speed	0.2103430285
mean air temperature	0.2278763799

Appendix 2 (Scatter Plot)



Appendix 3 (1st Regression Analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), CPI (C), Covid case, total rainfall, Mean amount of Cloud, mean pressure, Mean wind speed, mean air temperature, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12

Regression Equation

Total (y) = 5407163 + 1724 Time (x) + 111422 Composite CPI - 27474 CPI (A) - 127550 CPI (B) + 32337 CPI (C) - 20.53 Covid case - 2.8 total rainfall - 609 Mean amount of Cloud - 3787 mean pressure - 452 Mean wind speed - 4551 mean air temperature - 93300 Q2 + 32051 Q3 + 1207 Q4 + 17237 Q5 + 12401 Q6 + 15696 Q7 + 5112 Q8 + 24822 Q9 + 52164 Q10 + 66732 Q11 + 58182 Q12

Coefficients

Term	Coef	SE	Coef T-Value	P-Value	VIF
Constant	5407163	2430366	2.22	0.031	
Time (x)	1724	615	2.80	0.007	33.32
Composite CPI	111422	98979	1.13	0.266	19029.67
CPI (A)	-27474	33923	-0.81	0.422	3120.79
CPI (B)	-127550	41818	-3.05	0.004	3012.52
CPI (C)	32337	40328	0.80	0.427	2734.60
Covid case	-20.53	6.14	-3.35	0.002	1.68
total rainfall	-2.8	23.7	-0.12	0.905	4.95
Mean amount of Cloud	-609	329	-1.85	0.070	2.35
mean pressure	-3787	2301	-1.65	0.106	34.55
Mean wind speed	-452	1039	-0.44	0.665	3.95
mean air temperature	-4551	3095	-1.47	0.148	40.95
Q2	-93300	11692	-7.98	0.000	2.13
Q3	32051	16153	1.98	0.053	4.06
Q4	1207	22236	0.05	0.957	7.69
Q5	17237	31641	0.54	0.588	15.58
Q6	12401	39001	0.32	0.752	23.67
Q7	15696	39368	0.40	0.692	24.12
Q8	5112	40714	0.13	0.901	25.79
Q9	24822	35376	0.70	0.486	19.47
Q10	52164	28699	1.82	0.075	12.82
Q11	66732	19100	3.49	0.001	5.68
Q12	58182	12404	4.69	0.000	2.39

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
18800.6	89.02%	84.09%	74.68%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	22	1.40411E+11	6382295623	18.06	0.000
Time (x)	1	2773467723	2773467723	7.85	0.007
Composite CPI	1	447919404	447919404	1.27	0.266
CPI (A)	1	231858056	231858056	0.66	0.422
CPI (B)	1	3288396730	3288396730	9.30	0.004
CPI (C)	1	227267225	227267225	0.64	0.427
Covid case	1	3955535496	3955535496	11.19	0.002
total rainfall	1	5074621	5074621	0.01	0.905
Mean amont of Cloud	1	1210439032	1210439032	3.42	0.070
mean pressure	1	957177843	957177843	2.71	0.106
Mean wind speed	1	66893369	66893369	0.19	0.665
mean air temperature	1	764345258	764345258	2.16	0.148
Q2	1	22507057976	22507057976	63.68	0.000
Q3	1	1391660846	1391660846	3.94	0.053
Q4	1	1042136	1042136	0.00	0.957
Q5	1	104891828	104891828	0.30	0.588
Q6	1	35737923	35737923	0.10	0.752
Q7	1	56189109	56189109	0.16	0.692
Q8	1	5572954	5572954	0.02	0.901
Q9	1	174020310	174020310	0.49	0.486
Q10	1	1167744165	1167744165	3.30	0.075
Q11	1	4314433994	4314433994	12.21	0.001
Q12	1	7776842110	7776842110	22.00	0.000
Error	49	17319730440	353463887		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

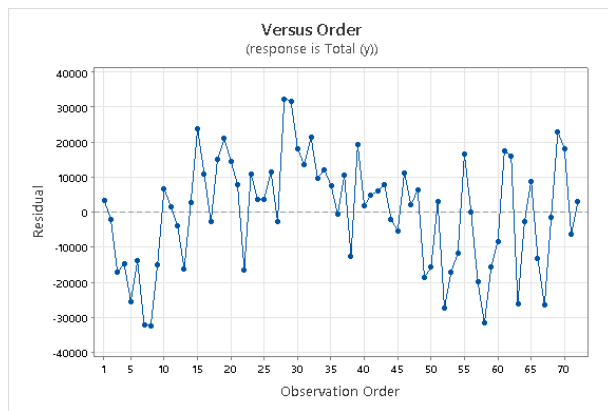
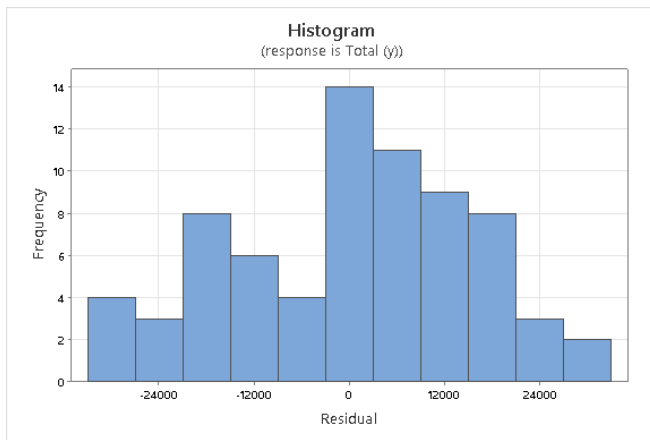
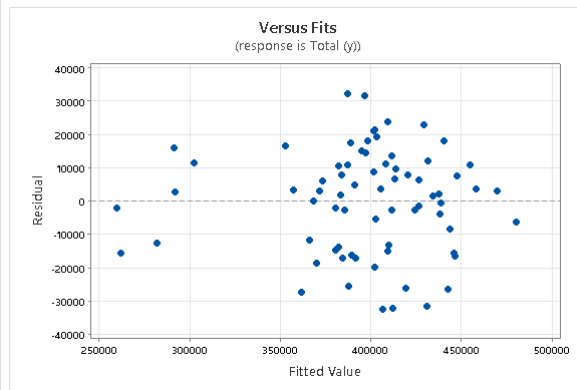
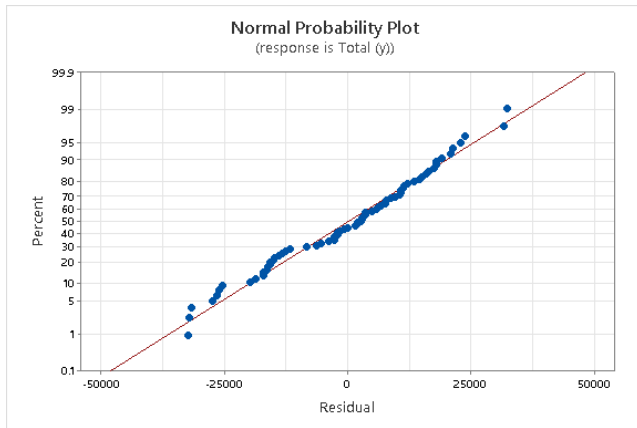
Obs	Total (y)	Fit	Resid	Std Resid
7	380154	412382	-32228	-2.03 R
8	374117	406420	-32303	-2.02 R
58	399316	430981	-31665	-2.19 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.08981

MSIM 3103 Business Forecasting - Forecast of Airport control point passenger flow



Appendix 4 (2nd Regression analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), CPI (C), Covid case, total rainfall, Mean amount of Cloud, mean pressure, Mean wind speed, mean air temperature, Q2, Q3, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12

Regression Equation

Total (y) = 5447323 + 1722 Time (x) + 112545 Composite CPI - 27852 CPI (A) - 127817 CPI (B)
 + 31866 CPI (C) - 20.49 Covid case - 2.8 total rainfall - 605 Mean amount of Cloud
 - 3828 mean pressure - 462 Mean wind speed - 4464 mean air temperature - 93555 Q2
 + 31384 Q3 + 15709 Q5 + 10575 Q6 + 13843 Q7 + 3198 Q8 + 23164 Q9 + 51038 Q10
 + 65998 Q11 + 57955 Q12

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	5447323	2291895	2.38	0.021	
Time (x)	1722	608	2.83	0.007	33.16
Composite CPI	112545	95827	1.17	0.246	18199.65
CPI (A)	-27852	32870	-0.85	0.401	2989.80
CPI (B)	-127817	41111	-3.11	0.003	2970.84
CPI (C)	31866	38988	0.82	0.418	2607.85
Covid case	-20.49	6.03	-3.40	0.001	1.65
total rainfall	-2.8	23.4	-0.12	0.904	4.95
Mean amount of Cloud	-605	318	-1.90	0.063	2.25
mean pressure	-3828	2151	-1.78	0.081	30.79
Mean wind speed	-462	1011	-0.46	0.650	3.82
mean air temperature	-4464	2618	-1.71	0.094	29.90
Q2	-93555	10602	-8.82	0.000	1.78
Q3	31384	10369	3.03	0.004	1.71
Q5	15709	14331	1.10	0.278	3.26
Q6	10575	19547	0.54	0.591	6.07
Q7	13843	19412	0.71	0.479	5.98
Q8	3198	20161	0.16	0.875	6.45
Q9	23164	17705	1.31	0.197	4.98
Q10	51038	19635	2.60	0.012	6.12
Q11	65998	13358	4.94	0.000	2.83
Q12	57955	11562	5.01	0.000	2.12

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
18612.2	89.02%	84.41%	75.90%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	21	1.40409E+11	6686164837	19.30	0.000
Time (x)	1	2779708193	2779708193	8.02	0.007
Composite CPI	1	477830805	477830805	1.38	0.246
CPI (A)	1	248710182	248710182	0.72	0.401
CPI (B)	1	3348504240	3348504240	9.67	0.003
CPI (C)	1	231415005	231415005	0.67	0.418
Covid case	1	3998445208	3998445208	11.54	0.001
total rainfall	1	5068805	5068805	0.01	0.904
Mean amount of Cloud	1	1249880584	1249880584	3.61	0.063
mean pressure	1	1097707364	1097707364	3.17	0.081
Mean wind speed	1	72324358	72324358	0.21	0.650
mean air temperature	1	1007042327	1007042327	2.91	0.094
Q2	1	26971898558	26971898558	77.86	0.000
Q3	1	3173609773	3173609773	9.16	0.004
Q5	1	416223528	416223528	1.20	0.278
Q6	1	101389536	101389536	0.29	0.591
Q7	1	176147365	176147365	0.51	0.479
Q8	1	8716209	8716209	0.03	0.875
Q9	1	592984268	592984268	1.71	0.197
Q10	1	2340597876	2340597876	6.76	0.012
Q11	1	8455967168	8455967168	24.41	0.000
Q12	1	8703289931	8703289931	25.12	0.000
Error	50	17320772576	346415452		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

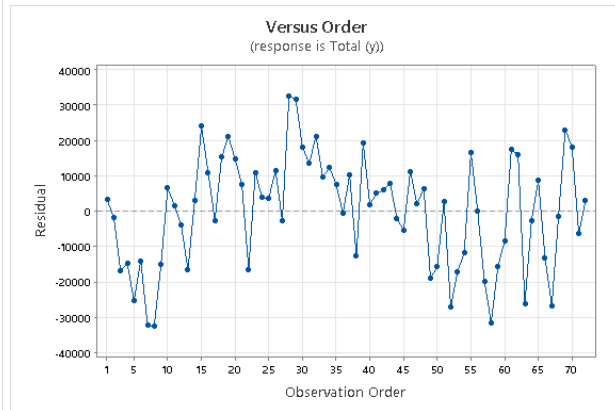
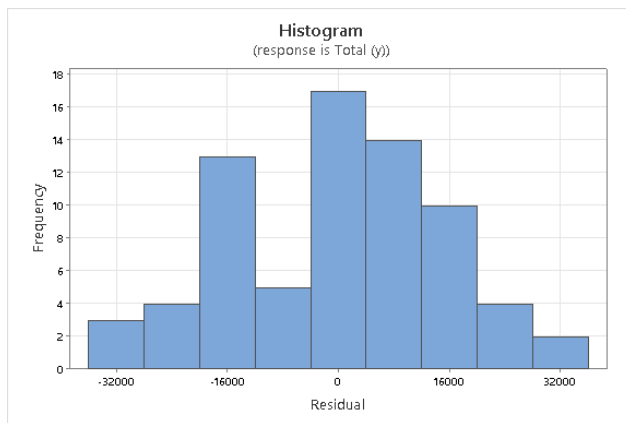
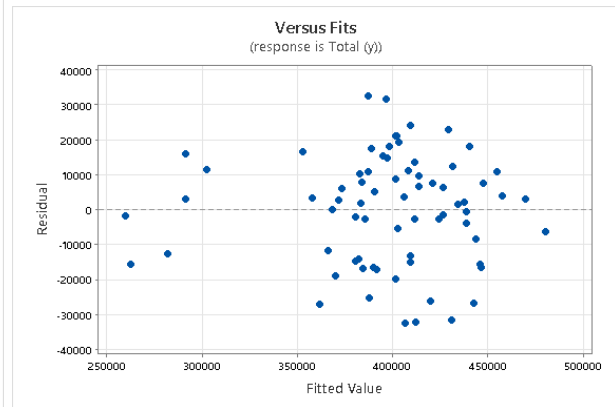
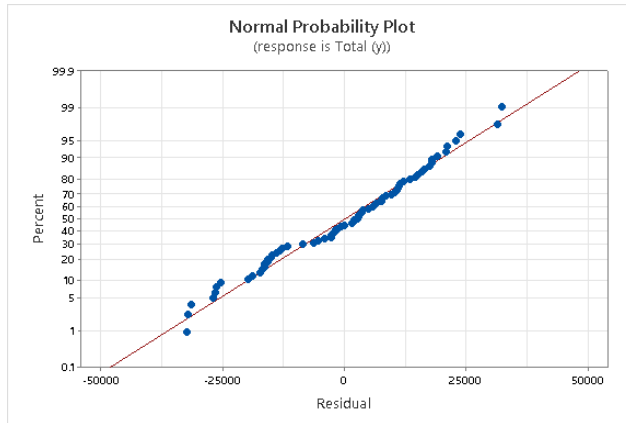
Obs	Total (y)	Fit	Resid	Std Resid
7	380154	412401	-32247	-2.05 R
8	374117	406457	-32340	-2.04 R
58	399316	430822	-31506	-2.15 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.08861

MSIM 3103 Business Forecasting - Forecast of Airport control point passenger flow



Appendix 5 (3rd Regression analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), CPI (C), Covid case, Mean amount of Cloud, mean pressure, Mean wind speed, mean air temperature, Q2, Q3, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12

Regression Equation

$$\begin{aligned} \text{Total (y)} = & 5345497 + 1712 \text{ Time (x)} + 115495 \text{ Composite CPI} - 28793 \text{ CPI (A)} - 129346 \text{ CPI (B)} \\ & + 31439 \text{ CPI (C)} - 20.39 \text{ Covid case} - 620 \text{ Mean amount of Cloud} - 3734 \text{ mean pressure} \\ & - 452 \text{ Mean wind speed} - 4359 \text{ mean air temperature} - 93493 \text{ Q2} + 31609 \text{ Q3} \\ & + 15404 \text{ Q5} + 9706 \text{ Q6} + 13278 \text{ Q7} + 2341 \text{ Q8} + 22348 \text{ Q9} + 50081 \text{ Q10} + 65628 \text{ Q11} \\ & + 57820 \text{ Q12} \end{aligned}$$

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	5345497	2111014	2.53	0.014	
Time (x)	1712	597	2.87	0.006	32.58
Composite CPI	115495	91771	1.26	0.214	17020.67
CPI (A)	-28793	31626	-0.91	0.367	2822.27
CPI (B)	-129346	38740	-3.34	0.002	2689.97
CPI (C)	31439	38450	0.82	0.417	2586.45
Covid case	-20.39	5.91	-3.45	0.001	1.62
Mean amount of Cloud	-620	292	-2.13	0.038	1.92
mean pressure	-3734	1986	-1.88	0.066	26.78
Mean wind speed	-452	998	-0.45	0.653	3.79
mean air temperature	-4359	2447	-1.78	0.081	26.63
Q2	-93493	10488	-8.91	0.000	1.78
Q3	31609	10102	3.13	0.003	1.65
Q5	15404	13971	1.10	0.275	3.16
Q6	9706	18001	0.54	0.592	5.25
Q7	13278	18661	0.71	0.480	5.64
Q8	2341	18691	0.13	0.901	5.66
Q9	22348	16210	1.38	0.174	4.25
Q10	50081	17797	2.81	0.007	5.13
Q11	65628	12877	5.10	0.000	2.68
Q12	57820	11396	5.07	0.000	2.10

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
18431.6	89.02%	84.71%	77.22%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	20	1.40404E+11	7020219638	20.66	0.000
Time (x)	1	2796934386	2796934386	8.23	0.006
Composite CPI	1	538067321	538067321	1.58	0.214
CPI (A)	1	281581141	281581141	0.83	0.367
CPI (B)	1	3787144956	3787144956	11.15	0.002
CPI (C)	1	227115070	227115070	0.67	0.417
Covid case	1	4036653286	4036653286	11.88	0.001
Mean amont of Cloud	1	1535162373	1535162373	4.52	0.038
mean pressure	1	1200632262	1200632262	3.53	0.066
Mean wind speed	1	69676867	69676867	0.21	0.653
mean air temperature	1	1078302698	1078302698	3.17	0.081
Q2	1	26998288581	26998288581	79.47	0.000
Q3	1	3326202532	3326202532	9.79	0.003
Q5	1	412991349	412991349	1.22	0.275
Q6	1	98757409	98757409	0.29	0.592
Q7	1	172011157	172011157	0.51	0.480
Q8	1	5327924	5327924	0.02	0.901
Q9	1	645719234	645719234	1.90	0.174
Q10	1	2690282664	2690282664	7.92	0.007
Q11	1	8824340339	8824340339	25.98	0.000
Q12	1	8744654469	8744654469	25.74	0.000
Error	51	17325841381	339722380		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

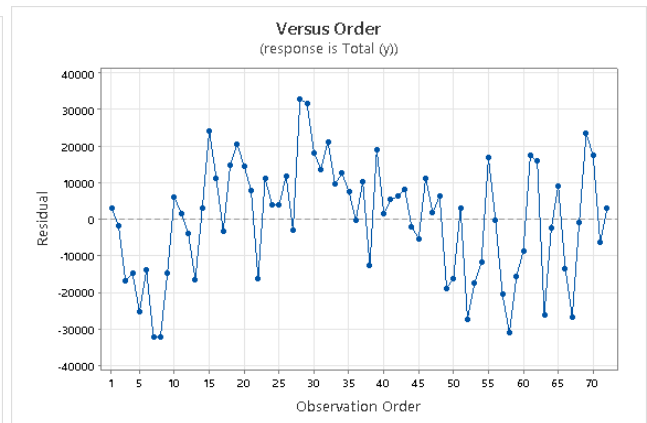
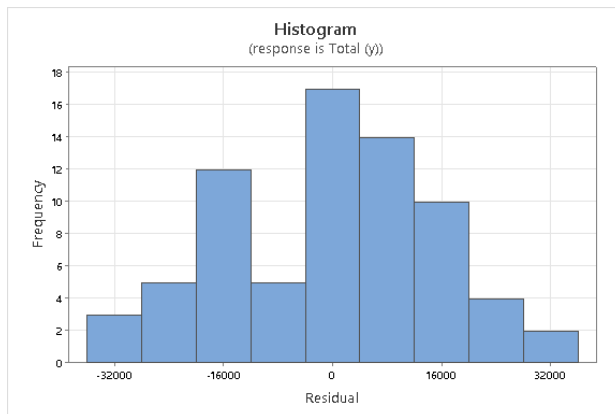
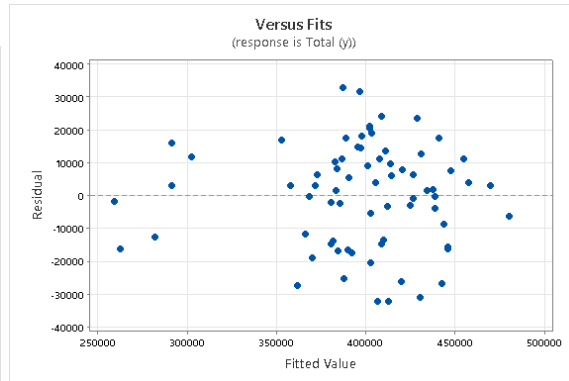
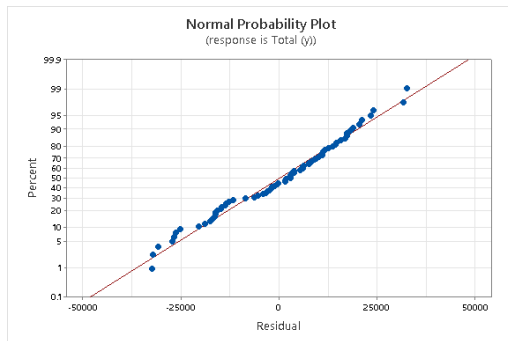
Obs	Total (y)	Fit	Resid	Std Resid
7	380154	412422	-32268	-2.08 R
8	374117	406345	-32228	-2.05 R
58	399316	430215	-30899	-2.02 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.09465

MSIM 3103 Business Forecasting - Forecast of Airport control point passenger flow



Appendix 6 (4th Regression analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), CPI (C), Covid case, Mean amount of Cloud, mean pressure, Mean wind speed, mean air temperature, Q2, Q3, Q5, Q6, Q7, Q9, Q10, Q11, Q12

Regression Equation

$$\begin{aligned} \text{Total (y)} = & 5485719 + 1718 \text{ Time (x)} + 117421 \text{ Composite CPI} - 29508 \text{ CPI (A)} - 129703 \text{ CPI (B)} \\ & + 30539 \text{ CPI (C)} - 20.31 \text{ Covid case} - 626 \text{ Mean amount of Cloud} - 3869 \text{ mean pressure} \\ & - 433 \text{ Mean wind speed} - 4332 \text{ mean air temperature} - 93212 \text{ Q2} + 31343 \text{ Q3} \\ & + 14203 \text{ Q5} + 7973 \text{ Q6} + 11427 \text{ Q7} + 20894 \text{ Q9} + 49177 \text{ Q10} + 65300 \text{ Q11} + 58063 \text{ Q12} \end{aligned}$$

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	5485719	1772578	3.09	0.003	
Time (x)	1718	589	2.92	0.005	32.38
Composite CPI	117421	89613	1.31	0.196	16542.52
CPI (A)	-29508	30811	-0.96	0.343	2730.32
CPI (B)	-129703	38268	-3.39	0.001	2675.41
CPI (C)	30539	37414	0.82	0.418	2496.09
Covid case	-20.31	5.83	-3.49	0.001	1.60
Mean amount of Cloud	-626	285	-2.20	0.033	1.87
mean pressure	-3869	1657	-2.33	0.023	19.00
Mean wind speed	-433	977	-0.44	0.659	3.71
mean air temperature	-4332	2414	-1.79	0.079	26.42
Q2	-93212	10147	-9.19	0.000	1.70
Q3	31343	9783	3.20	0.002	1.58
Q5	14203	10060	1.41	0.164	1.67
Q6	7973	11405	0.70	0.488	2.15
Q7	11427	11279	1.01	0.316	2.10
Q9	20894	11200	1.87	0.068	2.07
Q10	49177	16111	3.05	0.004	4.28
Q11	65300	12488	5.23	0.000	2.57
Q12	58063	11123	5.22	0.000	2.04

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
18256.3	89.01%	85.00%	77.78%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	19	1.40399E+11	7389424465	22.17	0.000
Time (x)	1	2833428637	2833428637	8.50	0.005
Composite CPI	1	572240789	572240789	1.72	0.196
CPI (A)	1	305696983	305696983	0.92	0.343
CPI (B)	1	3828799517	3828799517	11.49	0.001
CPI (C)	1	222055089	222055089	0.67	0.418
Covid case	1	4050746727	4050746727	12.15	0.001
Mean amount of Cloud	1	1608579711	1608579711	4.83	0.033
mean pressure	1	1816482371	1816482371	5.45	0.023
Mean wind speed	1	65501196	65501196	0.20	0.659
mean air temperature	1	1073355005	1073355005	3.22	0.079
Q2	1	28122951755	28122951755	84.38	0.000
Q3	1	3421190298	3421190298	10.26	0.002
Q5	1	664324356	664324356	1.99	0.164
Q6	1	162869828	162869828	0.49	0.488
Q7	1	342107857	342107857	1.03	0.316
Q9	1	1159950801	1159950801	3.48	0.068
Q10	1	3105400531	3105400531	9.32	0.004
Q11	1	9113642338	9113642338	27.34	0.000
Q12	1	9082104918	9082104918	27.25	0.000
Error	52	17331169305	333291717		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

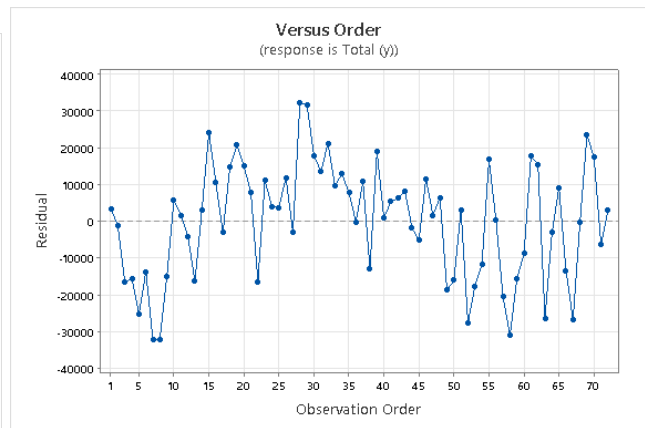
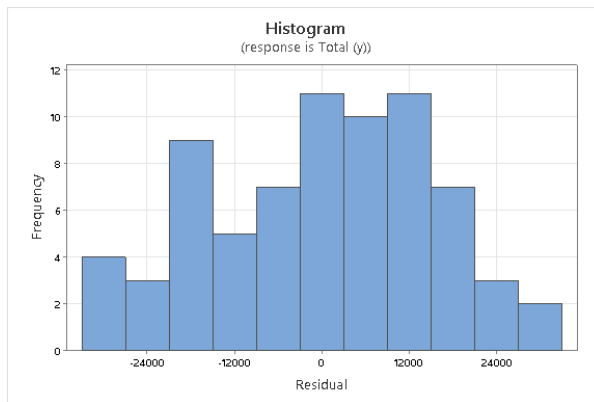
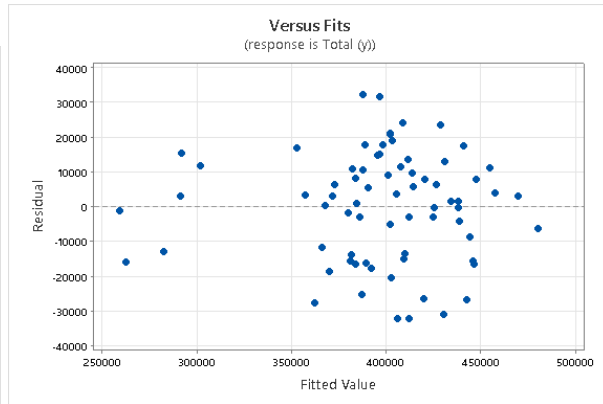
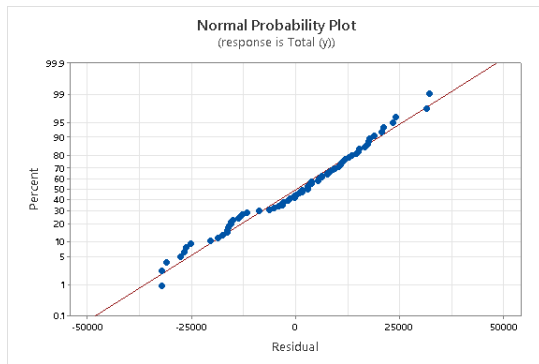
Obs	Total (y)	Fit	Resid	Std Resid
7	380154	412344	-32190	-2.09 R
8	374117	406173	-32056	-2.05 R
29	428271	396738	31533	2.01 R
58	399316	430251	-30935	-2.04 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.09689

MSIM 3103 Business Forecasting - Forecast of Airport control point passenger flow



Appendix 7 (5th Regression analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), CPI (C), Covid case, Mean amount of Cloud, mean pressure, mean air temperature, Q2, Q3, Q5, Q6, Q7, Q9, Q10, Q11, Q12

Regression Equation

Total (y) = 5276956 + 1708 Time (x) + 121984 Composite CPI - 31086 CPI (A) - 130791 CPI (B)
 + 28597 CPI (C) - 20.03 Covid case - 646 Mean amount of Cloud - 3678 mean pressure
 - 3792 mean air temperature - 92547 Q2 + 31676 Q3 + 13427 Q5 + 6184 Q6 + 9600 Q7
 + 20135 Q9 + 44080 Q10 + 62335 Q11 + 56805 Q12

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	5276956	1695877	3.11	0.003	
Time (x)	1708	584	2.92	0.005	32.34
Composite CPI	121984	88342	1.38	0.173	16324.29
CPI (A)	-31086	30372	-1.02	0.311	2693.86
CPI (B)	-130791	37898	-3.45	0.001	2664.41
CPI (C)	28597	36874	0.78	0.441	2461.88
Covid case	-20.03	5.75	-3.49	0.001	1.59
Mean amount of Cloud	-646	279	-2.31	0.025	1.82
mean pressure	-3678	1588	-2.32	0.024	17.72
mean air temperature	-3792	2069	-1.83	0.072	19.71
Q2	-92547	9959	-9.29	0.000	1.66
Q3	31676	9680	3.27	0.002	1.57
Q5	13427	9831	1.37	0.178	1.62
Q6	6184	10587	0.58	0.562	1.88
Q7	9600	10419	0.92	0.361	1.82
Q9	20135	10984	1.83	0.072	2.02
Q10	44080	11199	3.94	0.000	2.10
Q11	62335	10466	5.96	0.000	1.84
Q12	56805	10673	5.32	0.000	1.91

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
18117.4	88.97%	85.22%	78.72%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	18	1.40334E+11	7796309092	23.75	0.000
Time (x)	1	2804414954	2804414954	8.54	0.005
Composite CPI	1	625834226	625834226	1.91	0.173
CPI (A)	1	343870607	343870607	1.05	0.311
CPI (B)	1	3909376008	3909376008	11.91	0.001
CPI (C)	1	197418979	197418979	0.60	0.441
Covid case	1	3986899806	3986899806	12.15	0.001
Mean amount of Cloud	1	1757698123	1757698123	5.35	0.025
mean pressure	1	1760348002	1760348002	5.36	0.024
mean air temperature	1	1102846576	1102846576	3.36	0.072
Q2	1	28343084246	28343084246	86.35	0.000
Q3	1	3515004955	3515004955	10.71	0.002
Q5	1	612271007	612271007	1.87	0.178
Q6	1	112009189	112009189	0.34	0.562
Q7	1	278658520	278658520	0.85	0.361
Q9	1	1102982297	1102982297	3.36	0.072
Q10	1	5084871349	5084871349	15.49	0.000
Q11	1	11643106971	11643106971	35.47	0.000
Q12	1	9297911372	9297911372	28.33	0.000
Error	53	17396670501	328239066		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

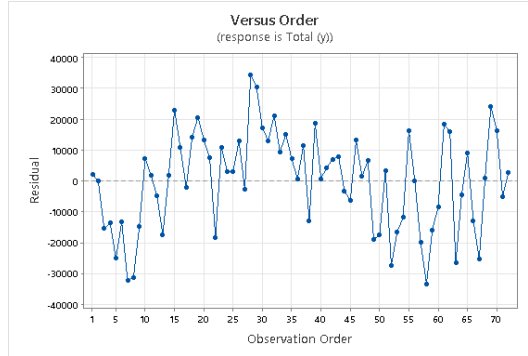
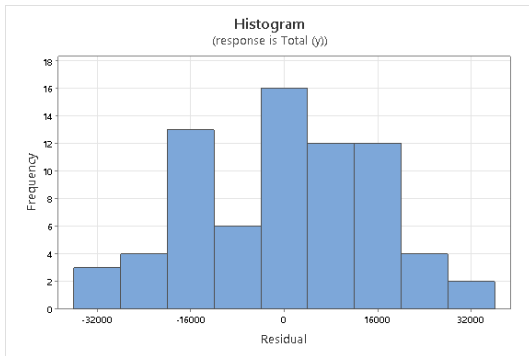
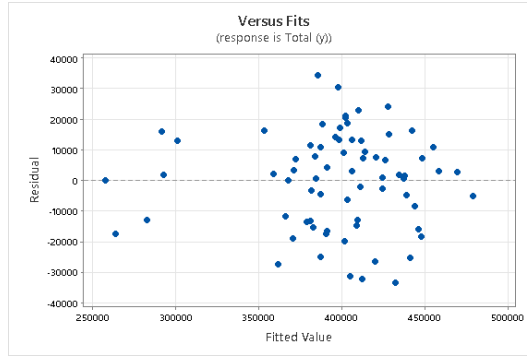
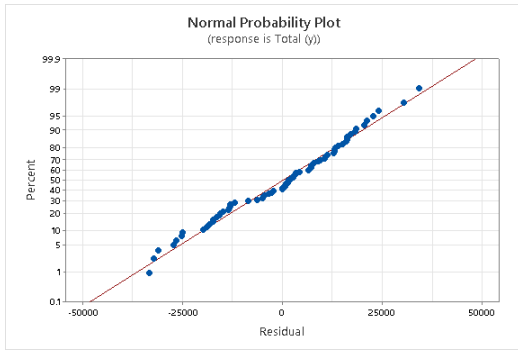
Obs	Total (y)	Fit	Resid	Std Resid
7	380154	412457	-32303	-2.11 R
58	399316	432615	-33299	-2.09 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.13104

MSIM 3103 Business Forecasting - Forecast of Airport control point passenger flow



Appendix 8 (6th Regression analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), **CPI (C)**, Covid case, Mean amount of Cloud, mean pressure, mean air temperature, Q2, Q3, Q5, Q7, Q9, Q10, Q11, Q12

Regression Equation

$$\begin{aligned} \text{Total (y)} = & 5177415 + 1774 \text{ Time (x)} + 118061 \text{ Composite CPI} - 30167 \text{ CPI (A)} - 125367 \text{ CPI (B)} \\ & + 25699 \text{ CPI (C)} - 20.41 \text{ Covid case} - 621 \text{ Mean amount of Cloud} - 3545 \text{ mean pressure} \\ & - 3406 \text{ mean air temperature} - 92597 \text{ Q2} + 30635 \text{ Q3} + 10971 \text{ Q5} + 7418 \text{ Q7} + 17647 \text{ Q9} \\ & + 41870 \text{ Q10} + 61245 \text{ Q11} + 57174 \text{ Q12} \end{aligned}$$

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	5177415	1676971	3.09	0.003	
Time (x)	1774	569	3.12	0.003	31.09
Composite CPI	118061	87548	1.35	0.183	16229.95
CPI (A)	-30167	30145	-1.00	0.321	2686.63
CPI (B)	-125367	36518	-3.43	0.001	2504.48
CPI (C)	25699	36315	0.71	0.482	2417.34
Covid case	-20.41	5.68	-3.59	0.001	1.57
Mean amount of Cloud	-621	274	-2.27	0.028	1.78
mean pressure	-3545	1562	-2.27	0.027	17.36
mean air temperature	-3406	1949	-1.75	0.086	17.70
Q2	-92597	9898	-9.36	0.000	1.66
Q3	30635	9456	3.24	0.002	1.52
Q5	10971	8832	1.24	0.220	1.32
Q7	7418	9667	0.77	0.446	1.59
Q9	17647	10063	1.75	0.085	1.72
Q10	41870	10477	4.00	0.000	1.86
Q11	61245	10235	5.98	0.000	1.78
Q12	57174	10589	5.40	0.000	1.90

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
18006.5	88.90%	85.41%	79.32%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	17	1.40222E+11	8248326733	25.44	0.000
Time (x)	1	3149112429	3149112429	9.71	0.003
Composite CPI	1	589633473	589633473	1.82	0.183
CPI (A)	1	324710495	324710495	1.00	0.321
CPI (B)	1	3821222651	3821222651	11.79	0.001
CPI (C)	1	162381025	162381025	0.50	0.482
Covid case	1	4188135251	4188135251	12.92	0.001
Mean amount of Cloud	1	1663960485	1663960485	5.13	0.028
mean pressure	1	1669747543	1669747543	5.15	0.027
mean air temperature	1	990838157	990838157	3.06	0.086
Q2	1	28376164381	28376164381	87.52	0.000
Q3	1	3403106823	3403106823	10.50	0.002
Q5	1	500261818	500261818	1.54	0.220
Q7	1	190920402	190920402	0.59	0.446
Q9	1	997155951	997155951	3.08	0.085
Q10	1	5178498452	5178498452	15.97	0.000
Q11	1	11608700785	11608700785	35.80	0.000
Q12	1	9452094674	9452094674	29.15	0.000
Error	54	17508679690	324234809		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

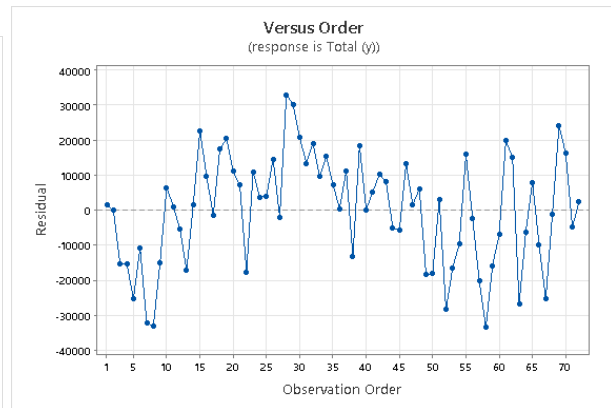
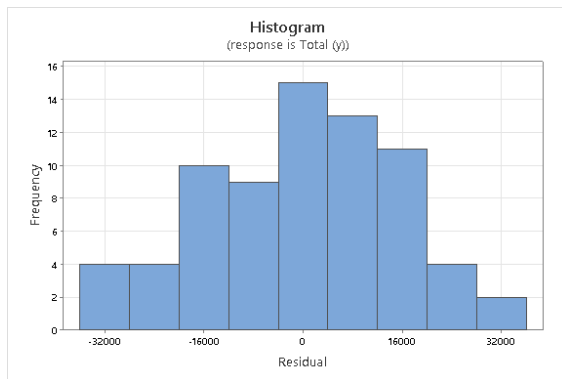
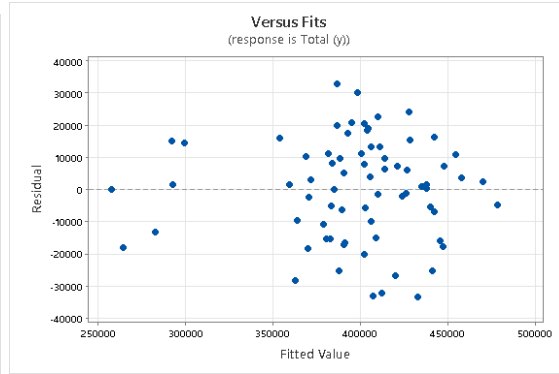
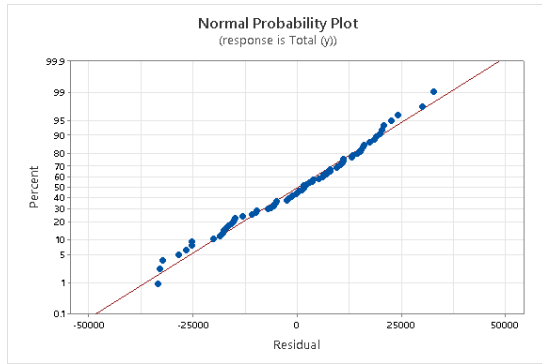
Obs	Total (y)	Fit	Resid	Std Resid
7	380154	412385	-32231	-2.12 R
8	374117	407098	-32981	-2.09 R
58	399316	432661	-33345	-2.10 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.10391

MSIM 3103 Business Forecasting - Forecast of Airport control point passenger flow



Appendix 9 (7th Regression analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), Covid case, Mean amount of Cloud, mean pressure, mean air temperature, Q2, Q3, Q5, Q7, Q9, Q10, Q11, Q12

Regression Equation

Total (y) = 5332972 + 1909 Time (x) + 167473 Composite CPI - 48200 CPI (A) - 131844 CPI (B)
 - 20.73 Covid case - 584 Mean amount of Cloud - 3626 mean pressure
 - 3554 mean air temperature - 92906 Q2 + 29360 Q3 + 11391 Q5 + 9061 Q7 + 17492 Q9
 + 43635 Q10 + 61476 Q11 + 59528 Q12

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	5332972	1654941	3.22	0.002	
Time (x)	1909	534	3.58	0.001	27.60
Composite CPI	167473	52574	3.19	0.002	5906.53
CPI (A)	-48200	16034	-3.01	0.004	767.06
CPI (B)	-131844	35192	-3.75	0.000	2347.16
Covid case	-20.73	5.63	-3.68	0.001	1.56
Mean amount of Cloud	-584	268	-2.18	0.033	1.72
mean pressure	-3626	1551	-2.34	0.023	17.27
mean air temperature	-3554	1928	-1.84	0.071	17.49
Q2	-92906	9844	-9.44	0.000	1.66
Q3	29360	9241	3.18	0.002	1.46
Q5	11391	8772	1.30	0.200	1.32
Q7	9061	9341	0.97	0.336	1.49
Q9	17492	10015	1.75	0.086	1.72
Q10	43635	10130	4.31	0.000	1.76
Q11	61476	10184	6.04	0.000	1.78
Q12	59528	10008	5.95	0.000	1.71

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
17924.6	88.80%	85.54%	80.01%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	16	1.40059E+11	8753698340	27.25	0.000
Time (x)	1	4107531295	4107531295	12.78	0.001
Composite CPI	1	3260209120	3260209120	10.15	0.002
CPI (A)	1	2903307962	2903307962	9.04	0.004
CPI (B)	1	4509521150	4509521150	14.04	0.000
Covid case	1	4349950883	4349950883	13.54	0.001
Mean amount of Cloud	1	1528156455	1528156455	4.76	0.033
mean pressure	1	1755700670	1755700670	5.46	0.023
mean air temperature	1	1091199807	1091199807	3.40	0.071
Q2	1	28621091731	28621091731	89.08	0.000
Q3	1	3243462513	3243462513	10.10	0.002
Q5	1	541760833	541760833	1.69	0.200
Q7	1	302360321	302360321	0.94	0.336
Q9	1	980183966	980183966	3.05	0.086
Q10	1	5961832886	5961832886	18.56	0.000
Q11	1	11708536949	11708536949	36.44	0.000
Q12	1	11367331522	11367331522	35.38	0.000
Error	55	17671060715	321292013		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

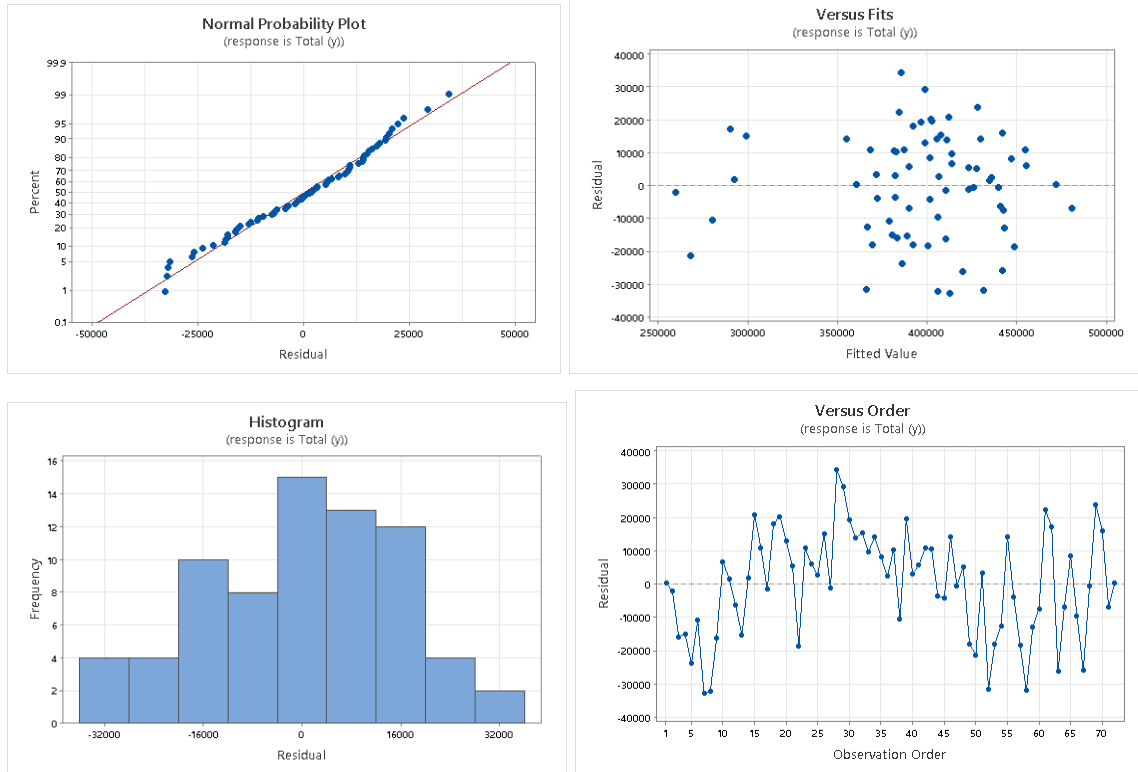
Obs	Total (y)	Fit	Resid	Std Resid
7	380154	412893	-32739	-2.16 R
8	374117	406243	-32126	-2.04 R
58	399316	431336	-32020	-2.01 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.10053

MSIM 3103 Business Forecasting - Forecast of Airport control point passenger flow



Appendix 10 (8th Regression analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), Covid case, Mean amount of Cloud, mean pressure, mean air temperature, Q2, Q3, Q5, Q9, Q10, Q11, Q12

Regression Equation

Total (y) = 5284805 + 1848 Time (x) + 178234 Composite CPI - 51749 CPI (A) - 138691 CPI (B)
 - 20.06 Covid case - 608 Mean amount of Cloud - 3616 mean pressure
 - 3230 mean air temperature - 92055 Q2 + 29863 Q3 + 9470 Q5 + 14204 Q9
 + 41925 Q10 + 60282 Q11 + 59413 Q12

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	5284805	1653326	3.20	0.002	
Time (x)	1848	530	3.49	0.001	27.22
Composite CPI	178234	51364	3.47	0.001	5643.60
CPI (A)	-51749	15603	-3.32	0.002	727.13
CPI (B)	-138691	34459	-4.02	0.000	2252.76
Covid case	-20.06	5.59	-3.59	0.001	1.53
Mean amount of Cloud	-608	267	-2.28	0.026	1.70
mean pressure	-3616	1550	-2.33	0.023	17.27
mean air temperature	-3230	1898	-1.70	0.094	16.97
Q2	-92055	9799	-9.39	0.000	1.65
Q3	29863	9221	3.24	0.002	1.46
Q5	9470	8541	1.11	0.272	1.25
Q9	14204	9419	1.51	0.137	1.52
Q10	41925	9970	4.21	0.000	1.70
Q11	60282	10104	5.97	0.000	1.75
Q12	59413	10002	5.94	0.000	1.71

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
17915.2	88.60%	85.55%	80.51%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	15	1.39757E+11	9317120874	29.03	0.000
Time (x)	1	3902659259	3902659259	12.16	0.001
Composite CPI	1	3864663314	3864663314	12.04	0.001
CPI (A)	1	3530363651	3530363651	11.00	0.002
CPI (B)	1	5199136295	5199136295	16.20	0.000
Covid case	1	4135447932	4135447932	12.88	0.001
Mean amount of Cloud	1	1668621586	1668621586	5.20	0.026
mean pressure	1	1746595380	1746595380	5.44	0.023
mean air temperature	1	929116844	929116844	2.89	0.094
Q2	1	28324131672	28324131672	88.25	0.000
Q3	1	3366200118	3366200118	10.49	0.002
Q5	1	394530290	394530290	1.23	0.272
Q9	1	729914377	729914377	2.27	0.137
Q10	1	5675594505	5675594505	17.68	0.000
Q11	1	11425055921	11425055921	35.60	0.000
Q12	1	11325228222	11325228222	35.29	0.000
Error	56	17973421036	320953947		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

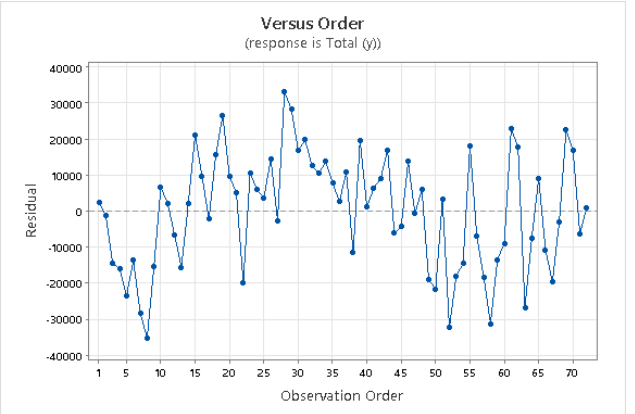
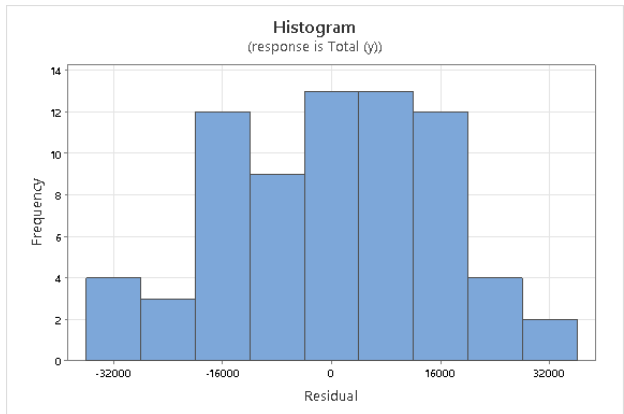
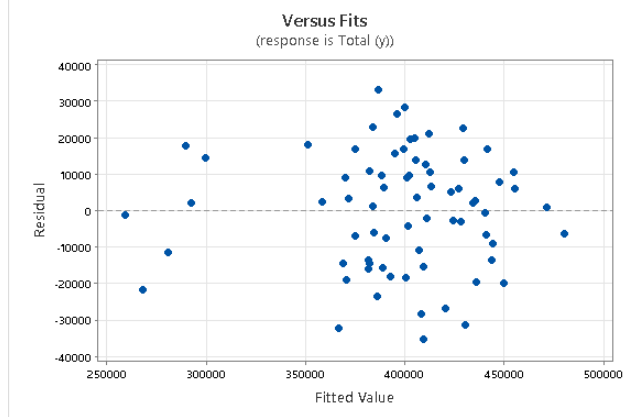
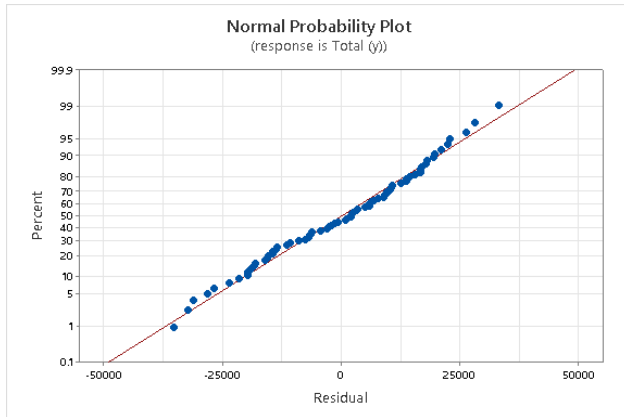
Obs	Total (y)	Fit	Resid	Std Resid
8	374117	409293	-35176	-2.19 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.15023

MSIM 3103 Business Forecasting - Forecast of Airport control point passenger flow



Appendix 11 (9th Regression analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), Covid case, Mean amount of Cloud, mean pressure, mean air temperature, Q2, Q3, Q9, Q10, Q11, Q12

Regression Equation

Total (y) = 4782267 + 1868 Time (x) + 175146 Composite CPI - 50535 CPI (A) - 137034 CPI (B)
 - 20.52 Covid case - 571 Mean amount of Cloud - 3116 mean pressure
 - 2583 mean air temperature - 93236 Q2 + 28578 Q3 + 11992 Q9 + 38697 Q10
 + 57605 Q11 + 57932 Q12

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	4782267	1593175	3.00	0.004	
Time (x)	1868	531	3.52	0.001	27.19
Composite CPI	175146	51391	3.41	0.001	5627.01
CPI (A)	-50535	15596	-3.24	0.002	723.55
CPI (B)	-137034	34496	-3.97	0.000	2248.53
Covid case	-20.52	5.58	-3.67	0.001	1.53
Mean amount of Cloud	-571	265	-2.15	0.036	1.67
mean pressure	-3116	1486	-2.10	0.040	15.80
mean air temperature	-2583	1810	-1.43	0.159	15.36
Q2	-93236	9761	-9.55	0.000	1.63
Q3	28578	9166	3.12	0.003	1.43
Q9	11992	9224	1.30	0.199	1.45
Q10	38697	9554	4.05	0.000	1.56
Q11	57605	9831	5.86	0.000	1.65
Q12	57932	9932	5.83	0.000	1.68

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
17951.2	88.35%	85.49%	80.75%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	14	1.39362E+11	9954448773	30.89	0.000
Time (x)	1	3991856464	3991856464	12.39	0.001
Composite CPI	1	3742919501	3742919501	11.62	0.001
CPI (A)	1	3383376861	3383376861	10.50	0.002
CPI (B)	1	5085261115	5085261115	15.78	0.000
Covid case	1	4350661675	4350661675	13.50	0.001
Mean amount of Cloud	1	1493221375	1493221375	4.63	0.036
mean pressure	1	1416850925	1416850925	4.40	0.040
mean air temperature	1	656182500	656182500	2.04	0.159
Q2	1	29403533590	29403533590	91.25	0.000
Q3	1	3132129743	3132129743	9.72	0.003
Q9	1	544752353	544752353	1.69	0.199
Q10	1	5286069670	5286069670	16.40	0.000
Q11	1	11064789206	11064789206	34.34	0.000
Q12	1	10963203575	10963203575	34.02	0.000
Error	57	18367951326	322244760		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

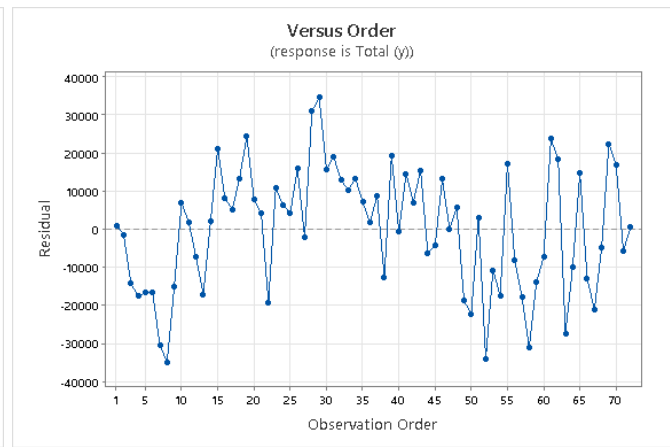
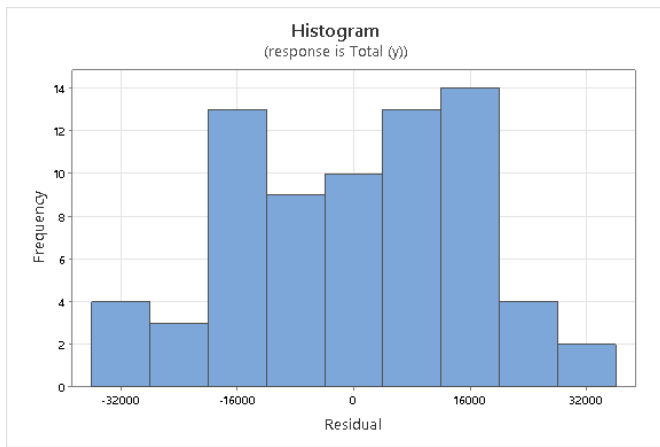
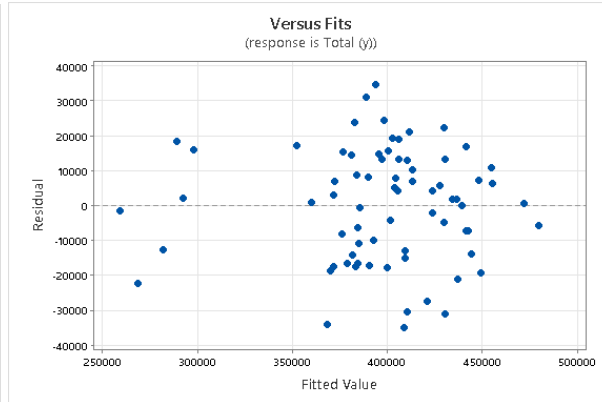
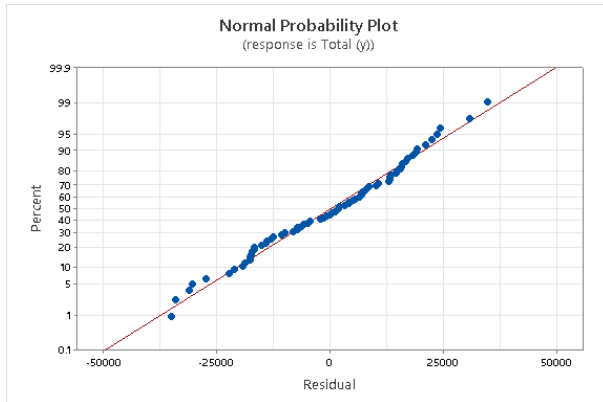
Obs	Total (y)	Fit	Resid	Std Resid
8	374117	408968	-34851	-2.16 R
29	428271	393664	34607	2.07 R
52	334557	368625	-34068	-2.03 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.18201

MSIM 3103 Business Forecasting - Forecast of Airport control point passenger flow



Appendix 12 (10th Regression analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), Covid case, Mean amount of Cloud, mean pressure, mean air temperature, Q2, Q3, Q10, Q11, Q12

Regression Equation

Total (y) = 4427690 + 1937 Time (x) + 180990 Composite CPI - 52933 CPI (A) - 140924 CPI (B)
 - 21.72 Covid case - 645 Mean amount of Cloud - 2734 mean pressure
 - 1944 mean air temperature - 92955 Q2 + 29361 Q3 + 35513 Q10 + 54900 Q11
 + 56789 Q12

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	4427690	1578976	2.80	0.007	
Time (x)	1937	531	3.65	0.001	26.91
Composite CPI	180990	51498	3.51	0.001	5583.97
CPI (A)	-52933	15579	-3.40	0.001	713.43
CPI (B)	-140924	34570	-4.08	0.000	2231.62
Covid case	-21.72	5.54	-3.92	0.000	1.48
Mean amount of Cloud	-645	260	-2.48	0.016	1.60
mean pressure	-2734	1465	-1.87	0.067	15.19
mean air temperature	-1944	1752	-1.11	0.272	14.23
Q2	-92955	9816	-9.47	0.000	1.63
Q3	29361	9201	3.19	0.002	1.43
Q10	35513	9290	3.82	0.000	1.46
Q11	54900	9665	5.68	0.000	1.58
Q12	56789	9952	5.71	0.000	1.67

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
18057.7	88.01%	85.32%	80.88%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	13	1.38818E+11	10678271575	32.75	0.000
Time (x)	1	4337277329	4337277329	13.30	0.001
Composite CPI	1	4027669114	4027669114	12.35	0.001
CPI (A)	1	3764675736	3764675736	11.55	0.001
CPI (B)	1	5418742574	5418742574	16.62	0.000
Covid case	1	5016084948	5016084948	15.38	0.000
Mean amount of Cloud	1	1997847323	1997847323	6.13	0.016
mean pressure	1	1135254268	1135254268	3.48	0.067
mean air temperature	1	401340159	401340159	1.23	0.272
Q2	1	29240712518	29240712518	89.67	0.000
Q3	1	3320672273	3320672273	10.18	0.002
Q10	1	4765024096	4765024096	14.61	0.000
Q11	1	10521255935	10521255935	32.27	0.000
Q12	1	10618090387	10618090387	32.56	0.000
Error	58	18912703679	326081098		
Total	71	1.57730E+11			

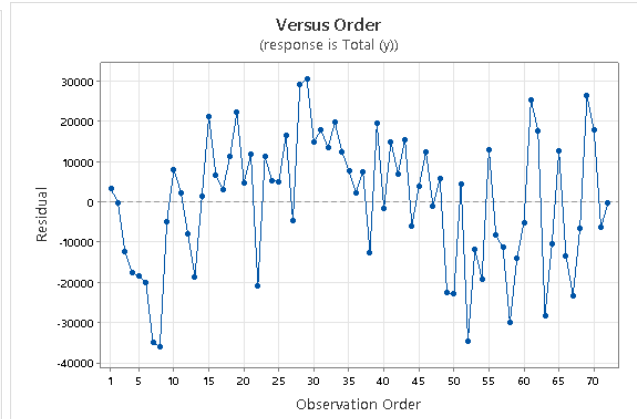
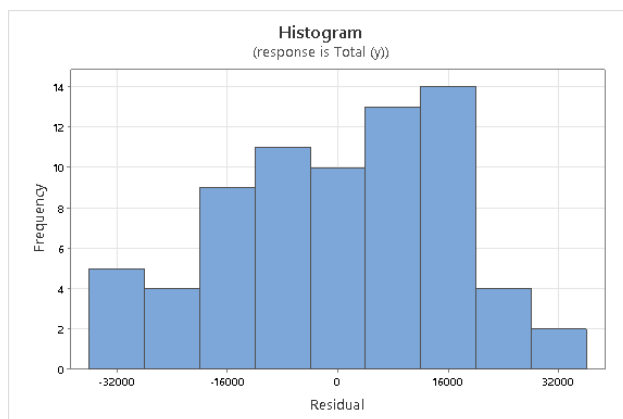
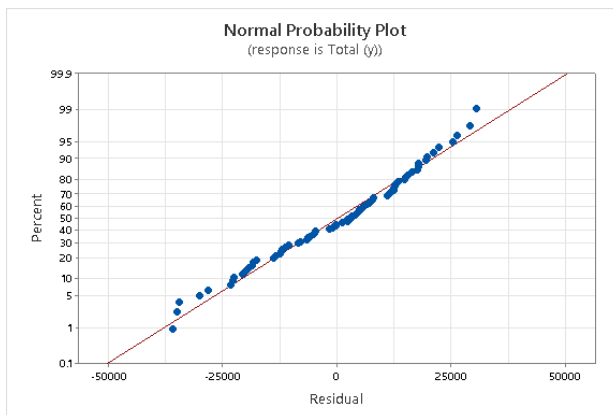
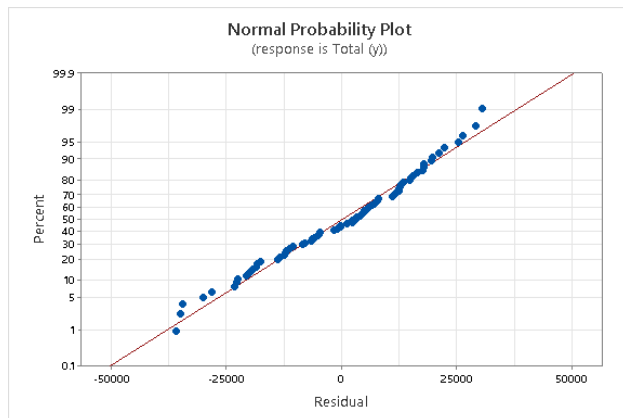
Fits and Diagnostics for Unusual Observations

Obs	Total (y)	Fit	Resid	Std Resid
7	380154	415051	-34897	-2.12 R
8	374117	410013	-35896	-2.21 R
52	334557	369069	-34512	-2.04 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.23403



Appendix 13 (11th Regression analysis)

Total (y) versus Time (x), Composite CPI, CPI (A), CPI (B), Covid case, Mean amount of Cloud, mean pressure, Q2, Q3, Q10, Q11, Q12

Regression Equation

$$\begin{aligned} \text{Total (y)} = & 2831883 + 1847 \text{ Time (x)} + 183121 \text{ Composite CPI} - 53050 \text{ CPI (A)} - 142659 \text{ CPI (B)} \\ & - 20.68 \text{ Covid case} - 570 \text{ Mean amount of Cloud} - 1234 \text{ mean pressure} - 91572 \text{ Q2} \\ & + 30994 \text{ Q3} + 31279 \text{ Q10} + 51526 \text{ Q11} + 56399 \text{ Q12} \end{aligned}$$

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	2831883	652503	4.34	0.000	
Time (x)	1847	526	3.51	0.001	26.28
Composite CPI	183121	51563	3.55	0.001	5576.20
CPI (A)	-53050	15609	-3.40	0.001	713.40
CPI (B)	-142659	34602	-4.12	0.000	2227.05
Covid case	-20.68	5.47	-3.78	0.000	1.44
Mean amount of Cloud	-570	252	-2.26	0.027	1.49
mean pressure	-1234	566	-2.18	0.033	2.25
Q2	-91572	9756	-9.39	0.000	1.60
Q3	30994	9100	3.41	0.001	1.39
Q10	31279	8486	3.69	0.000	1.21
Q11	51526	9192	5.61	0.000	1.42
Q12	56399	9965	5.66	0.000	1.67

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
18093.0	87.76%	85.26%	81.42%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	12	1.38416E+11	11534682526	35.24	0.000
Time (x)	1	4036971419	4036971419	12.33	0.001
Composite CPI	1	4128799001	4128799001	12.61	0.001
CPI (A)	1	3781472834	3781472834	11.55	0.001
CPI (B)	1	5564452405	5564452405	17.00	0.000
Covid case	1	4681331185	4681331185	14.30	0.000
Mean amount of Cloud	1	1673506822	1673506822	5.11	0.027
mean pressure	1	1558174974	1558174974	4.76	0.033
Q2	1	28842242216	28842242216	88.11	0.000
Q3	1	3797281181	3797281181	11.60	0.001
Q10	1	4447077398	4447077398	13.58	0.000
Q11	1	10286297661	10286297661	31.42	0.000
Q12	1	10485789543	10485789543	32.03	0.000
Error	59	19314043839	327356675		
Total	71	1.57730E+11			

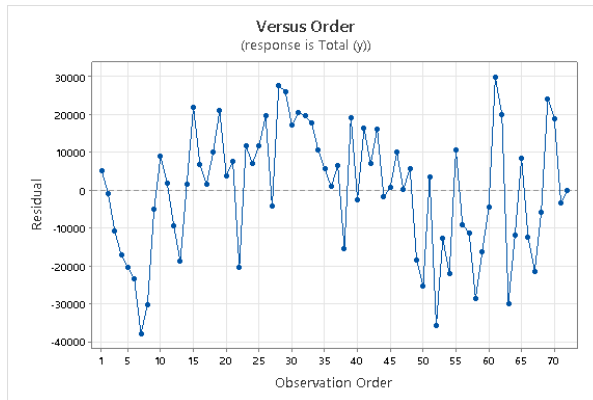
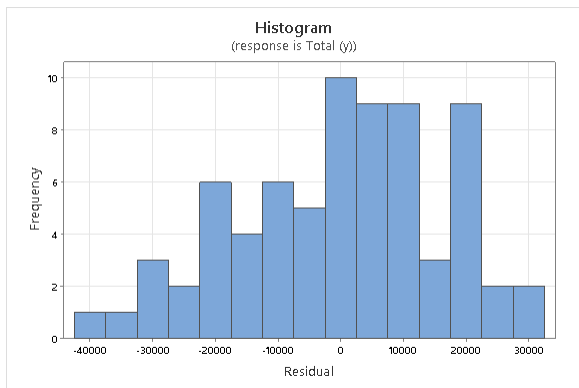
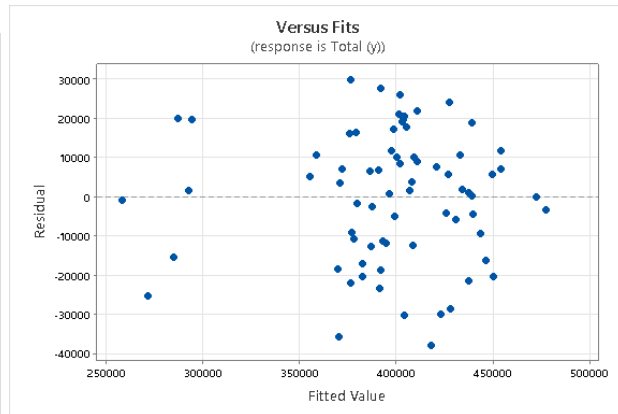
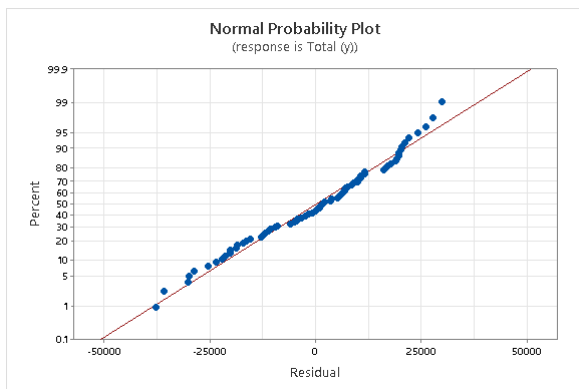
Fits and Diagnostics for Unusual Observations

Obs	Total (y)	Fit	Resid	Std Resid
7	380154	417964	-37810	-2.26 R
52	334557	370368	-35811	-2.11 R
61	406499	376688	29811	2.01 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.16490



Appendix 14 (12th Regression analysis)

Regression Equation

Total (y) = 3422593 + 2758 Time (x) + 2035 CPI (A) - 20579 CPI (B) - 23.08 Covid case
 - 556 Mean amount of Cloud - 1270 mean pressure - 94236 Q2 + 23400 Q3 + 28261 Q10
 + 56263 Q11 + 60909 Q12

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	3422593	689305	4.97	0.000	
Time (x)	2758	502	5.50	0.000	20.03
CPI (A)	2035	1907	1.07	0.290	8.92
CPI (B)	-20579	4322	-4.76	0.000	29.11
Covid case	-23.08	5.93	-3.89	0.000	1.42
Mean amount of Cloud	-556	275	-2.02	0.048	1.49
mean pressure	-1270	618	-2.06	0.044	2.25
Q2	-94236	10627	-8.87	0.000	1.59
Q3	23400	9664	2.42	0.018	1.31
Q10	28261	9225	3.06	0.003	1.20
Q11	56263	9936	5.66	0.000	1.39
Q12	60909	10798	5.64	0.000	1.64

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
19766.5	85.14%	82.41%	78.85%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	11	1.34287E+11	12207944664	31.25	0.000
Time (x)	1	11811741216	11811741216	30.23	0.000
CPI (A)	1	444887164	444887164	1.14	0.290
CPI (B)	1	8859744735	8859744735	22.68	0.000
Covid case	1	5921185872	5921185872	15.15	0.000
Mean amount of Cloud	1	1592867557	1592867557	4.08	0.048
mean pressure	1	1650059177	1650059177	4.22	0.044
Q2	1	30726683196	30726683196	78.64	0.000
Q3	1	2291054273	2291054273	5.86	0.018
Q10	1	3667185488	3667185488	9.39	0.003
Q11	1	12528517169	12528517169	32.07	0.000
Q12	1	12431802726	12431802726	31.82	0.000
Error	60	23442842840	390714047		
Total	71	1.57730E+11			

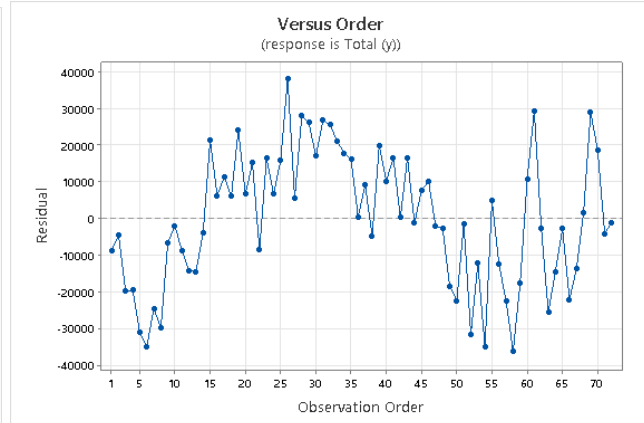
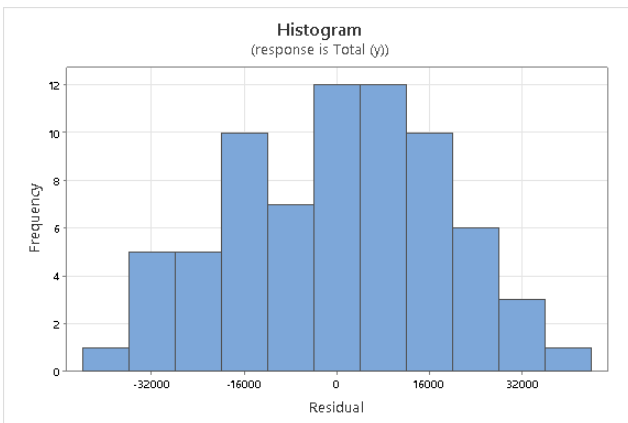
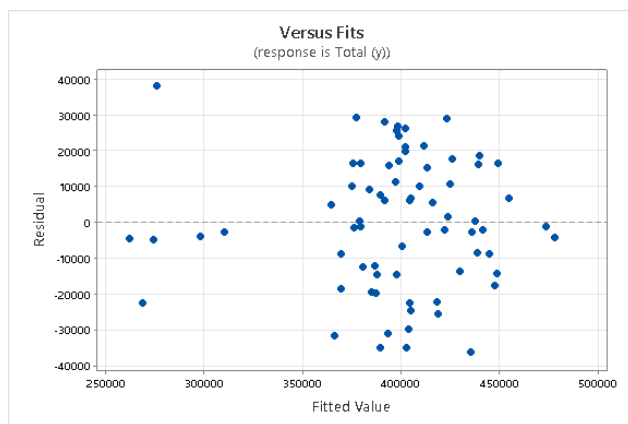
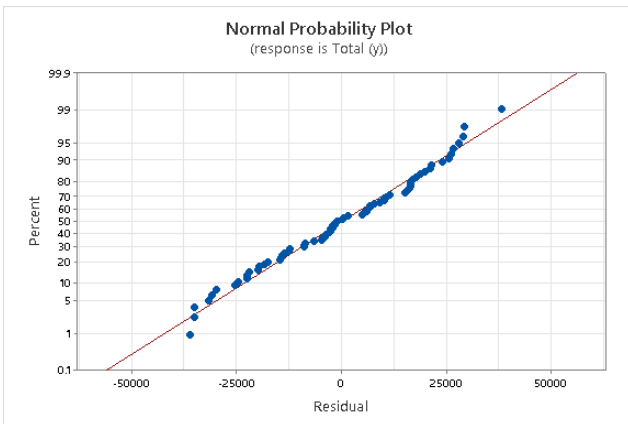
Fits and Diagnostics for Unusual Observations

Obs	Total (y)	Fit	Resid	Std Resid
26	313932	275828	38104	2.13 R
58	399316	435472	-36156	-2.03 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 0.805519



Appendix 15 (13th Regression analysis)

Regression Equation

Total (y) = 2296914 + 768 Time (x) - 3499 CPI (A) - 17.44 Covid case
 - 535 Mean amount of Cloud - 1533 mean pressure - 96076 Q2 + 23198 Q3 + 34620 Q10
 + 62911 Q11 + 66986 Q12

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	2296914	753818	3.05	0.003	
Time (x)	768	323	2.38	0.021	6.13
CPI (A)	-3499	1760	-1.99	0.051	5.61
Covid case	-17.44	6.76	-2.58	0.012	1.36
Mean amount of Cloud	-535	321	-1.67	0.100	1.49
mean pressure	-1533	716	-2.14	0.036	2.23
Q2	-96076	12363	-7.77	0.000	1.59
Q3	23198	11250	2.06	0.043	1.31
Q10	34620	10626	3.26	0.002	1.17
Q11	62911	11452	5.49	0.000	1.36
Q12	66986	12483	5.37	0.000	1.62

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
23012.0	79.52%	76.16%	70.20%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	10	1.25428E+11	12542764657	23.69	0.000
Time (x)	1	2994032042	2994032042	5.65	0.021
CPI (A)	1	2092010762	2092010762	3.95	0.051
Covid case	1	3521093281	3521093281	6.65	0.012
Mean amount of Cloud	1	1473393251	1473393251	2.78	0.100
mean pressure	1	2423353143	2423353143	4.58	0.036
Q2	1	31980104864	31980104864	60.39	0.000
Q3	1	2251606118	2251606118	4.25	0.043
Q10	1	5620923470	5620923470	10.61	0.002
Q11	1	15979316137	15979316137	30.18	0.000
Q12	1	15249264582	15249264582	28.80	0.000
Error	61	32302587575	529550616		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

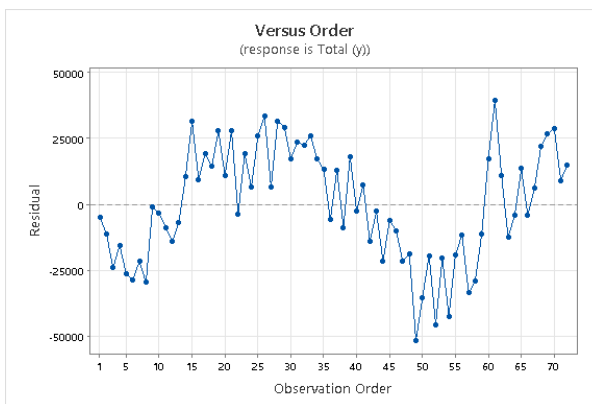
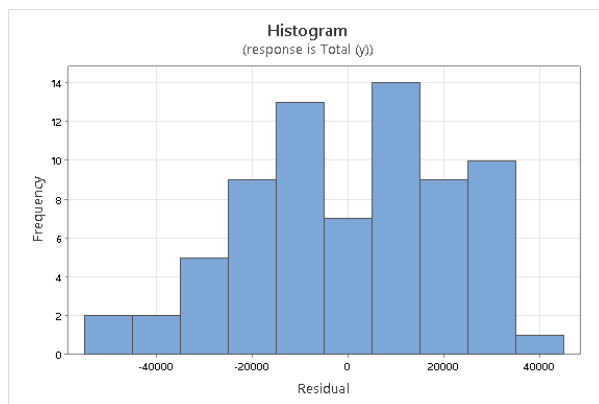
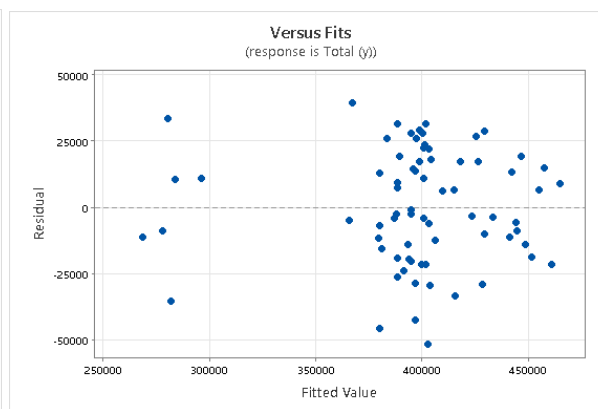
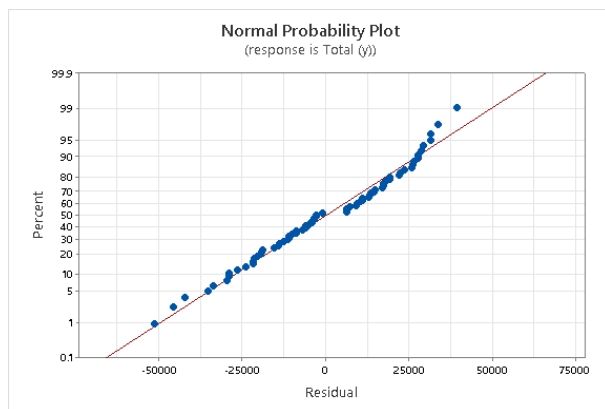
Obs	Total (y)	Fit	Resid	Std Resid
49	351348	402764	-51416	-2.55 R
52	334557	380045	-45488	-2.08 R
60	435327	417911	17416	1.05 X
61	406499	367249	39250	2.06 R

R Large residual

X Unusual *X*

Durbin-Watson Statistic

Durbin-Watson Statistic = 0.620902



Appendix 16 (14th Regression analysis)**Regression Equation**

Total (y) = 2021052 + 233 CPI (A) - 10.68 Covid case - 495 Mean amount of Cloud
 - 1597 mean pressure - 100668 Q2 + 18862 Q3 + 34157 Q10 + 62052 Q11 + 65304 Q12

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	2021052	772285	2.62	0.011	
CPI (A)	233	827	0.28	0.779	1.15
Covid case	-10.68	6.36	-1.68	0.098	1.12
Mean amount of Cloud	-495	332	-1.49	0.141	1.48
mean pressure	-1597	742	-2.15	0.035	2.23
Q2	-100668	12661	-7.95	0.000	1.55
Q3	18862	11510	1.64	0.106	1.28
Q10	34157	11016	3.10	0.003	1.17
Q11	62052	11869	5.23	0.000	1.36
Q12	65304	12922	5.05	0.000	1.61

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
23860.0	77.62%	74.37%	70.41%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	9	1.22434E+11	13603734948	23.90	0.000
CPI (A)	1	45256399	45256399	0.08	0.779
Covid case	1	1603914629	1603914629	2.82	0.098
Mean amount of Cloud	1	1265856722	1265856722	2.22	0.141
mean pressure	1	2633502146	2633502146	4.63	0.035
Q2	1	35989012510	35989012510	63.22	0.000
Q3	1	1528701683	1528701683	2.69	0.106
Q10	1	5473352365	5473352365	9.61	0.003
Q11	1	15561841871	15561841871	27.34	0.000
Q12	1	14539668671	14539668671	25.54	0.000
Error	62	35296619618	569300316		
Total	71	1.57730E+11			

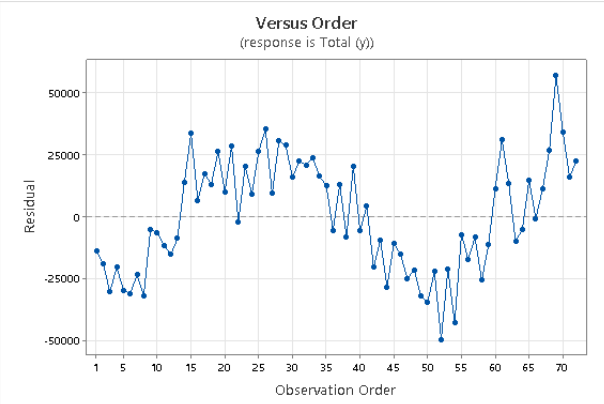
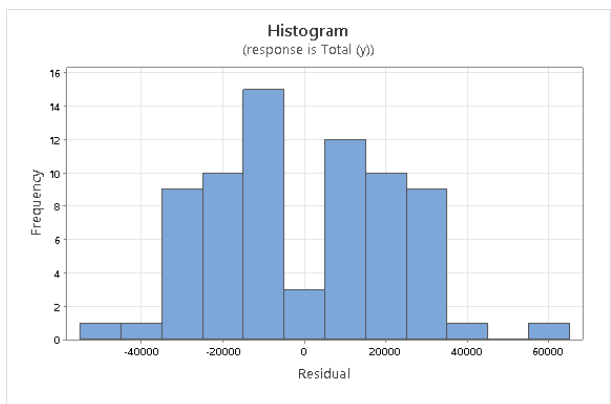
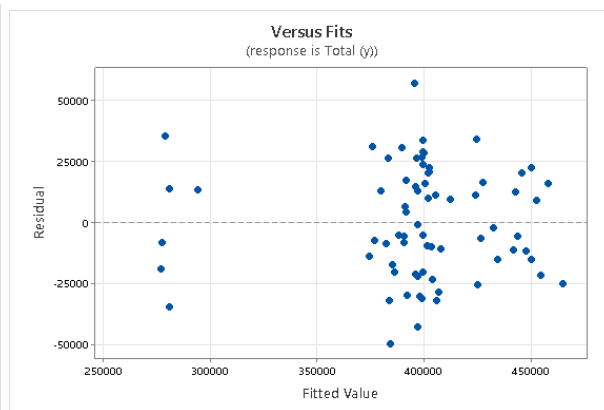
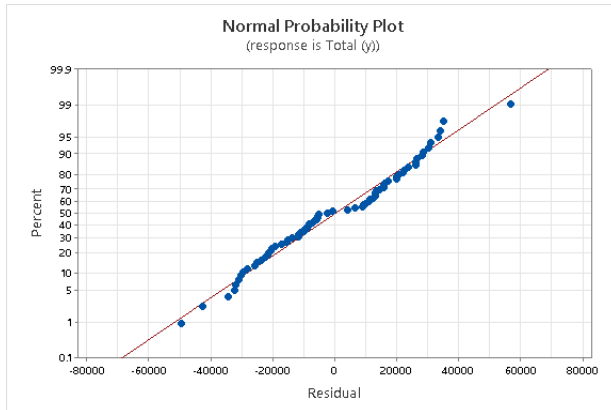
Fits and Diagnostics for Unusual Observations

Obs	Total (y)	Fit	Resid	Std Resid
52	334557	384139	-49582	-2.18 R
60	435327	424099	11228	0.64 X
69	452026	395357	56669	2.41 R

R Large residual
X Unusual X

Durbin-Watson Statistic

Durbin-Watson Statistic = 0.569905



Appendix 17 (15th Regression analysis)

Regression Equation

$$\text{Total (y)} = 2073215 - 10.28 \text{ Covid case} - 514 \text{ Mean amount of Cloud} - 1624 \text{ mean pressure} \\ - 100311 \text{ Q2} + 19209 \text{ Q3} + 34434 \text{ Q10} + 62389 \text{ Q11} + 65598 \text{ Q12}$$

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	2073215	744299	2.79	0.007	
Covid case	-10.28	6.16	-1.67	0.100	1.07
Mean amount of Cloud	-514	323	-1.59	0.116	1.42
mean pressure	-1624	730	-2.22	0.030	2.19
Q2	-100311	12505	-8.02	0.000	1.53
Q3	19209	11360	1.69	0.096	1.27
Q10	34434	10892	3.16	0.002	1.16
Q11	62389	11722	5.32	0.000	1.35
Q12	65598	12786	5.13	0.000	1.60

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
23685.1	77.59%	74.75%	71.23%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	8	1.22388E+11	15298544766	27.27	0.000
Covid case	1	1563604617	1563604617	2.79	0.100
Mean amount of Cloud	1	1424569049	1424569049	2.54	0.116
mean pressure	1	2775290978	2775290978	4.95	0.030
Q2	1	36095598475	36095598475	64.34	0.000
Q3	1	1603926207	1603926207	2.86	0.096
Q10	1	5606955163	5606955163	9.99	0.002
Q11	1	15891580187	15891580187	28.33	0.000
Q12	1	14766694971	14766694971	26.32	0.000
Error	63	35341876016	560982159		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

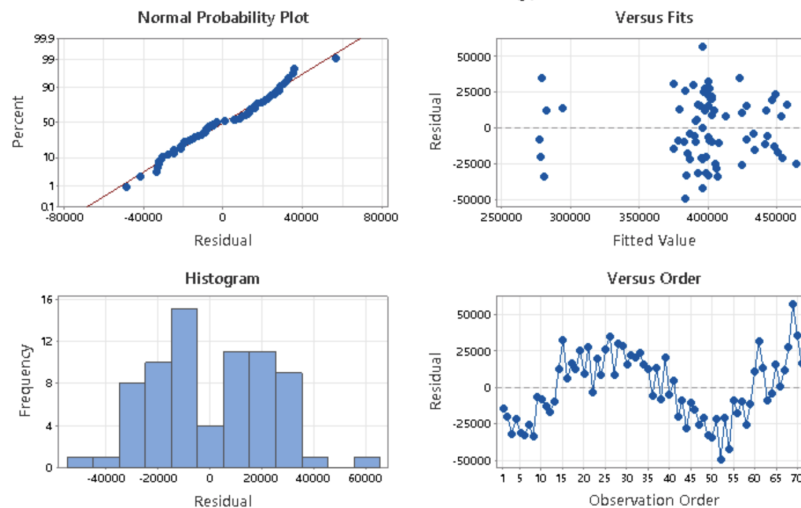
Obs	Total (y)	Fit	Resid	Std Resid	
52	334557	383071	-48514	-2.12	R
60	435327	424543	10784	0.62	X
69	452026	395631	56395	2.41	R

R Large residual
X Unusual X

Durbin-Watson Statistic

Durbin-Watson Statistic = 0.560624

Residual Plots for Total (y)



Appendix 18 (16th Regression analysis)

Regression Equation

$$\text{Total (y)} = 1710410 - 8.79 \text{ Covid case} - 1302 \text{ mean pressure} - 99911 \text{ Q2} + 16424 \text{ Q3} + 38115 \text{ Q10} + 65781 \text{ Q11} + 67942 \text{ Q12}$$

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	1710410	717096	2.39	0.020	
Covid case	-8.79	6.16	-1.43	0.158	1.04
mean pressure	-1302	710	-1.83	0.071	2.02
Q2	-99911	12652	-7.90	0.000	1.53
Q3	16424	11359	1.45	0.153	1.24
Q10	38115	10771	3.54	0.001	1.11
Q11	65781	11665	5.64	0.000	1.30
Q12	67942	12853	5.29	0.000	1.58

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
23968.2	76.69%	74.14%	70.84%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	7	1.20964E+11	17280541297	30.08	0.000
Covid case	1	1169528893	1169528893	2.04	0.158
mean pressure	1	1931724483	1931724483	3.36	0.071
Q2	1	35822333918	35822333918	62.36	0.000
Q3	1	1200892244	1200892244	2.09	0.153
Q10	1	7193318501	7193318501	12.52	0.001
Q11	1	18269204486	18269204486	31.80	0.000
Q12	1	16053158526	16053158526	27.94	0.000
Error	64	36766445066	574475704		
Lack-of-Fit	63	36576085994	580572794	3.05	0.431
Pure Error	1	190359072	190359072		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

Obs	Total (y)	Fit	Resid	Std Resid
52	334557	384095	-49538	-2.13 R
60	435327	428192	7135	0.40 X
69	452026	394692	57334	2.42 R

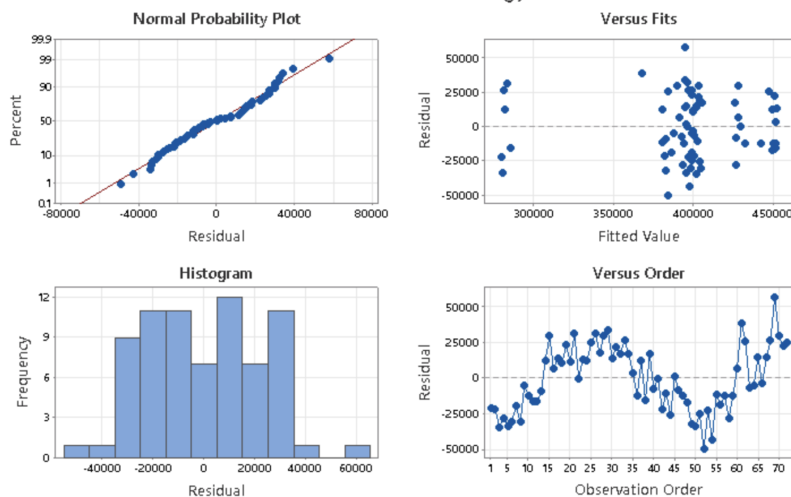
R Large residual

X Unusual X

Durbin-Watson Statistic

Durbin-Watson Statistic = 0.548793

Residual Plots for Total (y)



Appendix 19 (17th Regression analysis)

Regression Equation

$$\text{Total (y)} = 1308115 - 8.85 \text{ Covid case} - 902 \text{ mean pressure} - 105652 \text{ Q2} + 34978 \text{ Q10} + 61131 \text{ Q11} + 62093 \text{ Q12}$$

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	1308115	666433	1.96	0.054	
Covid case	-8.85	6.21	-1.42	0.159	1.04
mean pressure	-902	659	-1.37	0.176	1.72
Q2	-105652	12113	-8.72	0.000	1.38
Q10	34978	10639	3.29	0.002	1.07
Q11	61131	11306	5.41	0.000	1.20
Q12	62093	12301	5.05	0.000	1.42

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
24168.4	75.93%	73.71%	71.17%

Fits and Diagnostics for Unusual Observations

Obs	Total (y)	Fit	Resid	Std Resid
52	334557	388424	-53867	-2.28 R
60	435327	427907	7420	0.41 X
69	452026	396352	55674	2.33 R

R Large residual

X Unusual X

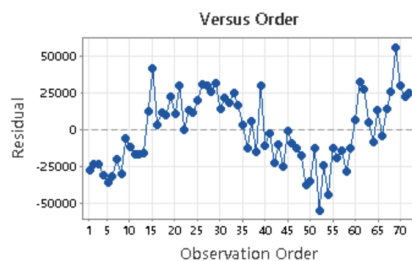
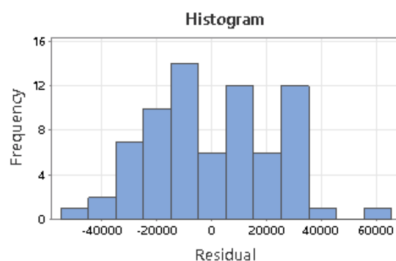
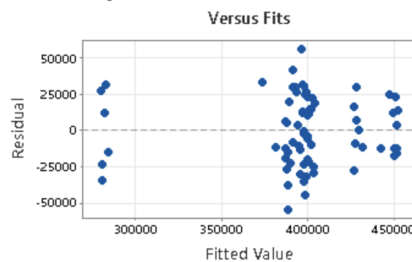
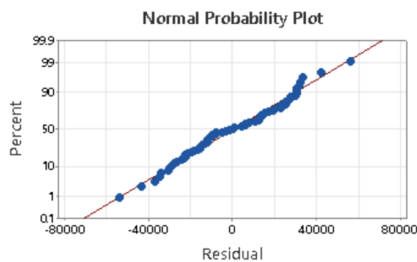
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	6	1.19763E+11	19960482806	34.17	0.000
Covid case	1	1184812112	1184812112	2.03	0.159
mean pressure	1	1093012669	1093012669	1.87	0.176
Q2	1	44434982447	44434982447	76.07	0.000
Q10	1	6314248234	6314248234	10.81	0.002
Q11	1	17075710420	17075710420	29.23	0.000
Q12	1	14882509402	14882509402	25.48	0.000
Error	65	37967337309	584112882		
Lack-of-Fit	64	37776978237	590265285	3.10	0.428
Pure Error	1	190359072	190359072		
Total	71	1.57730E+11			

Durbin-Watson Statistic

Durbin-Watson Statistic = 0.602877

Residual Plots for Total (y)



Appendix 20 (18th Regression analysis)

Regression Equation

$$\text{Total (y)} = 396494 - 9.22 \text{ Covid case} - 113982 \text{ Q2} + 32510 \text{ Q10} + 55279 \text{ Q11} + 53610 \text{ Q12}$$

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	396494	3656	108.46	0.000	
Covid case	-9.22	6.25	-1.48	0.145	1.04
Q2	-113982	10540	-10.81	0.000	1.03
Q10	32510	10553	3.08	0.003	1.04
Q11	55279	10535	5.25	0.000	1.03
Q12	53610	10694	5.01	0.000	1.06

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
24327.4	75.24%	73.36%	71.49%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	5	1.18670E+11	23733976834	40.10	0.000
Covid case	1	1290591782	1290591782	2.18	0.145
Q2	1	69211577656	69211577656	116.95	0.000
Q10	1	5616019013	5616019013	9.49	0.003
Q11	1	16295828405	16295828405	27.53	0.000
Q12	1	14874074958	14874074958	25.13	0.000
Error	66	39060349978	591823485		
Lack-of-Fit	23	19447488139	845542963	1.85	0.040
Pure Error	43	19612861839	456113066		
Total	71	1.57730E+11			

Fits and Diagnostics for Unusual Observations

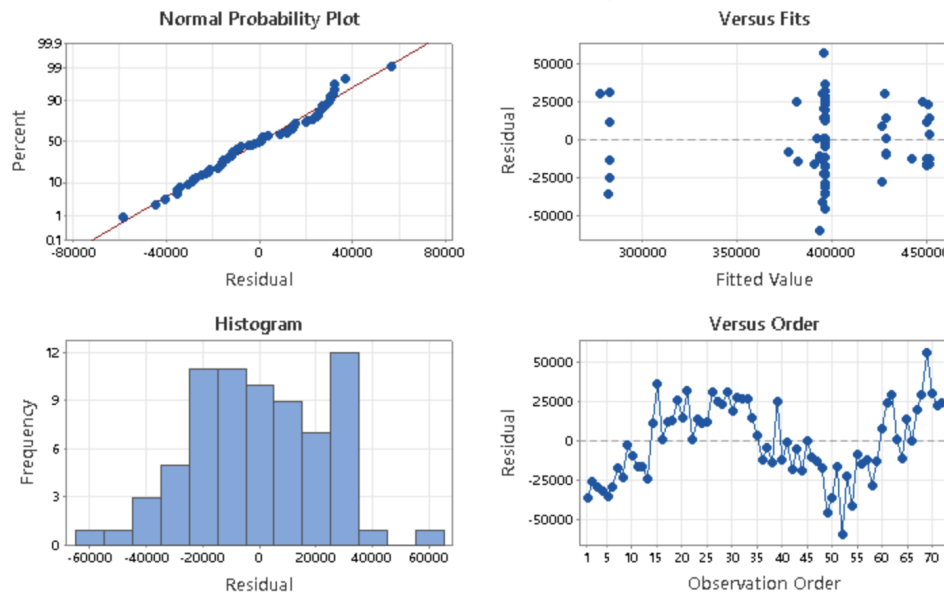
Obs	Total (y)	Fit	Resid	Std Resid
52	334557	393515	-58958	-2.45 R
55	369477	377400	-7923	-0.38 X
60	435327	426748	8579	0.48 X
69	452026	395480	56546	2.35 R

R Large residual
X Unusual X

Durbin-Watson Statistic

Durbin-Watson Statistic = 0.567110

Residual Plots for Total (y)



Appendix 21 (19th Regression analysis)

Regression Equation

$$\text{Total (y)} = 394992 - 113456 \text{ Q2} + 33452 \text{ Q10} + 55119 \text{ Q11} + 50892 \text{ Q12}$$

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	394992	3542	111.51	0.000	
Q2	-113456	10626	-10.68	0.000	1.03
Q10	33452	10626	3.15	0.002	1.03
Q11	55119	10626	5.19	0.000	1.03
Q12	50892	10626	4.79	0.000	1.03

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
24540.8	74.42%	72.89%	71.07%

Fits and Diagnostics for Unusual Observations

Obs	Total (y)	Fit	Resid	Std Resid
52	334557	394992	-60435	-2.49 R
69	452026	394992	57034	2.35 R

R Large residual

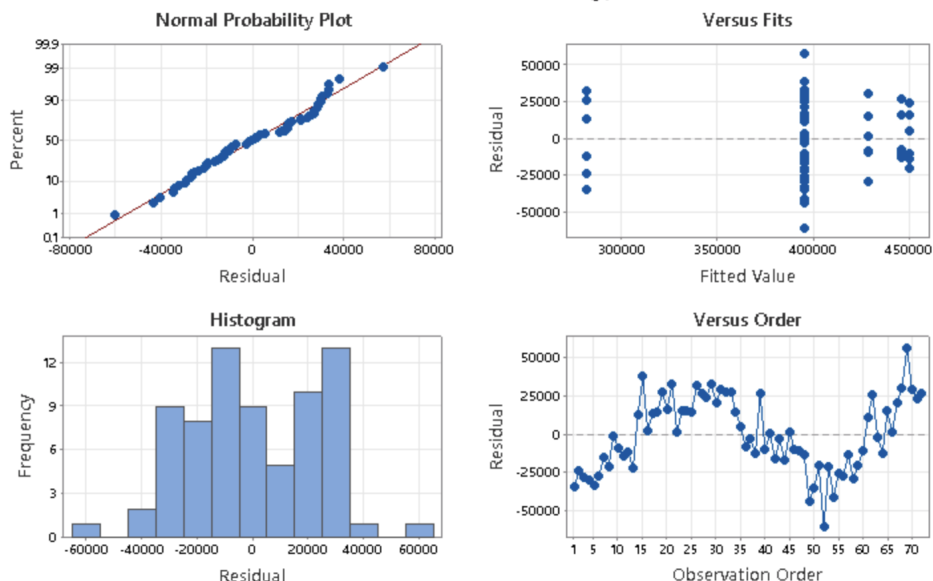
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	4	1.17379E+11	29344823097	48.73	0.000
Q2	1	68652679425	68652679425	113.99	0.000
Q10	1	5968253092	5968253092	9.91	0.002
Q11	1	16203516161	16203516161	26.90	0.000
Q12	1	13813310208	13813310208	22.94	0.000
Error	67	40350941760	602252862		
Total	71	1.57730E+11			

Durbin-Watson Statistic

Durbin-Watson Statistic = 0.531143

Residual Plots for Total (y)



Appendix 22 (20th Regression analysis)

Regression Equation

$$\text{Total (y)} = 324477 - 113749 Q2 + 27515 Q10 + 46290 Q11 + 38050 Q12 + 0.1852 Y(t-1)$$

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	324477	26098	12.43	0.000	
Q2	-113749	10071	-11.29	0.000	1.03
Q10	27515	10246	2.69	0.009	1.07
Q11	46290	10491	4.41	0.000	1.12
Q12	38050	10989	3.46	0.001	1.23
Y(t-1)	0.1852	0.0673	2.75	0.008	1.27

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
23228.0	77.58%	75.85%	73.86%

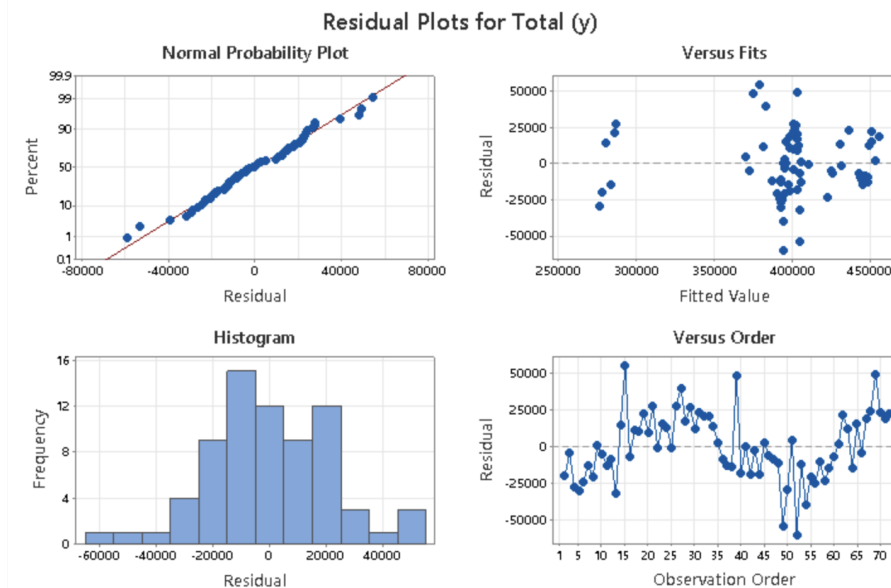
Fits and Diagnostics for Unusual Observations

Obs	Total (y)	Fit	Resid	Std Resid
15	432992	378989	54003	2.44 R
39	422207	374368	47839	2.21 R
49	351348	404677	-53329	-2.34 R
52	334557	393861	-59304	-2.58 R
69	452026	403237	48789	2.14 R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.12452



Appendix 23(Anova)

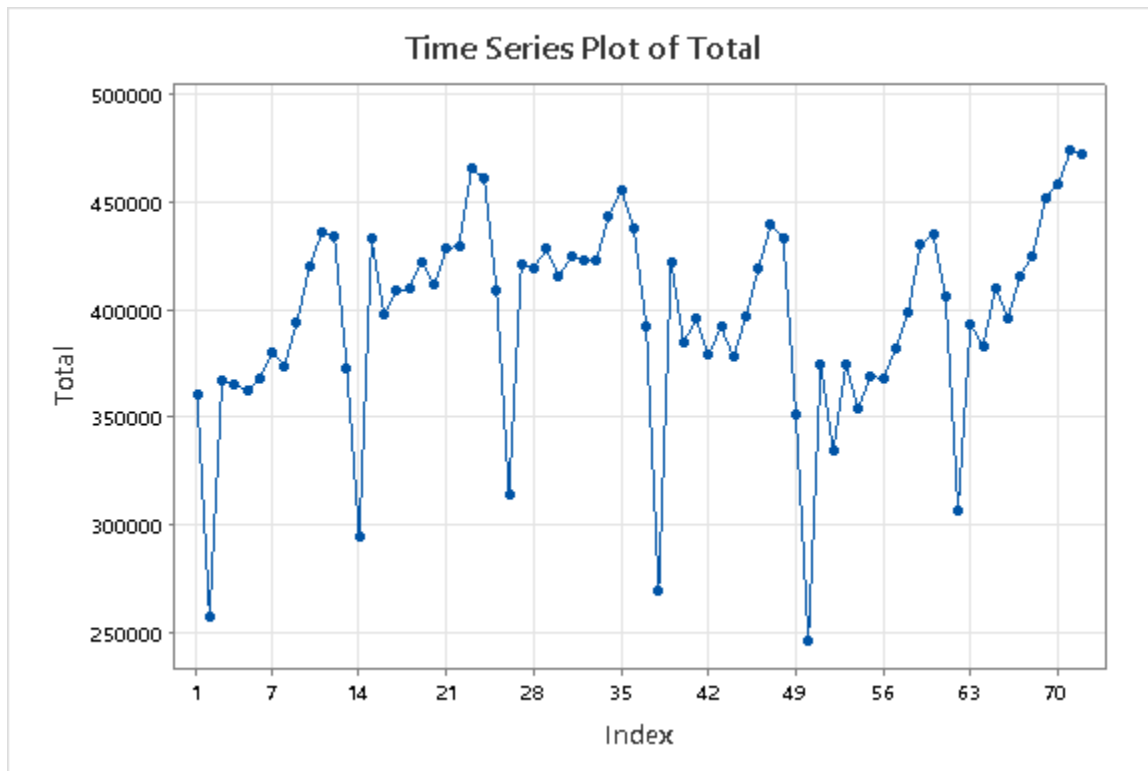
Summary Output

<i>Regression Statistics</i>	
Multiple R	0.879746
R square	0.773953
Adjusted R Square	0.756828
Standard error	23242.63
Observation	72

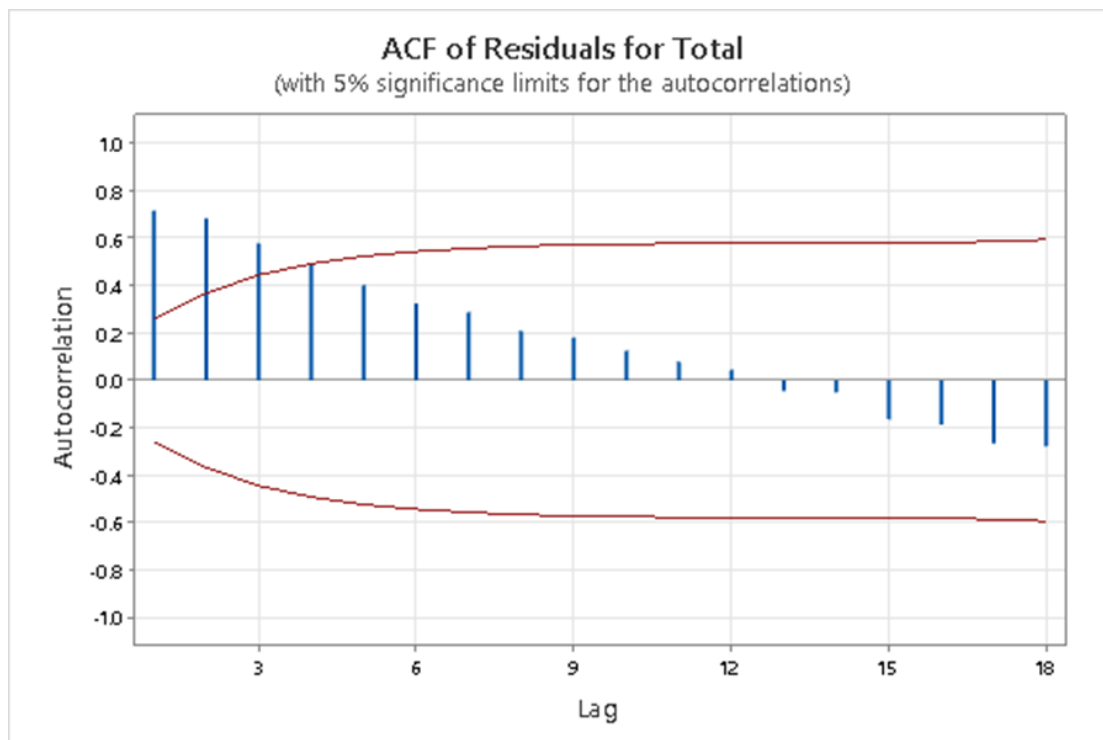
ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significant F</i>
regression	5	1.22E+11	2.44E+10	45.19485	5.07647E-20
residual	66	3.57E+10	5.4E+08		
total	71	1.58E+11			

	<i>Coefficients</i>	<i>andard Err</i>	<i>t stat</i>	<i>p-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
intercept	344765.7	17361.81	19.8577	1.54E-29	310101.6984	379429.6528
Q2	-114212.8	10067.62	-11.34457	3.74E-17	-134313.4723	-94112.16405
Q10	28631.68	10196.28	2.808052	0.006548	8274.156141	48989.21038
Q11	48216.68	10333.06	4.666253	1.55E-05	27586.05452	68847.29657
Q12	41100.03	10598.13	3.878046	0.000245	19940.18605	62259.87976
Y(t-1)	0.133341	0.045224	2.948487	0.004412	0.043049278	0.223632607

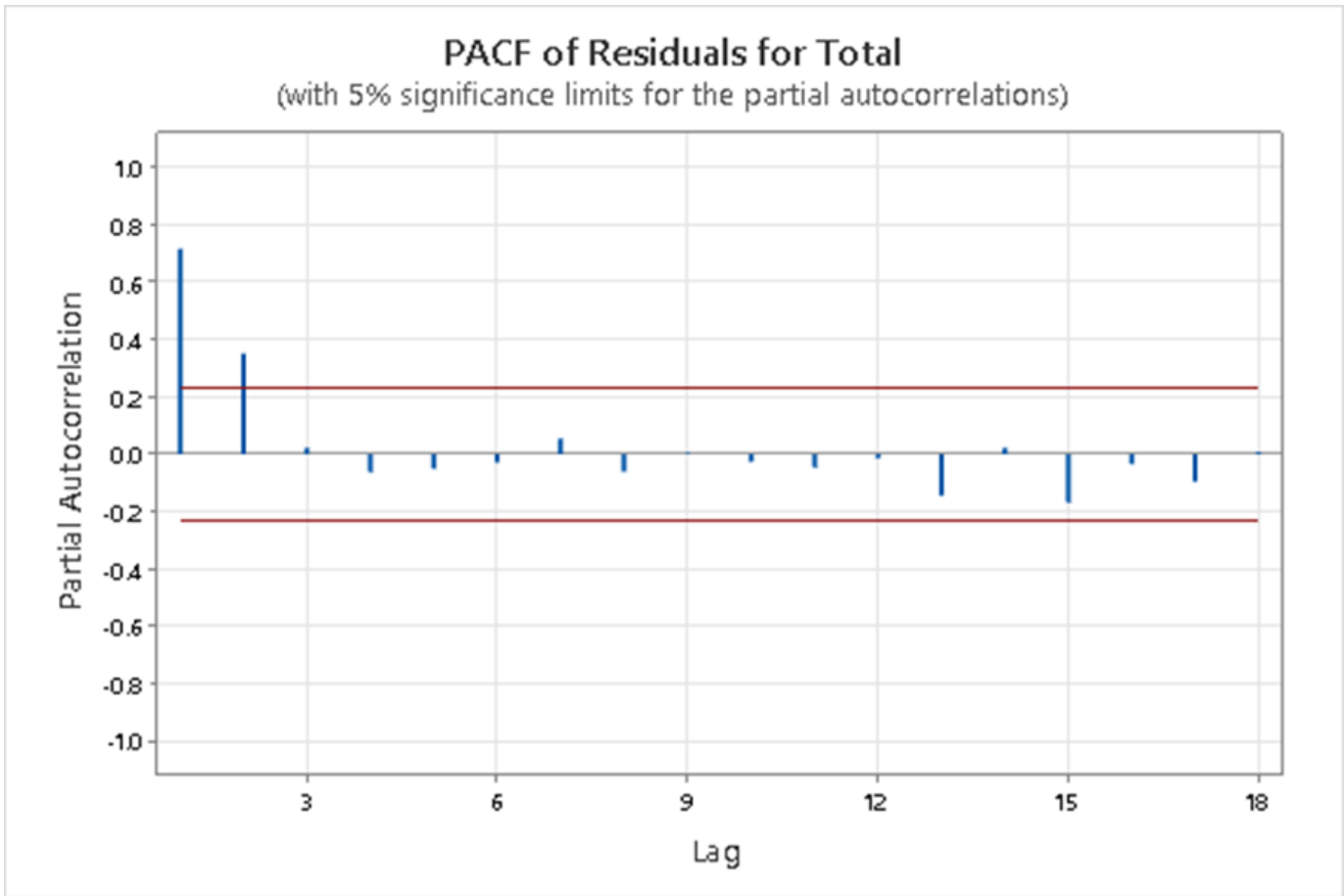
Appendix 24 (Time Series)



Appendix 25 (ACF graph for total, SAR1,SD1,SMA1)



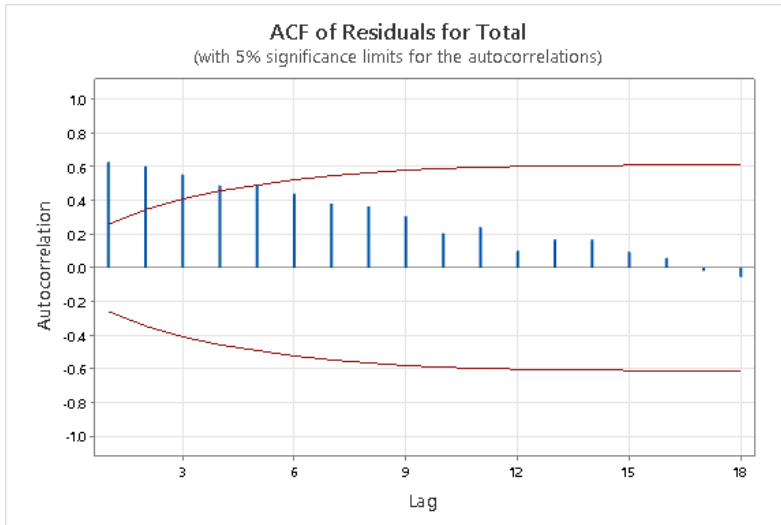
Appendix 26 (PACF graph for total, SAR1,SD1,SMA1)



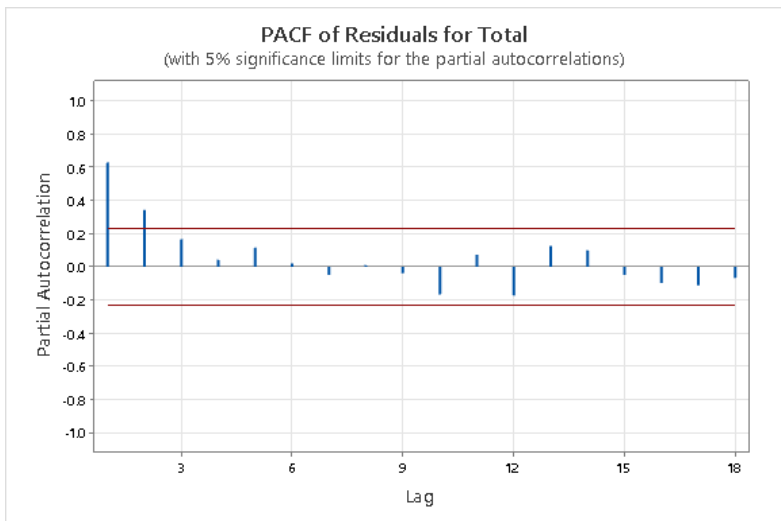
Appendix 27 (Final Estimates of Parameters, SAR1,SD1,SMA1)

Type	Coef	SE Coef	T-Value	P-Value
SAR 12	-0.522	0.158	-3.30	0.002
SMA 12	0.853	0.136	6.29	0.000
Constant	-3672	660	-5.56	0.000

Appendix 28(ACF of residual for Total, SAR1, SD1, SMA2)



Appendix 29(PACF of residual for Total, SAR1, SD1, SMA2)



Appendix 30 (Final Estimates of Parameters, SAR1,SD1,SMA2)

Type	Coef	SE Coef	T-Value	P-Value
SAR 12	-0.098	0.406	-0.24	0.811
SMA 12	0.200	0.467	0.43	0.670
SMA 24	0.663	0.306	2.17	0.034
Constant	6137	1129	5.44	0.000

Appendix 31 (MAPE accuracy table)

Accuracy Measures

MAPE 9
MAD 32804
MSD 2258662699

