Forecast the monthly demand on automobiles to increase sales for automotive company

BAFT Group 5

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Executive Summary

Our client is an automotive corporation (e.g. Suzuki) who sell automobiles and motorcycles in Taiwan. Our forecasting goal is to forecast the demand of automobile in 2015 of four of Taiwan's largest cities: Taipei, New Taipei, Taichung, and Kaohsiung. The forecast results will be used to set promotional plans among regions and seasons, and measure amount of automobile to import in 2015. Potential business benefits include reducing costs (inventory costs and advertisement at lower sales seasons), and improving marketing strategies (targeting the right seasons).

We consider two set of data to generate our automobile demand forecast: (1) The number of new automobile registration (2012:01 - 2014:11), and (2) The number of automobile (accumulated; 2000:01 - 2014:09). The first data help us to understand the trend in the future (upward or downward), in order to decide the long term business goal regarding increasing automobile import or the opposite. The second series is used to observed seasonal pattern, in order to make (short term) seasonal promotional plans in four regions. Since the first data has trend but no seasonality, we apply the double exponential method. On the other hand, the second data contains seasonality but no trend, so we employ the linear regression method. The validation period for the number of new automobile registration is 3 year, and for the number of automobile is an year. The forecasts of new automobile registration and the number of automobile have better RMSE than the naive forecast. The forecast results of new automobile registration indicate a steadily increase in the next 3 year, and the results of the number of automobile shows similar seasonality pattern as the historical data.

In addition, we found an opportunity for our client to boost the motorcycle sales in 2015. Since there is a policy that encourage the retirement of old motorcycles before October 2013, the number of motorcycle decline sharply in July 2013. However, since the policy is an one-time event, we expect the future demand for new motorcycle will increase. The data also suggest that the number of motorcycle regain increase in recent months.

Based on our forecasting results, we have the following 3 recommendations for our client: (1) increase automobile import in the next three year; (2) develop different promotional plans based on seasons; and (3) promote automobile sales with motorcycle sales in 2015 (e.g. discount for customers who buy automobile with motorcycle).

1. Problem description

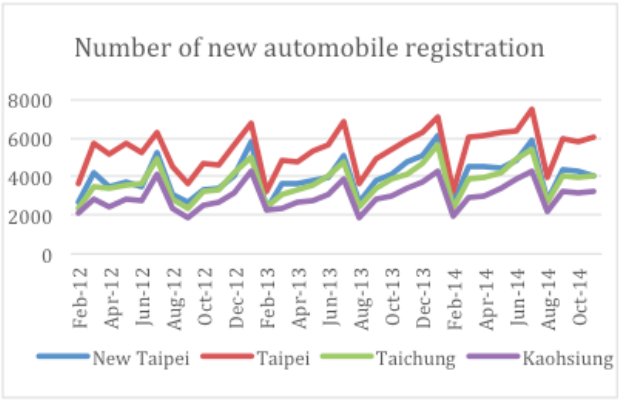
Our client is an automotive corporation (e.g. Suzuki) who sell automobiles and motorcycles in Taiwan. We are hired to forecast sales of automobile in 2015 in four of Taiwan's largest cities: Taipei, New Taipei, Taichung, and Kaohsiung. The forecast results will be used to set promotional plans among regions and seasons, and measure the amount of automobile to import in 2015. Potential business benefits include reducing costs (inventory costs and advertisement at lower sales seasons), and improving marketing strategies (targeting the right seasons).

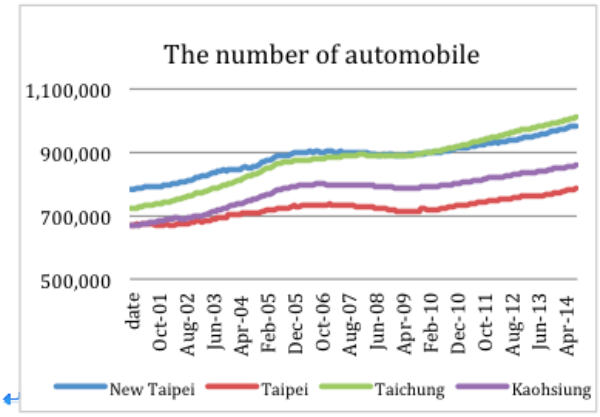
2. Data description

- **Source:** The website of Ministry of Transportation and Communications R.O.C
- **Main data: (1) Number of New Automobile Registration;(2) Number Of Automobile**

1. The data is measured the number of new automobile registration monthly in four regions (Taipei, New Taipei, Taichung, Kaohsiung). There are four series from 2012:01 to 2014:11, 35 observations in total. The series have 6 months seasonality, and there are two peak period on January and July. We found that the peak in January is due to tax concerns and Chinese New year effect.

2. The number of automobile in four regions (Taipei, New Taipei, Taichung, Kaohsiung) from 2000:01 to 2014:09. We found the series has a upward trend.

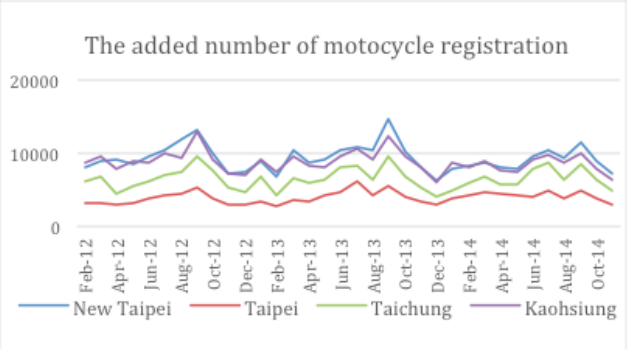


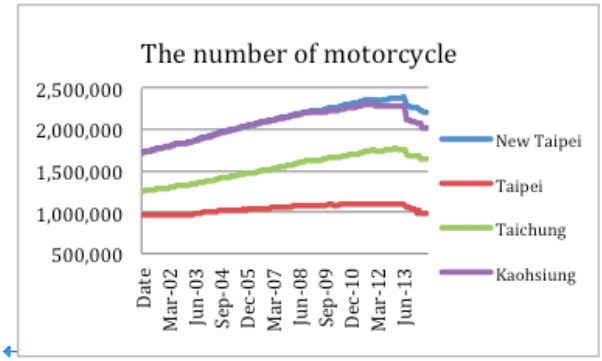


- **Reference data:**

The data are the same type and period for motorcycle.

1. The added number of motorcycle registration in four regions.We found there are one year seasonality from the plot.
2. The number motorcycle in four regions (Taipei, New Taipei, Taichung, Kaohsiung). The number of motorcycle has decrease sharply in July 2013, due to a policy that encourage the retirement of old motorcycles.





3. Data Preparation

Our data has 36 rows from 2012 to October in 2014. Since we are going to forecast demand of automobile in one year, we partition our data into one year for validation and others for training.

First of all, we got the two data, number of automobile and number of new automobile registration. The first problem we encountered was that the number of automobile data is accumulation, we can find only trend in our data. Too less things can do by this data, so we tried to find out some other data which is more useful. We also do lag-1 for number of automobile to make the dataset have seasonality.

The second problem is the model training problem. In the project, we do many models to train our data. In the Holt-Winter model, our seasonality move one month forward. We found out the problem that the data in 2014 only have eleven months from January to November, so holt-winter will lag for one month in the result. Some visualization are shown below.

4. Forecasting Solution

For the new automobile registration data, we considered three methods: seasonal naïve, linear regression and holt-winter. After we compare the RMSE and residuals of each model, linear regression got the smallest result as below.

Table 1: RMSE of three models

RMSE				
	New Taipei	Taipei	Taichung	Kaohsiung
Seasonal naive	990.68	1061.85	927.16	691.33
Regression	474.03	686.63	425.97	376.44
Holt-Winter	408.14	515.49	309.50	286.01

Table 2: Regression details (Taipei)

Regression Model

Input Variables	Coefficient	Std. Error	t-Statistic	P-Value
Intercept	6521.546	417.2545	15.6297	0
Time	13.1364	19.7798	0.6641	0.5216
month_10	-1700.227	584.4241	-2.9092	0.0156
month_11	-1535.364	590.7496	-2.599	0.0265
month_12	-1055.182	688.8925	-1.5317	0.1566
month_2	-3214.636	557.0031	-5.7713	0.0002
month_3	-1340.273	558.0557	-2.4017	0.0372
month_4	-1677.909	559.8057	-2.9973	0.0134
month_5	-1144.046	562.2464	-2.0348	0.0692
month_6	-1228.182	565.3691	-2.1724	0.055
month_7	-140.8182	569.1624	-0.2474	0.8096
month_8	-2631.455	573.6131	-4.5875	0.001
month_9	-2421.091	578.7059	-4.1836	0.0019

Because lag-1 of number of automobile data are only decrease the abandoned automobile, the examples only include number of registration in Taipei city below.

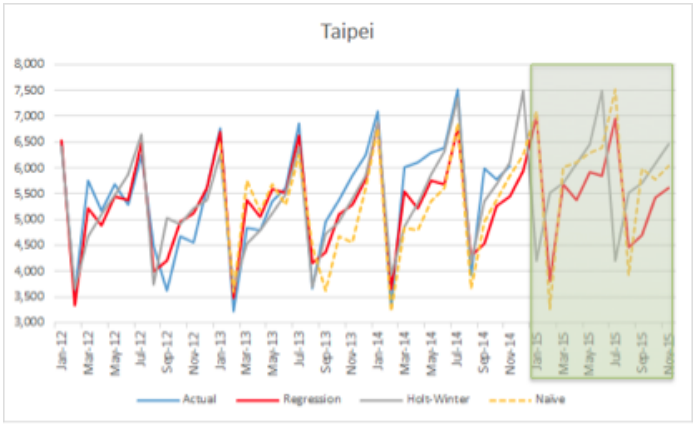
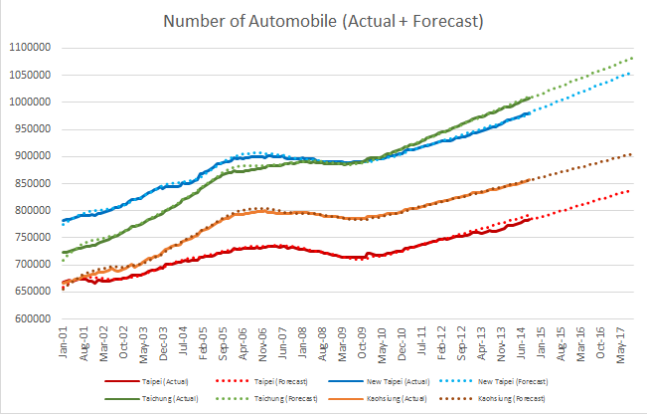
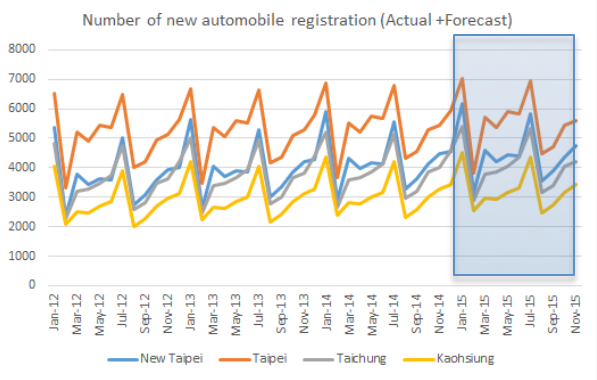


Figure 1: Forecast of three model (Taipei)

In these three models, linear regression has the best performance. Seasonal naive has the bigger forecast and holt-winter model forecast result easier. Thus, we chose linear regression as our final model. The Holt-Winter does not capture the high (January and July) and low (February and August) well. The reason might because that our sample period ends in November 2014 instead of December 2014, which does not complete a whole season. In the future, when we obtain the data of December 2014, the forecast done by Holt Winter will be improved. Details are in Appendix.

5. Time plot of series with future forecasts





6. Conclusions

- **Recommendations:**

(1) Increase automobile import in 2015

Forecasts of the total amount of automobile series show a steadily upward trend, indicates that the automobile sales will increase steadily in 2015. Thus we recommend our client Suzuki to increase the import amount of automobile in 2015.

(2) Develop different marketing strategy based on seasons

The chart of new registered automobiles shows clear seasonality, with peak in January and July, and low in February and August. The seasonal pattern is the same among the

four regions we consider; as a result, we suggest applying same marketing strategies among the regions but different promotional plans over the seasons. Based on this findings, we recommend invest more on advertisement near January and July.

(3) Opportunity: Demand for new motorcycle to increase

The total amount of motorcycle in Taiwan has decrease sharply since July 2014, due to a new policy that encourages old motorcycles to retire before October 2014 in order to waive tax. The decline is a one-time event. We consider it a great opportunity to promote motorcycle sales in 2015, because owners of retired motorcycle are likely to purchase new one. As a result, we forecast the demand of new motorcycle will increase in 2015, and recommend the company to increase its import amount of motorcycle.

- **Limitations:**

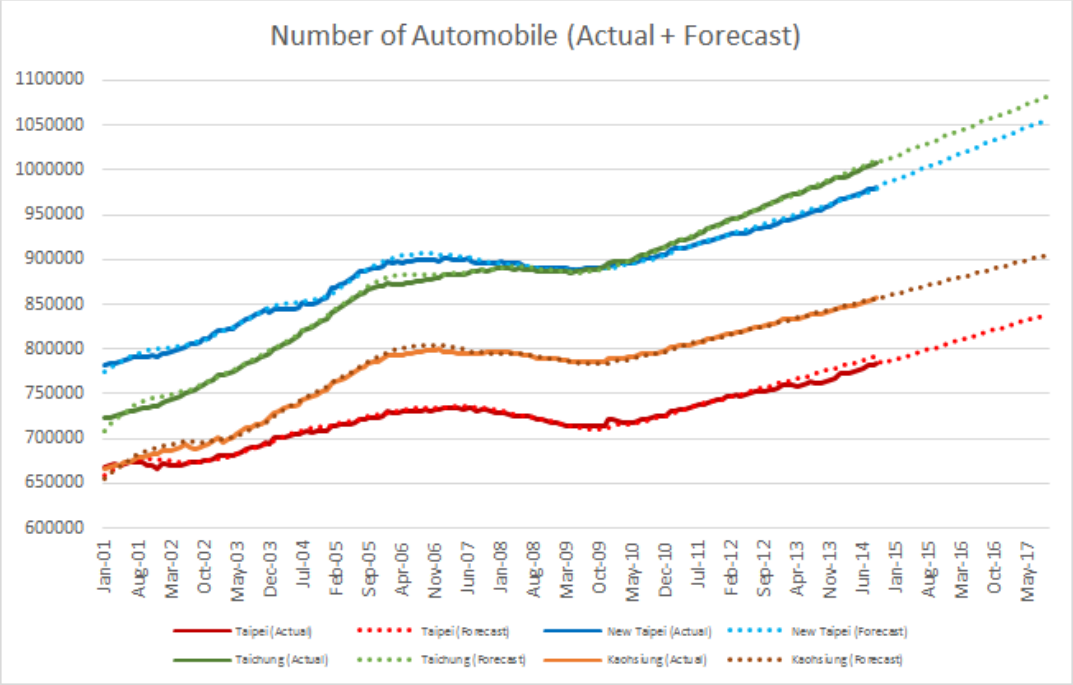
Our forecasts is an overall automobile demand in the four cities in Taiwan. We do not consider consumer preference for different brands. Since Suzuki has around 10% market share among all foreign cars (in 2014), if we have detail sales data of Suzuki cars, we can make more accurate forecasts for Suzuki.

Besides, there are more factors that affect automobile sales. For example, the state of the economy, household income, oil prices, etc. Including these factors and applying more advenced methods (e.g. multivariate regression) in the analysis would give a better picture of the market sentiment for automobile demand. We leave this to future works.

Appendix

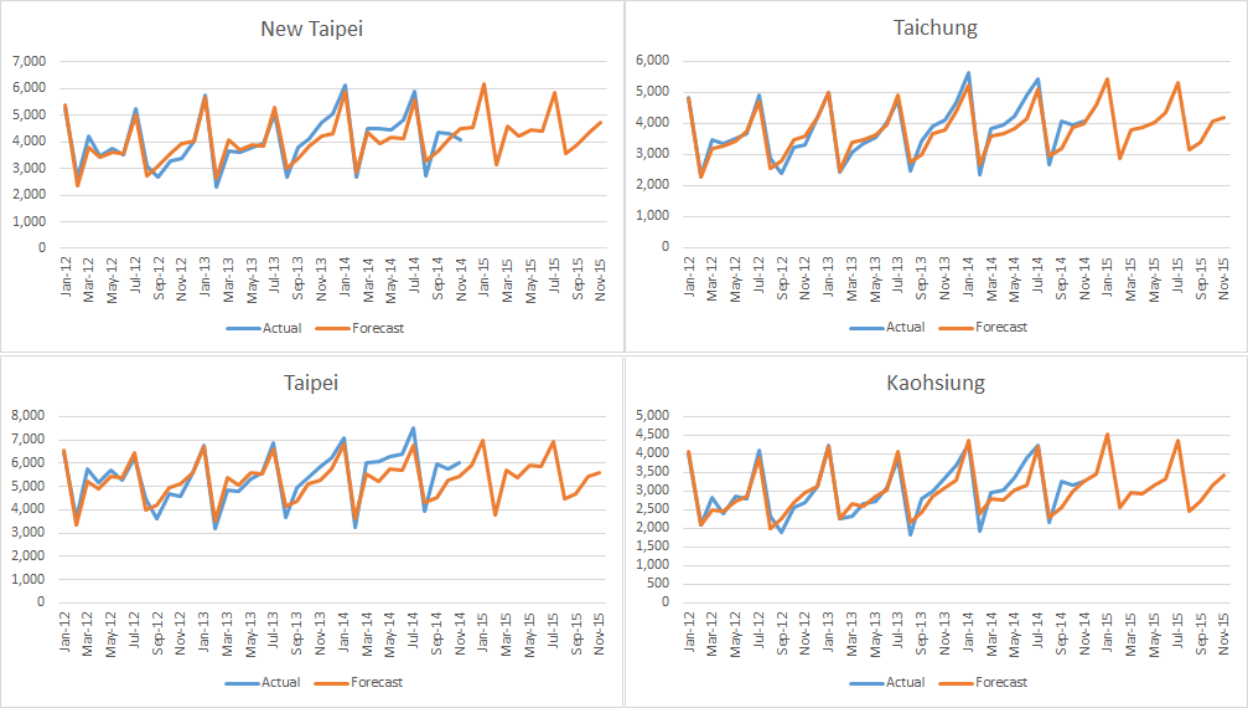
Forecasts of number of automobile

- Method: Double Exponential

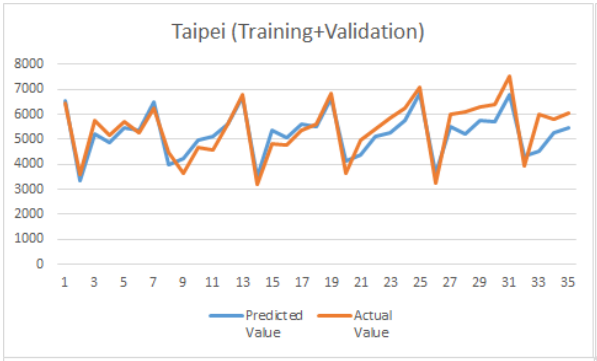


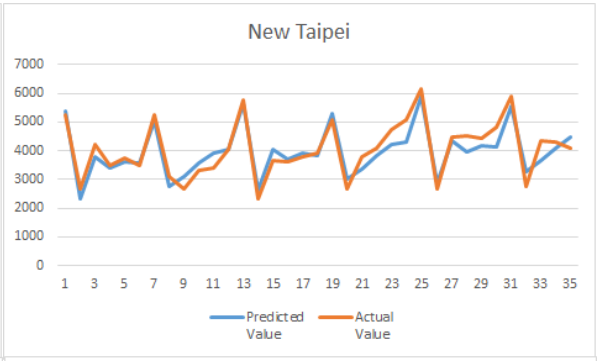
Forecasts of new automobile registration

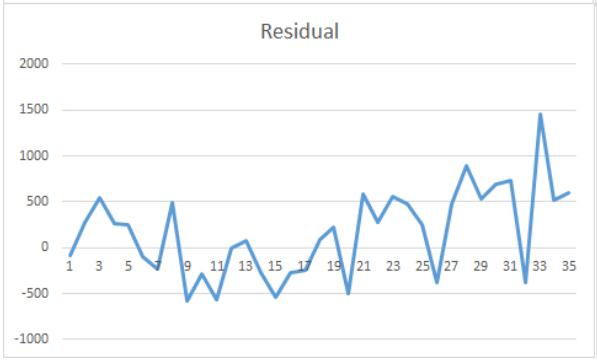
- Method: Linear Regression (with 11 dummies)

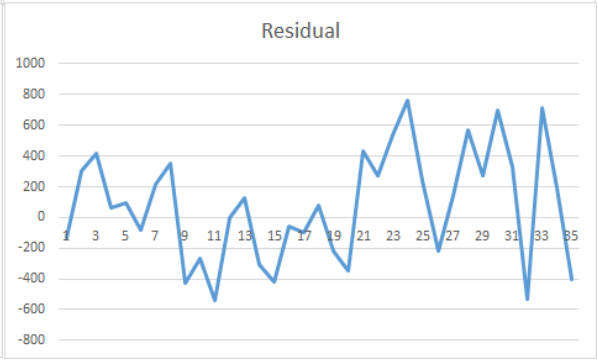


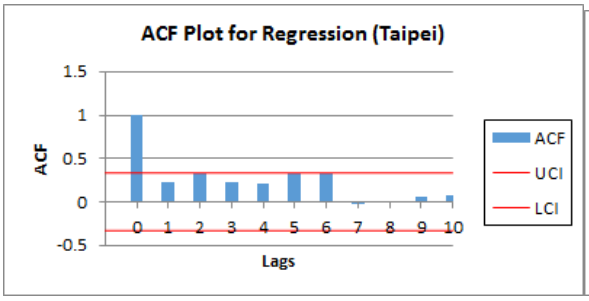
Training and Validation period

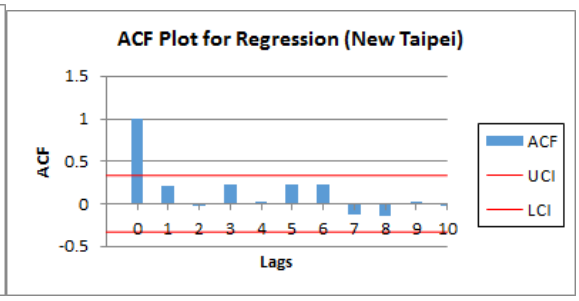


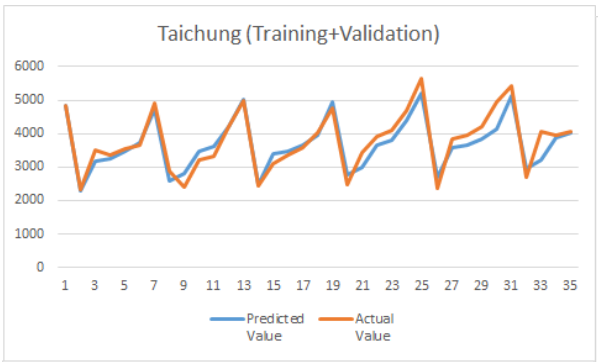


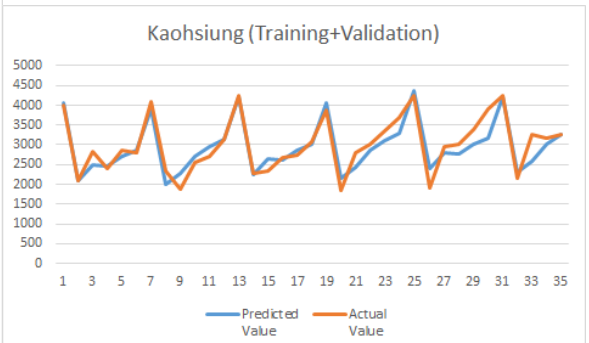


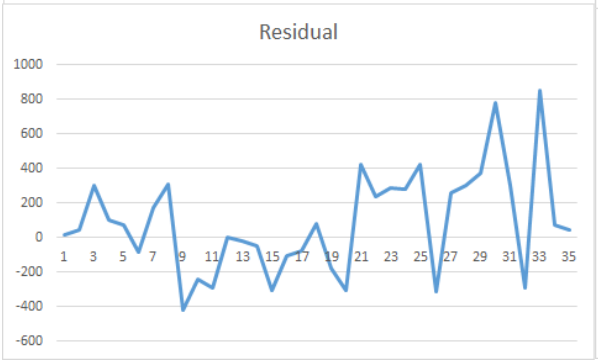


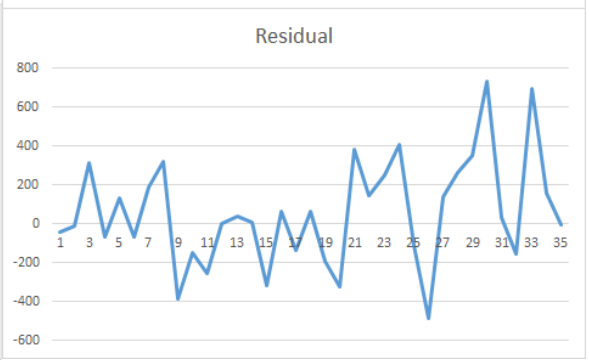


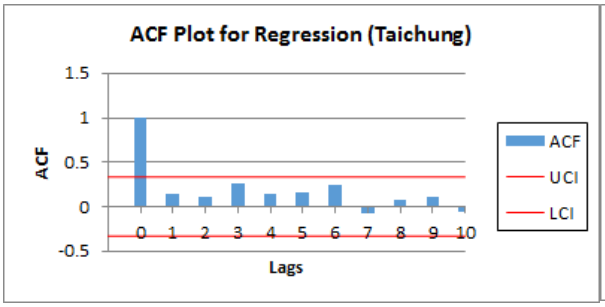


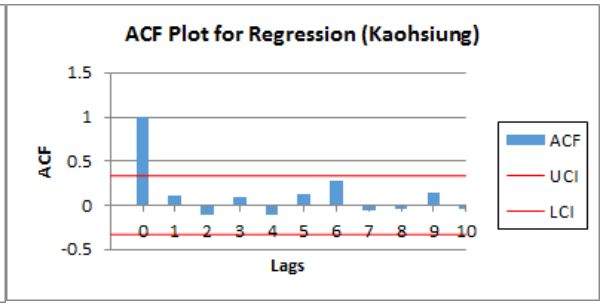












Number of motorcycle (Actual)