

# Forecasting the Sales of Light Trucks in the United States

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**Abstract.** The motor vehicles and parts industry in the United States employed as much as 7.4% of the labour force in the manufacturing industry in 2006. The purpose of this paper is to canvass various forecasting models, determine the optimal forecasting model and then forecast the sales of light trucks. A secondary purpose is to investigate the relationship between the gasoline price and the light truck sales.

The specific models considered are the time series model, including trend, seasonality, and cycles; VAR(p); ARIMA(p,I,q); regression; various smoothing techniques; and lastly the ARCH/GARCH model. The optimal model was found to be the ARCH(1) model. This model takes into account two additional variables; the gasoline price and the sales of regular cars. The forecast revealed that the sales of light trucks will begin to slowly decrease over the next few years. Furthermore, the regression model indicates that the gasoline price is significantly related to the sales of light trucks. As the growth rate of gasoline price increases by 1%, the growth rate of light truck sales decreases by 0.18%, *ceteris paribus*.

## 1. Introduction

In the United States, the light car and light truck industry alone employed almost 200 000 people (2006 est). As a whole, the motor vehicles and parts industry employed as many as 1.07 million people (2006 est). This amounts to 7.4 % of the labour force in the manufacturing industry in 2006. [1] The two components of light vehicle sales are regular car sales and light truck sales. These two are obviously closely related. Both vehicles are for the common man's transportation necessities. Therefore, what impacts the first will impact the second in a similar manner. The sales of automobiles, and hence also light trucks, are easily said to be dependent upon the supply and demand for the two variables. The demand is usually modelled as some utility function of buying a light vehicle dependent on various factors such as income, price of the car, etc., while the supply side is generally modelled as an oligopoly market dependent on the various firms' cost functions, etc. [2] This paper will focus on a different simplified approach, namely trying to explain the sales of

light trucks with regular car sales and the gasoline price.

The purpose of this paper is to forecast the sales of light truck and hopefully shed some light about the impact gasoline prices has on the sales of light trucks.

In the section to come the various forecasting models are considered in order to determine the optimal model. This model is determined and used. The next section concludes the findings.

## 2. Analysis

The dataset of light truck sales within the U.S. was collected from the Bureau of Economic Analysis. Light trucks are trucks up to 14 000 pounds gross vehicle weight (this includes minivans and sport utility vehicles (SUV's)). The datasets consist of 355 monthly observations of non-seasonally adjusted figures of new light truck sales. The data stretches from June 1977 to December 2006. This yields a dataset which is well over the 30 observations limit, hence a dataset of great past information and hopefully with the power of robustly explaining future variations.

The various forecasting models considered in this paper are; the time series model, including trend, seasonality, and cycles; VAR(p); ARIMA(p,I,q); regression; various smoothing techniques; and lastly the ARCH/GARCH model. However, due to lack of space, only two models will be discussed in more detail. These are the regression model due to the secondary purpose and the optimal forecasting model. The general version of the regression model estimated it is shown below.

$$y_t = \beta_0 + \beta_1 x_t + \beta_2 z_t + \mu_t \quad (1)$$

where  $y_t$  is the growth rate of light truck sales at time period  $t$ ,  $x_t$  is the growth rate of automobile sales at time  $t$ ,  $z_t$  is the growth rate of the gasoline price at time  $t$ , and finally  $\mu_t$  is an error term. After adjusting for various statistical problems and determining that the model is not misspecified, one can conclude that the two explanatory variables ( $x_t$  and  $z_t$ ) explain as much as 72.8% of the variation in the growth rate of light truck sales which is

considered very good. Furthermore, the regression model indicates that the gasoline price is significantly related to the sales of light truck sales and as the growth rate of gasoline price increases by 1% the growth rate of light truck sales decreases by 0.18%, ceteris paribus.

The optimal forecasting model is determined by the root mean square error (RMSE), which basically measures how 'wrong' the forecast was. The model producing the lowest RMSE is therefore the best model. Table 1 presents all RMSE from the various models examined.

Table: 1  
Comparison of root mean square errors (RMSE)

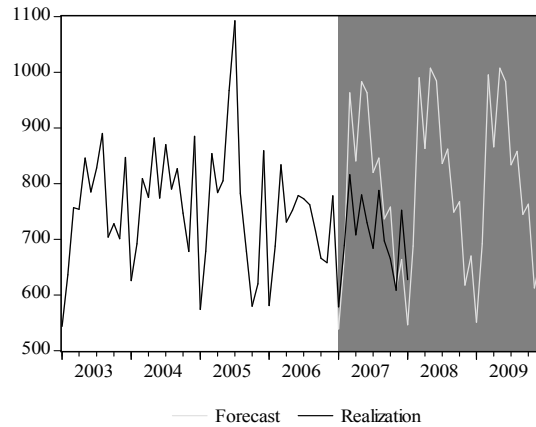
Forecasting Models	RMSE
linear trend, seasonal dummies, and ARMA(2,4)	0.142730
VAR(13)	0.163698
ARIMA(0,1,1)	0.377975
Regression	0.103276
smoothing single	0.173015
smoothing double	0.173196
smoothing HW	0.141961
ARCH(1)	0.102005

From the table, one can see that the ARCH(1) model has the lowest value, so this is therefore the optimal forecasting model. ARCH stands for autoregressive conditional heteroscedasticity and is a way of modelling a time series' volatility, especially in financial time series such as stock prices, inflation rates, and foreign exchange rates. Just as the error term can be serially correlated with previous values, the error variance can be serially correlated in the same manner. The ARCH model says that the error variance is related to the squared error term lagged one time period. The general form of an ARCH(1) model can be written as following:

$$y_t = \beta_0 + \beta_1 x_t + \beta_2 z_t + \mu_t \quad (2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \mu_{t-1}^2 \quad (3)$$

As can be seen from equation (2), ARCH(1) also takes into account the same explanatory variables as in the regression model, namely the growth rate of automobile sales and the growth rate of gasoline prices. These two series were first forecasted using the first forecasting model with trend, seasonal dummies and ARMA(p,q) schedules. Including these forecasts of the explanatory variables, the main 5-year-ahead-forecast is now obtainable and it is shown in Figure 1. Because we are fortunate to have the benefit of hindsight, the actual sales to present day from December 2006 is also included. Figure 1. 5-year-ahead-forecast



From the graph, one cannot see whether or not the sales trend upwards or downwards. Due to lack of space a longer time period will not be presented. However, the forecasting trend is slightly downward trending. This is consistent with the realization, though the forecast may have received unforeseen help by the current housing slump which is currently affecting the entire economy. It is important to note that this forecast is very dependent on shocks in the sales of automobiles and the gasoline price.

### 3. Conclusion

The purpose of this paper was to canvass various forecasting models in order to determine the best performing model with the help of the RMSE, and then finally forecast the sales of light trucks within the United States using the selected model. The best model found was the ARCH(1) model. The forecast revealed that the sales of light trucks will begin to slowly decrease over the next few years. This is mostly due to the forecasted increase of the percentage of regular car sales, which is positively related to the percentage sale of light trucks. This is also due to the increase in the percentage of the gasoline price, which makes people more reluctant to buy a bigger, more fuel inefficient car. The secondary purpose was to investigate whether or not the gasoline price has had any impact on the sales of light trucks. The regression model results indicate that the gasoline price is statistically significant in affecting the sales of light trucks. As the growth rate of the gasoline price increases by 1%, the growth rate of the light truck sales decreases by 0.18%, ceteris paribus.

[1] Bureau of Labour Statistics. Employment, Hours, and Earnings from the Current Employment Statistics survey (National), Retrieved January 24<sup>th</sup>, 2008, from <http://data.bls.gov/PDQ/servlet/SurveyOutputServlet;jessioid=f030cc0d50bb3f30153> (own calculations)

[2] Goldberg, P.K. (1995). Product Differentiation and Oligopoly in International Markets: The Case of the U.S. Automobile Industry. *Econometrica*, 63(4), pp. 891 – 951.