

## Determination of vehicle credits on transport demand

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### Abstract

This study proposes a car ownership model by taking into account the vehicle credits, income rate and the fuel pumping prices. The analysis on number of motor vehicles and the number of sold vehicles are investigated. The regression model and the time-lagged inflation models are used to find the future values of credit amount and the per capita vehicle ownerships out of thousand. The inflation rate is correspondingly investigated if there is any effect on the vehicle ownerships. Total number of vehicles and the car share are used based on trend analysis. The demand for car ownership is forecasted under four scenarios. Results showed that the vehicle credit cause to a rapid increase on vehicle ownerships, but inflation rate does not. It only affects during the prediction of the credit amount .

*Keywords:* Vehicle credit, transport demand, income

### 1. Introduction

The automobile has had a dramatic impact on society during the last century. Its proliferation has altered the design of cities, accelerated further technological growth, opened up mass tourism industries, and changed the way in which people go about regular activities, such as shopping, travel to work and basic social interaction

Vehicle ownership figures have been dramatically increasing for more than ten years. The costs of acquisition and use of the car were significantly reduced, with extensive systems of subsidies being provided to many motorists through their employers and through the pricing of transport at levels substantially lower than its full social and environmental costs.

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Traffic levels are doubled in many car-dependent countries in the period of 1975 –1995 (Banister et al., 2000), but the expansion of the infrastructure has been more modest, typically a 10-15% increase in the road network.

Lam and Tam (2002) presented an aggregate car ownership model for Hong-Kong and examined the reliability of territory-wide car ownership figures. The effect of income distribution was studied by Dargay (2001) and it was found that the elasticity with respect to rising income was significantly greater than the elasticity with respect to the falling income. Dargay and Gately (1997) forecasted the growth on car ownership until 2015 for OECD and six Asian countries. They found that the increase on fuel consumption and emissions on those countries were about the same within same period.

The rapid increase on vehicle ownerships is dependent on many variables such as Gross National Product (GNP), population and other socio-economic parameters. One of the parameter that would truly affect the rapid increase of vehicles ownership may be the vehicle credits. This study therefore analysis to estimate the vehicle ownership figures by taking into account vehicle credits, income and pumping prices.

## 2. Data collection and evaluation

Data are collected from National Statistics (NS, 2005) and Banks Association of Turkey (BAT, 2005). The number of monthly sold vehicles is given in Figure 1 for the period of 1996-2004. Vehicle credits provided by various banks are given in Figure 2 as a monthly basis between 1996 and 2004. The data on pumping prices are collected from the NS (2005) and they are given in Figure 3.

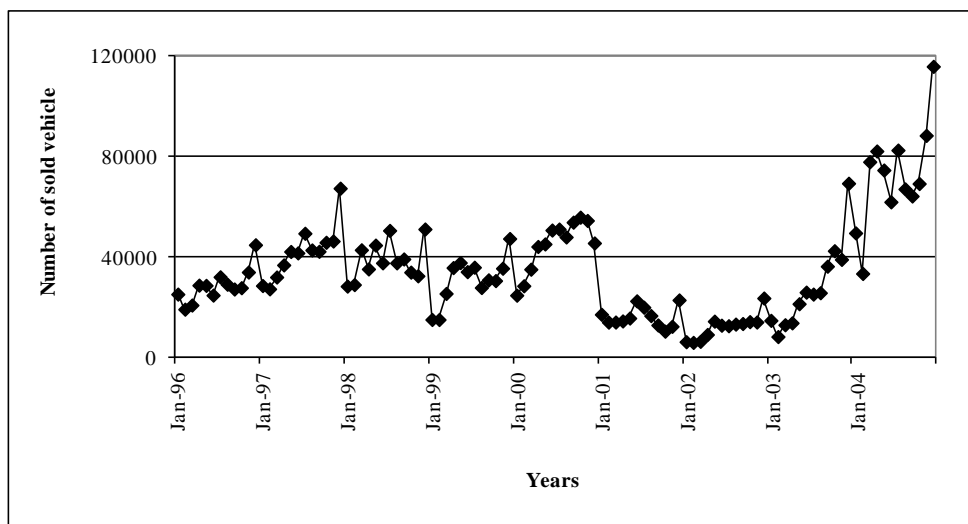


Figure 1: Number of motor vehicles

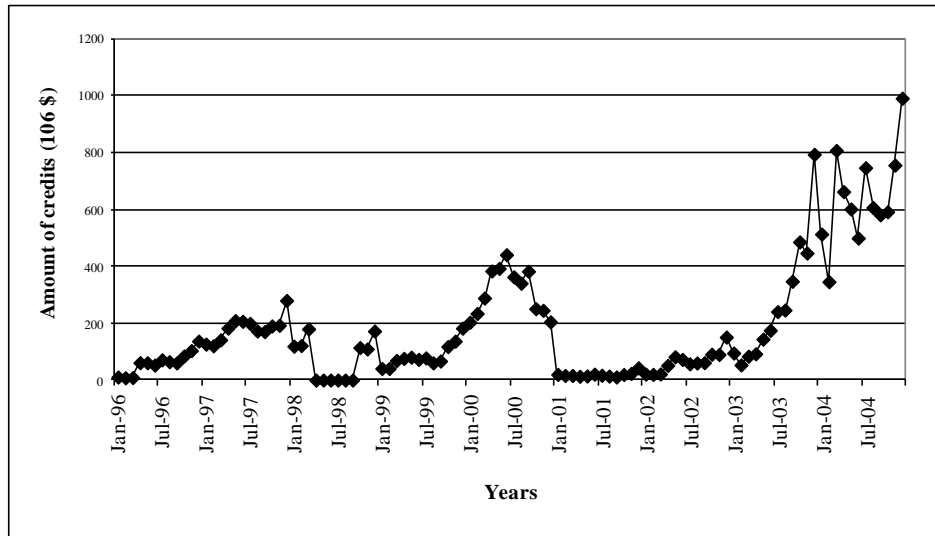


Figure 2: Vehicle credits

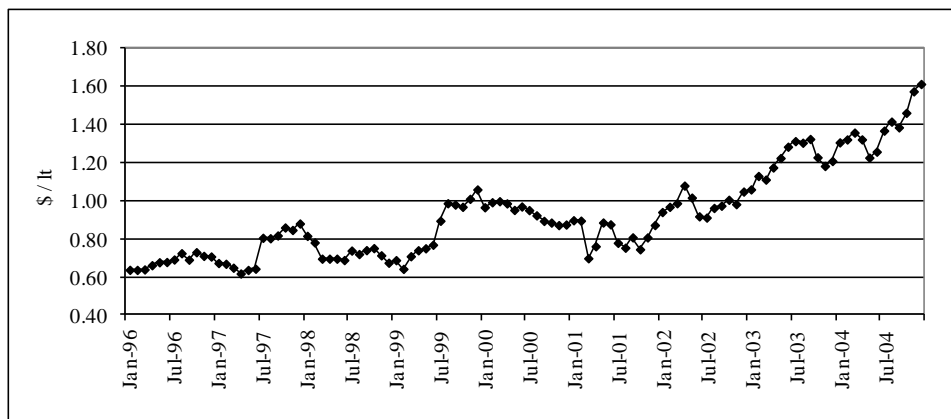


Figure 3: Monthly unleaded pumping prices in period of 1996-2004

### 3. Model development

The correlation matrix is shown in Table 1 among the selected parameters that are vehicle credit, per capita income and the pumping prices. There is a significant correlation between the selected parameters and any of the parameter individually selected to analyse vehicle ownership figures, but it is obtained that selecting all the parameters increase the precision of the analysis (Haldenbilen and Ceylan, 2005). Thus all the parameters are used.

Table 1: Correlation Matrix

	Number of sold vehicles	Vehicle Credit	Pumping prices	Income
Number of sold vehicles	1.00			
Vehicle Credit	0.85	1.00		
Pumping prices	0.45	0.74	1.00	
Income	0.72	0.76	0.63	1.00

During the analysis, 108 of collected data are used for regression analysis and 96 are used for testing fitted equation.

The vehicle ownership model is given in Eqn. (1) as:

$$Y = a + b * X_1 + c * X_2 + d * X_3 \quad (1)$$

where  $Y$  is the number of vehicles,  $X_1$  is the vehicle credit ( $10^6$ \$),  $X_2$  is the pumping price (\$),  $X_3$  is the per capita income (\$) and  $a, b, c, d$  are the coefficients.

The solution of the model

$$Y = 23790.09 + 81.42 * X_1 - 38897.50 * X_2 + 121.71 * X_3$$

$$R^2 = 0.66 \quad (2)$$

The performance of Eqn. (1) is compared with the observed values and their results are given in Table 2. In testing period, total average relative error is about 16% and it would be acceptable for future prediction of the vehicle ownership figures.

Table 2: Comparison of results of observed and model values

Years	Observed	Regression Model	Relative Error (%)
01/2004	49560	57132	13.25
02/2004	33398	42891	22.13
03/2004	77948	79097	1.45
04/2004	82221	68686	-19.71
05/2004	74638	67428	-10.69
06/2004	61953	57882	-7.03
07/2004	82597	74989	-10.14
08/2004	67111	61241	-9.58
09/2004	64291	60282	-6.65
10/2004	69254	58137	-19.12
11/2004	88450	67539	-30.96
12/2004	115963	85914	-34.98
Average Error			15.47

### 3.1. Parameter forecasting

#### 3.1.1. Credits

In order to forecast the vehicle credits in future, it would be unavoidable to estimate the inflation rate since it affects the vehicle credit amount. Thus, the inflation is estimated in the following way.

First, the observed monthly inflation rates were obtained from the Central Bank of Turkey (CBT, 2005) for the period of 1998-2004, and then Eqn. (3) is fitted as a time series. The recorded inflation rate and the change of vehicle credits can be seen in Figure 4

$$\begin{aligned} INF &= a * X^b \\ INF &= 9.93 * X^{-0.55} \end{aligned} \quad (3)$$

where  $INF$  is the inflation rate,  $X$  is the time series and  $a, b$  is the coefficients.

After determination of inflation rates, the following time-lagged equation is fitted to obtain the amount of vehicle credits.

$$\begin{aligned} Y_n &= a * Y_{n-2} + b * Y_{n-1} + c * INF_n \\ Y_n &= 0.35 * Y_{n-2} + 0.67 * Y_{n-1} - 0.10 * INF_n \end{aligned} \quad (4)$$

where  $Y_n$  is amount of credit based on a reference month,  $n$  and  $INF$  is the inflation rate.

Inflation parameter is excluded during demand prediction since it has no affect on the vehicle ownership figures, but it would be helpful to estimate the amount of vehicle credits.

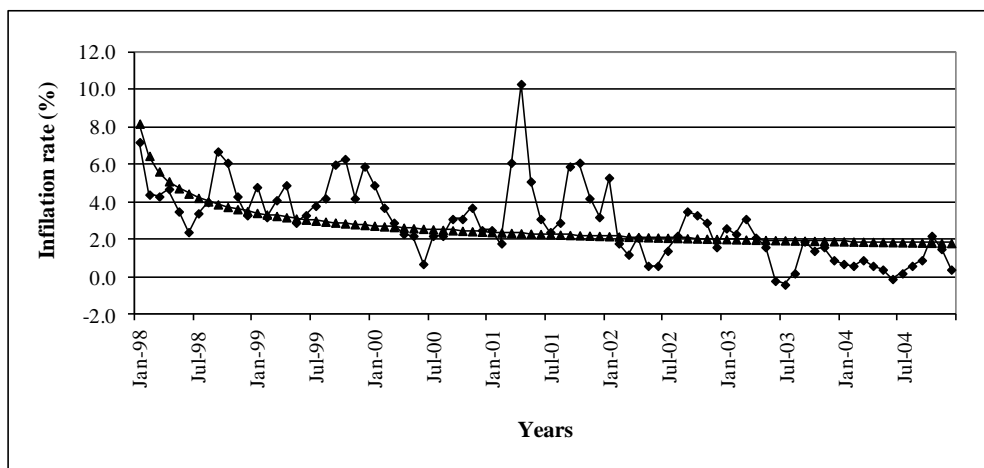


Figure 4: Estimation of inflation rates

Predicted vehicle credits are given in Table 3 for the period of 2005-2015.

Table 3: Forecasted credit amount

Years	Credit( $10^6$ \$)	Years	Credit( $10^6$ \$)	Years	Credit( $10^6$ \$)
01/01/2005	686.87	01/12/2008	1197.48	01/06/2012	1825.42
01/06/2005	741.36	01/01/2009	1210.16	01/12/2012	1933.59
01/12/2005	798.52	01/06/2009	1275.02	01/01/2013	1952.13
01/01/2006	808.27	01/12/2009	1356.23	01/06/2013	2047.15
01/06/2006	858.07	01/01/2010	1370.14	01/12/2013	2166.41
01/12/2006	920.15	01/06/2010	1441.35	01/01/2014	2186.87
01/01/2007	930.76	01/12/2010	1530.59	01/06/2014	2291.68
01/06/2007	984.95	01/01/2011	1545.88	01/12/2014	2423.26
01/12/2007	1052.64	01/06/2011	1624.18	01/01/2015	2445.83
01/01/2008	1064.22	01/12/2011	1722.37	01/06/2015	2561.51
01/06/2008	1123.42	01/01/2012	1739.2	01/12/2015	2706.78

Predicted pumping prices and gross national product per capita (GNPPC) were taken from Haldenbilen (2005).

### 3.2. Forecasting vehicle ownerships

The total vehicle ownership figures are obtained for each class of the vehicles until 2015 with the following equation.

$$y = 768570 * \ln(x) - 3E + 06 \quad R^2 = 0.81 \quad (5)$$

where  $y$  is the motor vehicle ownership and  $x$  is the total yearly sold vehicles.

The results of the Eqn. (5) is given in Figure 5.

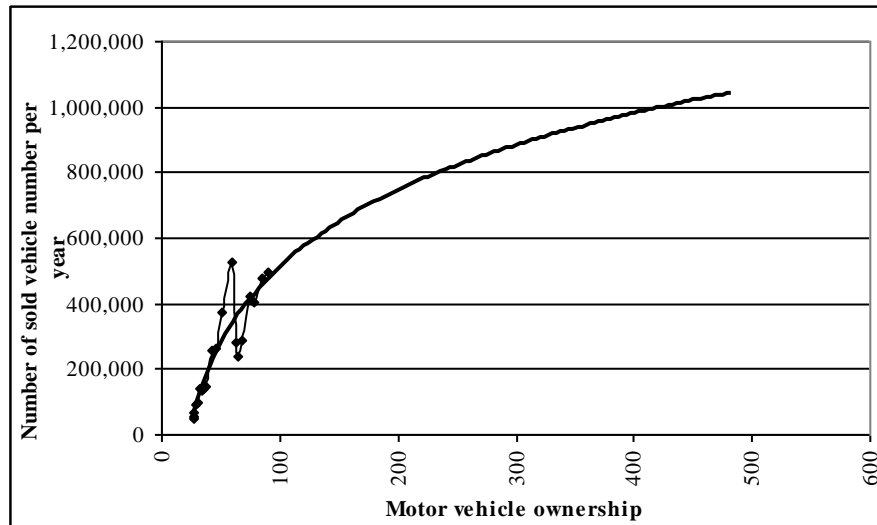


Figure 5. Relationship between sold motor vehicle ownership and ratio of car ownership

In addition, the ratio of automobile ownership is estimated using the following relation.

$$y = 0.01 * \ln(x) + 0.37 \quad R^2 = 0.87 \quad (6)$$

where y is the rate of automobile and  $x=1$  for 1965  $x=2$  for 1966.....

The application of Eqn. (6) is given Figure 6 corresponding to total yearly sold vehicles.

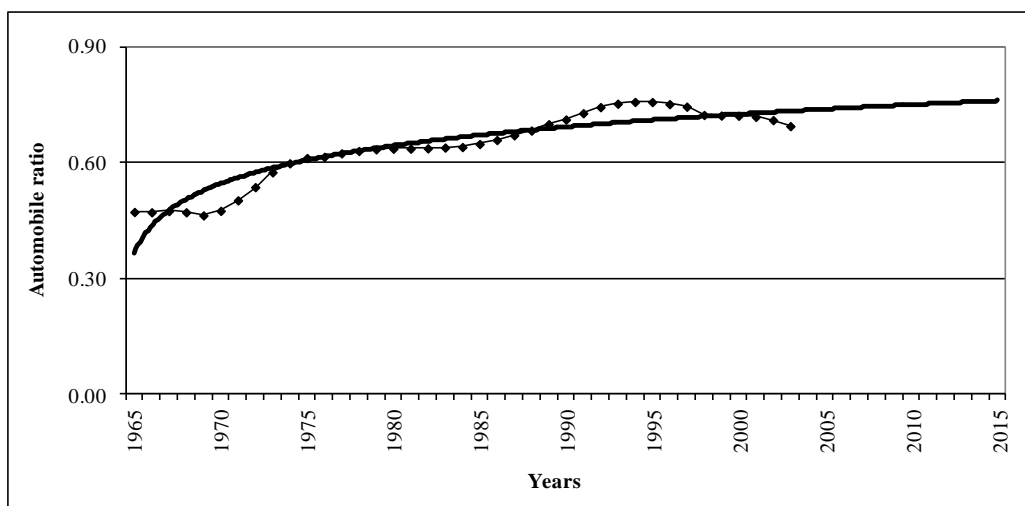


Figure 6: Ratio of automobile in the number of total vehicle

#### 4. Future Prediction

The prediction of automobile ownership with respect to vehicle credit, pumping price and income level is carried out under four scenarios until 2015. the proposed scenarios are:

- Scenario 1: Pumping price high, income low;
- Scenario 2: Pumping price low, income low;
- Scenario 3: Pumping price high, income high; and
- Scenario 4: Pumping price low, income high.

The results of the 4 scenarios are given in Table 4. The vehicle ownership figures will be between 203 and 222 per person out of 1000.

**Table 4:** Car ownership for per thousand population

Years	Scenario 1 Car ownership	Scenario 2 Car ownership	Scenario 3 Car ownership	Scenario 4 Car ownership
2005	86	87	87	87
2006	95	95	96	96
2007	103	104	105	106
2008	113	114	116	117
2009	123	125	127	129
2010	133	136	138	141
2011	145	149	151	155
2012	158	163	165	170
2013	172	177	180	186
2014	187	194	196	203
2015	203	211	214	222

#### 5. Conclusions

This study investigates the effect of vehicle credit, income and pumping prices on vehicle ownership figures. The data collection, model building and solution algorithms are given. The inflation rate is used to obtain the future vehicle credits. The car ownership figures are predicted until 2015 under four scenarios. The following conclusions can be drawn from this study.

Regression model for estimating the vehicle ownership figures are resulted in an about 16% relative estimation error in testing period. Time-lagged time series models are developed for estimating the inflation rates in future. It was found that the car share will reach to a value of about 70% of total unless there is no control measure are imposed on private car use.



The projected total number of vehicles will reach to a value of  $22 \cdot 10^6$  in 2015 and the population will be 83 million according to the NS (2005). Per person vehicle ownership will be between 203 and 222 in 2015.

The inflation rate may not directly affect the increase on number of vehicles per capita, but it would affect the credit amount.

## Acknowledgement

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