Modeling and Forecasting the Demand for Automotive Part of Foreign Markets to Thailand

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Abstract

The problem of this research is automotive part companies do not have order because of the world economic crisis and effect to automotive industry. Automotive and automotive parts demand in the world decrease. Automotive Industry of Thailand received affect. Automotive part companies cannot export to foreign markets. The companies in Thailand need the forecasting of automotive part quantity demanded by foreign markets by selecting the most accurate model. This paper presents the modeling for forecasting demand for automotive part of foreign markets to Thailand with time series forecasting techniques. In this study the automotive part are wheels and including parts and accessories because Thailand exported the most in group of automotive parts. These five countries have consistently demanded the largest number of wheels and including parts and accessories are Japan, China, South Korea, Germany, and Indonesia. The research involves historical collecting data for the period of 1997 to 2008. The evaluation function of forecast error is used with MAPE. The results reveal that each country suits for each model in term of the chosen dimension. The government can use the forecasting demand for effective production planning by informing manufactures.

Keywords: Modeling, Automotive part, Time series

1. Introduction

According to Thai government policy, automotive industry which is the strategic industry of Thailand has been promoted to be a car production center of this region or Detroit of Asia by promoting sale in both domestic and foreign countries, supporting automotive component research and development and establishing automotive component testing center [1]. Because of the policy to promote Thailand to be the car production center of this region, automotive companies have moved their factories into Thailand in order to use as the base of export place [2]. Those events have provided advantages for Thai automotive industry so the automotive component industry and automotive industry have grown up together. Nowadays, there are about 1,667 entrepreneurs of automotive component industry in Thailand. About 90,000 employees are employed by those factories. Most of them are small and medium enterprise (SMEs) which are about 1,641 entrepreneurs or 98.44% of all entrepreneurs. There are 2,242 factories which 2,160 of them are medium and small factories or 96.34% and large factories 3.66%.

Thai automotive market has encountered the decelerating condition in both domestic and foreign countries. In the export market, Thai cars have faced the problems that import country economic has been lower in the last 11 months. Nowadays, a signal of foreign market deceleration has shown continually because of the world economic crisis.

In 2008, Thai automotive component industry was affected by world economic problem in the last 2-3 months. In 2009, world economic crisis is forecasted to be more serious. Automotive industry around the world encounters very serious problems, especially, lacking of liquidity of automotive industry in USA which is waiting for government help. Now, main car producers in every region have announced to decrease employees, production and investment that will affect the direction of automotive component industrial export, especially, the type of original equipment manufacturing (OEM) which is in the car production system network of those car companies. So it is forecasted that in 2009, Thai automotive production may highly decrease. It will affect Thai automotive component production in the type of OEM seriously. Thai automotive component industry needs to adjust itself in order to cope with those situations

Thai automotive component entrepreneurs will encounter several pressure conditions so they have to find out new strategies for opportunity and run their business in economic crisis, especially, when car market in many regions encounters car sale deceleration. That problem affects automotive component entrepreneurs in several countries which has surplus production so cutting price strategy will be used to persuade some countries to buy because the price is lower than the products of Thailand.

Also, we need the forecasting of automotive part quantity demanded by foreign markets to Thailand. In this study the automotive part are wheels, including parts and accessories because of Thailand exported the most in group of automotive parts. These five countries have consistently demanded the largest number of wheels, including parts and accessories are Japan, China, South Korea, Germany, and Indonesia. The research involves historical collecting data for the period of 1997 to 2008 as Fig.1 shows demand wheels including parts and accessories.

2. Methodology

2.1 Data and Variables

This research used data from secondary sources for forecasting model estimation in the period 1997 to 2008. The data were obtained from the following sources of government services, private companies and other as:

- Customs Department
- Thailand Automotive Institute
- The Office Industrial Economics
- Department of Export Promotion
- Thai Autoparts Manufactures Association

2.2 Forecasting Model

Forecasting is a prediction that it will happen in the future by using past data. The forecasting usually consider by judgment [3]. For Time series are forecasting techniques by assuming that something was occurred in the past it will continue to the future. The important factor is the only time. Forecasting methods have many types such as Naïve, moving average, exponential smoothing, exponential smoothing with trend and regression etc.

2.3 Naïve Method

Naïve method is the simplest for forecasting [4]. It uses the latest demand for forecasting the next period. Model for Naïve method is:

$$F_{t+1}^{c} = A_{t}^{c} \quad (1)$$

Where

F_{t+1}^{c} = forecasting demand at time period $t+1$

A_{t}^{c} = actual demand at time period t

t = time period as yearly

c = the country such as Japan, China, South Korea, Germany and Indonesia

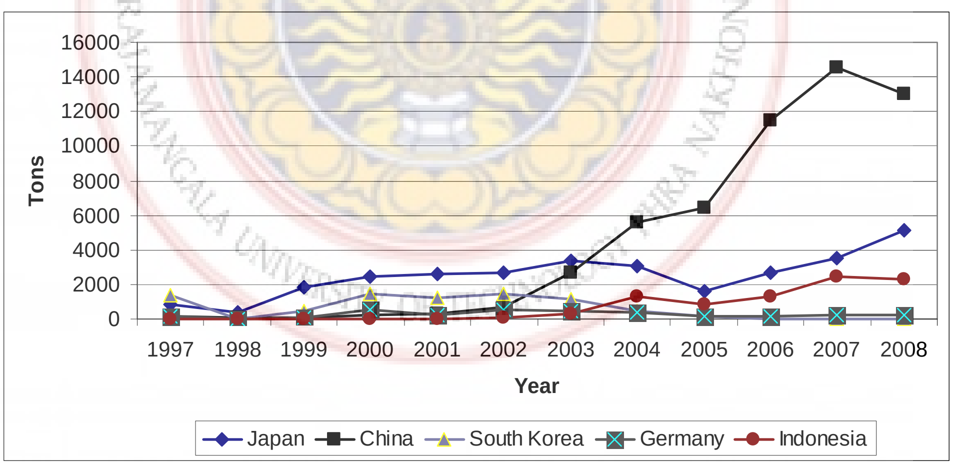

Fig. 1 Comparison of demand wheels, including parts and accessories for motor vehicles each country

2.4 Moving Average

For moving average used to forecast a future period. We will give equal weight to all of the past values. The forecasting by moving average that the important factor is an index n. We can calculate by:

$$F^{c}_{MA(n),t+1} = \frac{1}{n}\left(\sum_{t=i+1-n}^{i} A^{c}_{t}\right) \quad (2)$$

Where

$F^{c}_{MA(n),t+1}$ = forecasting demand in moving average n

$t+1$ = period at forecast

i = the last period for calculation

t = the first period in start for calculation

n = number of periods in moving average as yearly start at $n \geq 2$

2.5 Single Exponential Smoothing

A single exponential smoothing model allows us to vary the importance of recent demand to the forecast. We can calculate by:

$$F^{c}_{ex,t+1} = \alpha_c A^{c}_{t} + (1-\alpha_c)F^{c}_{ex,t} \quad (3)$$

Where

$F^{c}_{ex,t+1}$ = forecasting demand in single exponential smoothing in period $t+1$

$F^{c}_{ex,t}$ = forecasting demand in single exponential smoothing in period t

α_c = smoothing constant such that $0 < \alpha_c < 1$

2.6 Exponential Smoothing with Trend

As an extension of the single exponential smoothing approach by assuming the existence of a trend

$$F^{c}_{aex,t+1} = F^{c}_{ex,t+1} + T^{c}_{ex,t+1} \quad (4)$$

However, we can calculate $T^{c}_{ex,t+1}$ by formulation:

$$T^{c}_{ex,t+1} = \beta_c\left(F^{c}_{ex,t+1} - F^{c}_{ex,t}\right) + (1-\beta_c)T^{c}_{ex,t} \quad (5)$$

Where

$F^{c}_{aex,t+1}$ = adjusted exponential smoothing forecasted demand in period $t+1$

$F^{c}_{ex,t+1}$ = forecasting demand in single exponential smoothing period $t+1$

$T^{c}_{ex,t+1}$ = exponentially smoothed trend factor in period $t+1$

$F^{c}_{ex,t}$ = forecasting demand in single exponential smoothing in period t

$T^{c}_{ex,t}$ = exponentially smoothed trend factor in period t

β_c = smoothing constant $0 < \beta_c < 1$

2.7 Regression

A regression models attempts to represent the relationship between a set of dependent variables and an independent variable using a multivariate mathematical function (see Table1-5). In this study, the regression model appears in the form of:

$$F^{c}_{re,t} = \beta_0 + \beta_1 x_{1,t} + \beta_2 x_{2,t} + \beta_3 x_{3,t} + \beta_4 x_{4,t} + \beta_5 x_{5,t} + \beta_6 x_{6,t} + \beta_7 x_{7,t} \quad (6)$$

where

β_0 = the constant

$\beta_1 \ldots \beta_7$ = parameters representing contributions of the independent variables

$F^{c}_{re,t}$ = forecasting demand in regression in period t

$x_{1,t}$ = export in period t

$x_{2,t}$ = import in period t

$x_{3,t}$ = growth rate of GDP in period t

$x_{4,t}$ = foreign exchange rate in period t

$x_{5,t}$ = gross domestic expenditure per capita in period t

$x_{6,t}$ = average unit prices wheel including parts and accessories in period t

$x_{7,t}$ = population in period t

Table 1 An overview of inputs for regression of Japan

Year	Export (%)	Import (%)	Growth Rate of GDP (%)	Foreign Exchange Rate (JPY/US$)	Gross Domestic Expenditure Per Capita in Japan (US$)	Average Unit Prices Wheel Including Parts and Accessories for Motor Vehicles (US$/Ton)	Population	Demand Wheel Including Parts and Accessories for Motor Vehicles (Tons)
1997	11.11	0.51	1.57	121.05	33758.00	3239.56	126,150,187	821
1998	-2.71	-6.84	-2.05	130.88	30494.05	4859.25	126,468,939	411
1999	1.89	3.61	-0.14	113.81	34463.12	2389.04	126,765,489	1853
2000	12.70	9.19	2.86	107.86	36741.71	2637.81	127,034,058	2463
2001	-6.93	0.63	0.18	121.56	32178.65	2659.82	127,273,272	2584
2002	7.51	0.92	0.26	125.22	30736.18	1942.97	127,482,808	2646
2003	9.21	3.89	1.41	115.98	33128.06	2322.79	127,659,077	3341
2004	13.93	8.12	2.74	108.18	36040.75	3199.17	127,798,083	3098
2005	6.96	5.81	1.93	110.12	35592.71	4547.80	127,896,740	1628
2006	9.67	4.22	2.04	116.33	34199.99	4164.21	127,953,099	2644
2007	8.43	1.52	2.39	117.81	34224.71	4635.16	127,966,710	3499
2008	1.76	0.90	0.44	103.47	38577.83	4039.75	127,293,092	5128

Table 2 An overview of inputs for regression of China

Year	Export (%)	Import (%)	Growth Rate of GDP (%)	Foreign Exchange Rate (CNY/US$)	Gross Domestic Expenditure Per Capita in China (US$)	Average Unit Prices Wheel Including Parts and Accessories for Motor Vehicles (US$/Ton)	Population	Demand Wheel Including Parts and Accessories for Motor Vehicles (Tons)
1997	30.76	10.16	9.30	8.29	810.28	6664.20	1,215,688,291	118
1998	5.70	0.30	7.80	8.28	851.89	5964.86	1,226,923,557	98
1999	9.08	11.38	7.60	8.28	887.84	4184.68	1,237,648,051	110
2000	31.11	34.61	8.40	8.28	956.04	2409.86	1,247,685,039	200
2001	11.37	14.24	8.31	8.28	1047.31	2774.71	1,257,079,958	280
2002	19.72	21.19	9.10	8.29	1148.64	1870.01	1,265,880,056	653
2003	16.62	19.69	10.00	8.29	1293.26	972.66	1,274,233,866	2693
2004	21.98	23.80	10.10	8.29	1510.19	1049.29	1,282,294,203	5587
2005	21.74	17.56	10.40	8.2	1784.76	1587.22	1,290,208,472	6441
2006	18.65	16.07	11.61	7.98	2136.98	1547.94	1,298,014,226	11488
2007	15.69	12.90	13.01	7.62	2604.21	1477.55	1,305,713,911	14575
2008	9.58	7.08	9.05	6.96	3292.12	1847.71	1,314,357,176	12979

Table 3 An overview of inputs for regression of South Korea

Year	Export (%)	Import (%)	Growth Rate of GDP (%)	Foreign Exchange Rate (KRW/US$)	Gross Domestic Expenditure Per Capita in South Korea (US$)	Average Unit Prices Wheel Including Parts and Accessories for Motor Vehicles (US$/Ton)	Population	Demand Wheel Including Parts and Accessories for Motor Vehicles (Tons)
1997	21.63	3.46	4.65	954	11275.97	1294.34	45,786,154	1355
1998	12.65	-21.81	-6.85	1402.11	7485.63	605.51	46,146,197	14
1999	14.62	27.80	9.49	1190.13	9582.86	820.44	46,478,875	489
2000	19.14	20.06	8.49	1131.16	10937.50	1083.42	46,780,246	1427
2001	-3.43	-4.86	3.97	1291.5	10242.78	731.51	47,047,215	1222
2002	12.10	14.43	7.15	1249.79	11567.61	855.90	47,281,557	1477
2003	14.48	11.08	2.80	1194.54	12805.66	856.04	47,490,388	1124
2004	19.74	11.74	4.62	1150.91	14270.87	1418.83	47,683,978	477
2005	7.77	7.59	3.96	1027.59	16532.94	1223.32	47,869,837	171
2006	11.37	11.29	5.18	969.9	18481.07	1216.67	48,050,441	7
2007	12.61	11.68	5.11	935.27	19840.55	2201.48	48,223,854	11
2008	5.73	3.66	2.22	1102.84	19295.52	2128.84	48,152,294	7

Table 4 An overview of inputs for regression of Germany

Year	Export (%)	Import (%)	Growth Rate of GDP (%)	Foreign Exchange Rate (EUR/US$)	Gross Domestic Expenditure Per Capita in Germany (US$)	Average Unit Prices Wheel Including Parts and Accessories for Motor Vehicles (US$/Ton)	Population	Demand Wheel Including Parts and Accessories for Motor Vehicles (Tons)
1997	11.71	8.22	1.80	0.88	26325.93	8975.99	82,070,023	165
1998	7.96	9.45	2.03	0.90	26586.54	11042.45	82,164,693	28
1999	5.94	8.55	2.01	0.94	26066.33	7696.18	82,234,660	73
2000	13.53	10.17	3.21	1.08	23086.47	5302.14	82,308,801	561
2001	6.44	1.23	1.24	1.11	22949.73	5898.94	82,395,462	247
2002	4.29	-1.44	0.00	0.54	24453.02	6420.18	82,485,207	560
2003	2.46	5.36	-0.22	0.88	29577.03	5127.08	82,568,070	453
2004	10.25	7.28	1.21	0.81	33228.46	5411.30	82,627,591	350
2005	7.67	6.53	0.77	0.80	33772.47	6742.56	82,652,369	161
2006	12.69	11.85	2.96	0.80	35250.86	6836.95	82,640,853	143
2007	7.47	5.03	2.46	0.73	40162.21	6233.92	82,599,470	202
2008	2.68	4.21	1.27	0.68	44362.75	8018.61	82,264,266	233

Table 5 An overview of inputs for regression of Indonesia

Year	Export (%)	Import (%)	Growth Rate of GDP (%)	Foreign Exchange Rate (IDR/US$)	Gross Domestic Expenditure Per Capita in Indonesia (US$)	Average Unit Prices Wheel Including Parts and Accessories for Motor Vehicles (US$/Ton)	Population	Demand Wheel Including Parts and Accessories for Motor Vehicles (Tons)
1998	11.59	-6.04	-13.13	10285.38	507.12	4500.06	206,786,073	8
1999	-31.78	-39.44	0.79	7876.90	736.59	7321.19	208,825,347	12
2002	-1.22	-4.25	4.50	9350.14	899.73	10650.35	217,465,933	59
2003	5.89	1.56	4.78	8592.80	1065.43	3040.24	220,354,725	343
2004	13.53	26.65	5.03	8945.82	1150.57	2918.26	223,224,904	1330
2005	16.60	17.77	5.69	9721.65	1264.55	3754.61	226,063,044	840
2006	9.41	8.58	5.51	9183.77	1593.08	4543.92	228,864,475	1314
2007	8.02	8.89	6.32	9183.50	1868.60	3819.20	231,626,979	2446
2008	10.02	10.11	6.01	9684.89	2246.71	4156.18	227,345,082	2304

2.8 Measure of Forecast Accuracy

There are several measurements in the forecasting. The general accuracy of forecasting was measured mean absolute error (MAE), mean absolute percentage error (MAPE), mean square error (MSE), and root mean square error (RMSE). MAE is the easiest to understand and compute. It measures the overall accuracy and provides an indication of the overall spread, where all error are given equal weights. MAPE is a relative measurement that corresponds to MAE.

In general, the selected models were not very accurate in most of the measuring dimensions. The classified forecasts with MAPE values of less than 10% as highly accurate forecasting, between 10% and 20% as good forecasting, between 20% and 50% as reasonable, and forecasting, larger than 50% as inaccurate forecasting [7].

3. Results

For naïve, moving average, single exponential smoothing, exponential smoothing with trend and multiple regression were used to forecast demand wheels including parts and accessories. These five models are some of the common models in forecasting methods [5][6]. A naïve model forecasts the value of a demand at time $t+1$ using the value of the demand at time t. A moving average forecasting model calculates forecasting demand by changing number of periods n in moving average as yearly start at $n=2$ until $n=4$.

A single exponential smoothing model allows the importance of recent demand to the forecast. We can calculate by changing alpha α_c. Alpha is called smoothing constant. The smoothing constant must take a value between zero and one. We started to calculate $\alpha_c = 0.1$ until $\alpha_c = 0.9$ for each country. As an extension of the single exponential smoothing approach by assuming the existence of trend, an exponential smoothing with trend model generates. We calculate by changing α_c and β_c for each country.

The smoothing constant (β_c) must take a value between zero and one same the alpha(α_c). The exponential smoothing with trend, we started to calculate $\alpha_c = 0.1$ until $\alpha_c = 0.9$ and β_c started at 0.1 until 0.9. Lastly, a multiple regression model attempt to identify the relevant variables and the dependent variable in terms of parameters.

Table 6 Comparisons of forecasting model and accuracy measurements

	Naïve	Moving Average	Single Exponential Smoothing	Exponential Smoothing with Trend	Regression
Japan		**(4 Years)**	**(alpha=0.9)**	**(alpha=0.9, beta=0.1)**	
MAE	842.273	1057.969	860.626	806.752	243.102
MAPE(%)	41.956	36.229	42.241	41.306	16.188
MSE	1085953.909	1445225.602	1093339.088	1080010.986	99441.100
RMSE	1042.091	1202.175	1045.629	1039.236	315.343
China		**(2 Years)**	**(alpha=0.9)**	**(alpha=0.9, beta=0.9)**	
MAE	1463.000	2021.450	1539.875	1304.738	210.209
MAPE(%)	34.566	43.271	35.933	29.671	48.018
MSE	4633574.455	8721185.575	5148171.258	4051082.000	71276.506
RMSE	2152.574	2953.165	2268.958	2012.730	266.977
South Korea		**(2 Years)**	**(alpha=0.9)**	**(alpha=0.6, beta=0.9)**	
MAE	426.545	386.300	419.234	449.709	271.851
MAPE(%)	1141.622	598.135	1203.298	1106.337	944.730
MSE	334052.909	274482.250	334691.304	366792.000	106816.636
RMSE	577.973	523.911	578.525	605.633	326.828
Germany		**(2 Years)**	**(alpha=0.6)**	**(alpha=0.3, beta=0.9)**	
MAE	164.000	130.719	137.547	132.488	60.738
MAPE(%)	95.134	75.793	87.108	84.172	67.091
MSE	47095.273	17622.324	37756.780	36563.000	5939.529
RMSE	217.014	132.749	194.311	191.214	77.068
Indonesia		**(2 Years)**	**(alpha=0.8)**	**(alpha=0.6, beta=0.3)**	
MAE	445.000	501.571	425.733	388.313	160.917
MAPE(%)	51.977	49.772	36.058	47.751	85.864
MSE	353480.250	498593.786	266336.882	326085.394	81253.623
RMSE	594.542	706.112	516.078	571.039	285.050

The results for each model were shown on Table 6. We considered MAPE for measuring accuracy in forecasting. We found that moving average, single exponential smoothing and exponential smoothing with trend were able to achieve three reasonable forecasts and two inaccurate forecasts whereas naïve and regression attained two reasonable forecasts and three inaccurate forecasts. As revealed in Table 3 and Table 4, the number of demand wheels, including parts and accessories of South Korea and Germany had largely dropped after 2003. Also, any forecasting models cannot forecast because they are large error

4. Conclusions

This research has attempted to find out the forecasting model for each country by comparing the lowest error. When we know the forecasting model so we apply that model forecasts demand in the future. The forecasting models are naïve, moving average, single exponential smoothing, exponential smoothing with trend and multiple regressions. The empirical results showed that most of the models did not forecast very accurately. Furthermore, due to the input data of each country is difference, there are affected to different results.

Automotive parts industry is particular importance to Thailand. The government promotes to the first industry in Thailand. It brings foreign money and employment in country. Also, the need for accurate demand forecasting automotive parts is particularly important due to the industry's significant contribution to the economic. To a large extent, manufactures relies forecasting results for production planning for future and improvement manpower.

In the future research, we can use other techniques the more advanced time series forecasting. It may be high accuracy.

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