Passenger Car Ownership Estimation toward 2030 in Japan: BAU Scenario with Socio-economic Factors

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Passenger Car Ownership Estimation toward 2030 in Japan
-BAU Scenario with Socio-Economic Factors-

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Abstract

The estimation of passenger car ownership is a crucial estimation for auto-related production and for the analysis of many transportation-related policies such as Green House Gas (GHG), emissions, and energy consumption policies. Previous studies of car ownership estimation have generally focused on accurate adherence to the track record, statistical signification, or model structure; however, there are problems in focusing on all these factors together. A variation in the assumptions can produce different forecast results. Further, the uncertainties in the forecasting processes were enormous, and this made the final results unreliable. It is important for these previous studies with economic variables to have accurate results of passenger car ownership with regard to the various estimation factors such as emission levels, CO_2, and car parts production. For the production estimation and for the policy analysis, it is necessary to draw a car ownership pattern as a baseline scenario "the **B**usiness **a**s **U**sual."

The purpose of our passenger car ownership estimation model with the **B**usiness **a**s **U**sual scenario —JARI BAU Model—. JARI BAU Model is to estimate passenger car ownership by resolving these difficulties. Our passenger car ownership estimation model with the JARI BAU Model for the demand function is intended to provide information on the total passenger car ownership in Japan from the present time until the year 2030.

This paper is an attempt at methodological amelioration by conducting a fairly comprehensive literature survey on the estimation models of passenger car ownership. The estimated results will be strictly examined by t-value, and regression coefficients will be estimated at the 1% significance level. The accuracy of the estimated result will be compared to the statistical record.

This paper is unique in that it attempts to estimate car ownership solely on the basis of socioeconomic trends, without including the physical characteristics of automobiles such as fuel economy, vehicle age, or infrastructure development. Considering an aging society with a declining birth rate and an increasing governmental debt, the population may be polarized into high- and low-income groups. The polarization of income distribution affects the polarization of car ownership. We assume that the driver's license holders in the high-income group can own their vehicles.

The BAU model estimates 60.09 million passenger vehicles in 2010 and 61.59 million in 2030. The estimation model improves both the accuracy and statistical estimation. From the viewpoint of accuracy, the deviation is between –4% and +8% as compared with the actual record. The estimated t-values are significant for the entire data set and the limited data set (the 1970s, 1980s, and 1990–2002).

JEL classification: C32, C51, R41, N35, J11

Keywords: Time series models, Model construction and estimation, passenger car ownership, Japan, Demographic trends

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1. Introduction

The estimation of passenger car ownership is a crucial estimation for auto-related production and for the analysis of many transportation-related policies such as Green House Gas (GHG), emissions, and energy consumption policies.

Previous studies of car ownership estimation have generally focused on accurate adherence to the track record, statistical signification, or model structure; however, there are problems in focusing on all these factors together. A variation in the assumptions can produce different forecast results. Further, the uncertainties in the forecasting processes were enormous, and this made the final results unreliable. It is important for these previous studies with economic variables to have accurate results of passenger car ownership with regard to the various estimation factors such as emission levels, CO_2, and car parts production. For the production estimation and for the policy analysis, it is necessary to draw a car ownership pattern as a baseline scenario "the **B**usiness **a**s **U**sual."

The purpose of this passenger car ownership estimation model with JARI BAU Model. JARI BAU Model is to estimate passenger car ownership by resolving these difficulties. Our passenger car ownership estimation model with the JARI BAU Model for the demand function is intended to provide information on the total passenger car ownership in Japan from the present time until the year 2030, taking socioeconomic factors into account.

This paper is an attempt at methodological amelioration by conducting a fairly comprehensive literature survey on the estimation models of passenger car ownership. The estimated results will be strictly examined by t-value, and regression coefficients will be estimated at the 1% significance level. The accuracy of the estimated result will be compared to the statistical record.

This paper is unique in that it attempts to estimate car ownership solely on the basis of socioeconomic trends, without including the physical characteristics of automobiles such as fuel economy, vehicle age, or infrastructure development. Considering an aging society with a declining birth rate and an increasing governmental debt, the population may be polarized into high- and low-income groups. The polarization of income distribution affects the polarization of car ownership. We assume that the driver's license holders in the high-income group can own their vehicles.

The BAU model estimates 60.09 million passenger vehicles in 2010 and 61.59 million in 2030. The estimation model improves both the accuracy and statistical estimation. From the viewpoint of accuracy, the deviation is between –4% and +8% as compared with the actual record. The estimated t-values are significant for the entire data set and the limited data set (the 1970s, 1980s, and 1990–2002).

The uniqueness of this paper can also be its weakness. For further development of the estimation of car ownership, it is necessary to analyze the relationship between the characteristics of automobiles and the preferences of consumers.

2. Literature Survey and Empirical Studies

2.1. Literature Survey on the Estimation of Passenger Car Ownership

With regard to motor vehicle ownership estimation, the literature survey reveals that its main focus is the selection of variables and model structures. In general, the income level appears to be the most important economic variable that determined the number of motor vehicles. Tanner (1978 [39]) describes the development of car ownership forecasting since 1951. The first forecasting model was conceived in 1951 by Smeed in the Road Research Laboratory [30]. In this first forecast, real income was a major determinant of traffic growth. Rudd (1951 [29]) estimated car ownership by using income and motoring costs. These studies also provided broad trends in car ownership rather than precise indications.

After the first oil shock, the Department of Energy forecasted car ownership according to economic growth and the fuel price based on Tanner's model [38]. In its Energy Policy Review, the Department of Energy (1977 [8]) referred to crude oil prices as a reasonable planning assumption. Ingram and Liu (1999 [27]) researched the price elasticity of motor vehicle ownerships. The authors concluded that price elasticities are smaller than income elasticities because the variety of prices depending on car type makes an average price index difficult.

Chandler (1958[5]) forecasted car ownership in the UK by using past trends and car production capacity. The author concluded that car ownership would increase in the 1960s. Tanner (1958 [35]) observed that the higher the level of car ownership, the lower is the growth of car ownership per 1000 people. Following the article by Tulpule (1972 [42]) and Tanner (1975 [37]), various estimation methods were developed, such as the disaggregated model by vehicle class and the extension of past trends applied to different countries (Transport and Road Research Laboratory, TRRL 1979 [42]). Dargay [6] projected passenger car ownerships at the year

2025 using a dynamic Gompertz function on the basis of historical data for 82 countries. The author used GDP as a variable, but noted that there could be significant effects from non-income variables that were omitted from the model.

Previous studies of motor vehicle ownership models have generally focused on accurately adhering to the track record, statistical signification, or model structure; however, there are problems encountered in attempting to focus on all these factors together. Generally, forecasts according to the average income were underestimated as compared with the track record. For example, the hike in fuel price in 1973 could not have been predicted. Sharp (1973 [31]) pointed out that a variation in the assumptions can produce different forecast results. Further, the uncertainties in the forecasting processes were huge, and this made the final results unreliable. It is important for these previous studies with economic variables to be accurate in arriving at passenger car ownership results for further development. In order to apply for car ownership as business as usual toward 2030 in Japan, it is necessary to discuss whether the socioeconomic factors of previous studies are applicable by comparing them to the track record, as done in the following section.

2.2. Empirical Studies on Passenger Car Ownership Estimation

Accuracy and explanatory factors are examined through our empirical studies. Figure 2-1 illustrates the accuracy of literature surveys, empirical studies, and the JARI Model from Version 1 to Version 3. Since JARI models should focus on tractable methodology, this section explains the accuracy and explanatory factors.

The JARI passenger car vehicle ownership model (Ver. 1) employs a cohort model in which car registration is automatically estimated from the growth rate of new car sales 1965-2000 (Japan Automobile Manufacturers Association, Inc. (JAMA) [18],[20]); in response, the rate of car registration increases without limit (Hirota and Minato [24]). Furthermore, the number of car registrations was underestimated up to 2030. The deviation was large—between –98% to +7.9%—and the results were far from the track record 1965-2000.

The key solution was to incorporate economic background (Working Group of Vehicle-Related Taxes (WGVRT) 2001 [46]) into the car registration estimation model. Due to the deviation problem, the JARI passenger car ownership model (Ver. 2) resolved the optimization problem under budget. On examining the growth rate of the population with driver's licenses (JAMA [20]) as an influential factor on passenger car ownership with the dataset 1965-2001, we realized that the female demographic had grown more rapidly than the male counterparts. The rapid growth in the number of female drivers may also be attributable to the aspects of their lifestyle. The number of female workers [33] is currently on the rise. In their families, women provide transport to family members. If this growth rate continues, females will comprise half of the population with driver's licenses in the future (Hirota and Minato (2005 [24]). The other significant growth is in the population of elderly driver's license holders. Most of them no longer have mortgage payments or are responsible for their children's school fees; hence, they have more freedom of expenditure. According to a survey of Japan Automobile Manufacturers Association on the passenger car market for elderly drivers [19], it was found that the elderly prioritize the ease of driving when deciding on which car to buy. Assuming that the elderly population in 2010 will be 38 million, one quarter of the total number of driver's license holders in Japan will be elderly. The senior age group will thus be a key in the growth of car registrations.

We add average income [10], female wages, and elderly income [32] sequentially to the JARI passenger car ownership model Ver. 2. The log-log regression analysis determines the influence of variations in car ownership. The results overestimate/underestimate the track record 1990-2001. Although the deviation was narrower than Ver. 1 at +30% ~ –11%, it lacked reliability of forecasts. We need to focus on improving the motor vehicle ownership estimation model in order to achieve greater accuracy.

In order to grasp the average phenomenon, we decided to use the population with driver's licenses and the workforce as social factors 1965-2002 (Ver. 3). The deviation is between –0.005% ~ 4.6% as compared with the track record of passenger car ownerships; however, several parameters caused statistical instabilities that resulted in problems of multicollinearity in the model.

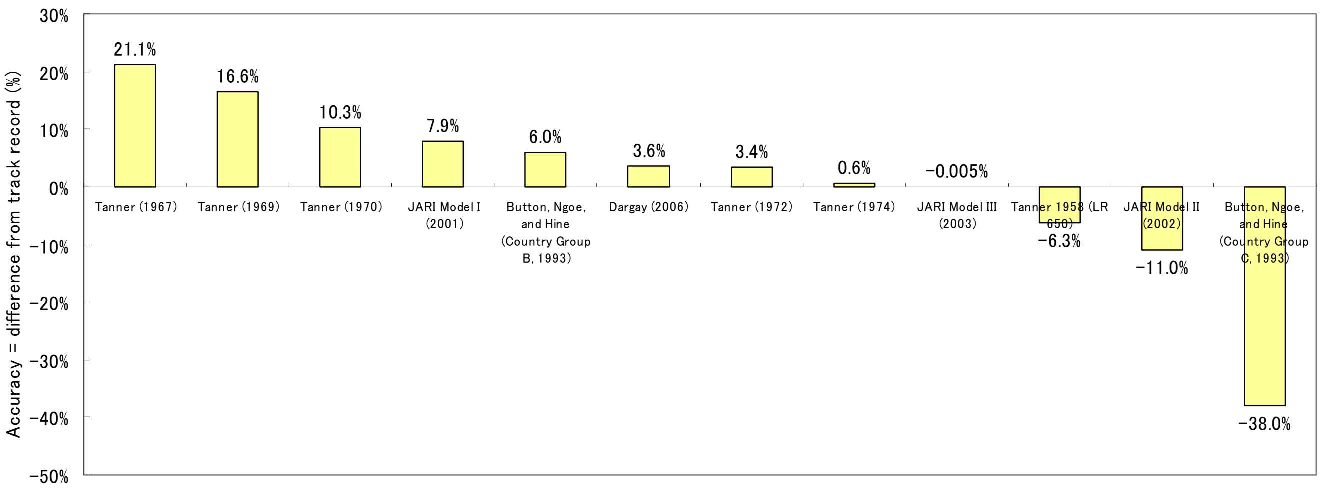

Figure 2-1　Accuracy of the Forecasts from Literature Surveys and Empirical Studies

3. Model Development

3.1. Selection of Socioeconomic Factors

Assuming that lifestyle depends on social factors such as gender and age (Tanner 1977 [38], Jones 1987 [22], Jansson (1989 [17]), in this chapter, we attempt to clarify the relationship between social factors and the amount of car use. Table 3-1 displays the coefficients and t-values of the regression model with variables in the logarithmic form (Eq1), which is used in surveys of the literature with the dataset 1965-2002. The dependent variable is motor vehicle ownership per 1000 units. In Table 3-1, numbers 3 ~ 6 include oil price variables (BP [1]) with higher R^2 and adjusted R^2 in the Table 3-1.

$$\ln P = \ln\beta_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + u \qquad \textbf{Eq 1}$$

P: Passenger car ownership per 1000 People from Track Records of Car Stock 1968-2003

β_n: coefficient (n=1~4)

X_2: GDP percapita (Yen)

X_3:Driver population (person)

X_4: International oil price (USD)

u:Disturbance

With regard to the adjusted R^2 and the positive/negative relationship between the explanatory variables and passenger car ownership, numbers 1, 2, and 7 are appropriate signs for passenger car ownership estimation from a statistical perspective. Oil price is excluded from our BAU model because it has positive signs instead of negative signs, which were unexpected.

On the price elasticity of demand, the following three studies argue that fuel price (BP [1]) and automobile technology exert an influence on the degree of environmental sustainability (De Jong and Gunn 2001 [7], Hirota and Poot, 2005 [25]). Espey (1998 [14]) observed consumer behavior with regard to two aspects: driving and ownership. It demonstrated that consumers tend to modify the distance (in kilometers) traveled by their vehicles in response to increases in fuel price and replace their cars with models that have more efficient fuel consumption. Drollas (1984 [9]) conducted an analysis by classifying influences into short- and long-term factors. The author pointed out that consumers tend to replace gasoline powered cars with alternative fuel cars (for example, LPG and diesel cars) and increase their use of public transport systems in response to increases in fuel costs. According to Eltony (1993[11]), within a year of an increase in the fuel price, 75% of families decreased the distances traveled, 15% of families replaced their cars with lightweight models, and 10% of families replaced their cars with models that had more efficient fuel consumption. These articles have demonstrated that the price effect, including tax, is relatively less effective in modifying consumer behavior. Tazaki, Murota, and Kaya (1982 [40]) point out that in the process of motorization in Japan, it is income factors that influence passenger car ownerships rather than car usage. On the other hand, some studies note that gasoline prices have little effect on vehicle ownership (Johansson and Schipper 1997[21], Hirota et al. 2005 [25]). Based on the survey of the literature and the empirical study, the multicollinearity problem of the oil price factor in JARI BAU model is caused by the characteristics of oil price data. The international oil price increases economic growth. Consequently, there is an increase in the GDP per capita.

Table 3-1 Coefficients of Logarithm Regression Model

$$\ln P = \ln\beta_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + u$$

( )=t value

Number	β_2 GDP	β_3 Drive. Pop	β_4 Oil Price	R^2	Adjusted R^2
1	0.955 (2.91)			0.913	0.910
2	1.779 (16.23)	0.083 (0.44)		0.990	0.990
3	3.386 (7.89)	2.866 (31.02)	0.131 (2.87)	0.974	0.971
4			0.184 (0.64)	0.012	-0.017
5		0.197 (0.79)	5.431 (2.29)	0.157	0.104
6	0.197 (0.79)		5.431 (2.29)	0.157	0.104
7		0.932 (28.61)		0.961	0.960

With respect to combination numbers 1, 2, and 7, the selection is made by considering the applicability for the Japanese socioeconomic structure toward 2030. Referring to the actual macroeconomic trend in Japan, the MOF announced in 2005 that the total public debt was 703.1 billion yen (Statistics Bureau [35]). The amounts of public debt are 12 times larger than the government revenue. It is natural to believe that the government should reform the harsh tax system, depreciate the yen, or increase the inflation rate in order to restore a healthy balance of payments in the future.

With regard to the actual Japanese demographic trend, tax payment per capita will be a huge burden in the future due to the decrease in total population and an increase in part-time employees. In November 2006, it was observed that the economic growth in Japan continued for 57 months, which exceeds the high economic growth period experienced in the 1960s. However, salaried employees do not appear to be benefiting from the economic growth. In fact, the rate of savings decreased from 10.4% (1999) to 3.1% (2005) (Statistics Bureau [34]). According to some economists, this economic growth is attributable to an increase in investment in infrastructure and facilities. Given this reason, number 1 is disregarded because GDP may not be able to adequately explain car ownership from the viewpoint of individual income level.

From the perspective of car ownership, holding a driver's license and possessing a vehicle are separate issues. Consequently, in considering the labor market and the salary distribution, income groups would be polarized into low- and high-income groups in the future. People with driver's licenses would choose to purchase private vehicles when they find it affordable according to their salary levels. If the high-income group can afford to own private cars, we should focus on the variable of driver's average income as an explanatory variable instead of GDP per capita. With this perspective, number 7 can be disregarded in the estimation of car ownership. The most appropriate choice appears to be number 2; however, the t-value of "driver's license holder population [20]" is not significant. As a result, none of the factors can be applied to the estimation of car ownership. Assuming the polarization of income distribution in Japan, we focus on the upper income group, which has a greater probability of vehicle ownership.

3.2. Model Description

When a driver's license holder becomes an owner of a passenger vehicle and thereby exits the state of non-ownership, the shift can be explained by probability. It appears that car ownership behavior comprises two steps: First, people obtain a driver's license. Second, they seek to buy a private vehicle when it is affordable. When the aggregation of acquisition behavior can be expressed as a normal distribution, the accumulation of the normal distribution appears like an S-curve. This logistic distribution is chosen for two reasons. First, from the mathematical standpoint, it is an extremely flexible and easily used function. Second, it enables the direct examination of our hypothesis of socioeconomic interpretations for motor vehicle ownership estimation. Tanner [38] explores the stable relationship between car ownership and income over time because societies become progressively car independent. This result confirms theoretical arguments made by various studies (Button et al. 1993[3], Hidano and Kashima 1985 [23], and Fujino 2005 [16]). Button, Ngoe, and Hine (1993 [3]) estimate car ownership in developing countries and forecast car ownership per 1000 people. This method is being commonly used because car ownership per 1000 people can be compared to other countries without using a population scale. In addition, it is easy to examine the feasibility of output. The passenger vehicle market saturates as the rate of car ownership per person gradually increases with the average income level. (Holger, 1970 [26], Tanner, 1978[39]), Button, Pearman, and Fowkes (1982 [2]) adopt a sigmoid function by using a nonlinear forecasting framework. Eq 2 represents the JARI BAU Model a logistic approach that has been used extensively for forecasting by Button, Pearman, and Fowkes (1982 [2]). The implication of the logistic model is that the growth rate of car ownership declines as it approaches the saturation level. The standard approach of the logistic model Eq 2 is employed using a driver's average income as an explanatory factor. The property of JARI BAU model (Eq 2)is estimation of saturation level *L*, aggregation of driver's income (*DrivInc*) and total driver license holder population *(DrivPop).*

$$P = \frac{L}{1 + e^{-a} + \left(\frac{DrivInc}{DrivPop}\right)^{-b}} \qquad \textbf{Eq 2}$$

L:Saturation Level

P: Passenger car ownership per 1000 People from Track Records of Car Stock 1968-2003

DrivInc: Aggregation of Drivers' Income (PPP)

DrivPop: Total Driver License Holder Population

a: Constant

b: Coefficient

Saturation refers to the level of vehicle diffusion within the domestic market and the saturation level represents factors that slow down the pace of motorization. A country with a higher density and rapid urbanization would encourage the use of public transport. The United Nation [44] estimates that by 2030, 73.1% of the total population in Japan will live in urban areas. According to the UITP data [45], a higher density confirms a lower car stock in the data set of 84 cities worldwide. From this data, we assume that people in Japan move to live in urban areas, which may affect car usage.

According to the saturation survey, Tanner [38] estimated 400 vehicles per 1000 people in the UK and the USA in the 1970s. According to the International Energy Outlook (IEO) estimations (Energy Information Administration (EIA) (2002 [12]), 620 units will be owned per 1000 people in 2010 and 638 units in 2020. According to Dargay [6], the saturation level is supposed to be 650 units per 1000 people in 2025. If the growth of car ownership keeps the same level, it will be around 720-740 units per 1000 persons. With consideration of income disparity among driver license population, the estimation of 720-740 units per 1000 people seems an overestimate. In JARI BAU model, we assume 650 units per 1000 people in 2030 with the following reasons. First, population forecast suggests 34% of population will be under age 20 and over age 75 in the year 2025. Second, driver license holder population will be 64.5% in 2030 according to our estimation. Third, the population is assumed to be polarized between “non-ownership of vehicle” and “ownership of vehicle”.

4. Variable Creation and Output toward 2030

4.1. Population of Driver’s License Holders

Jansson (1989 [17]) treats car ownership as average individual behavior by age and estimates the total passenger car ownerships from the age of owning one’s first private vehicle to the age of ceasing ownership by cohort model. In JARI BAU model, the population of driver’s license holders can be estimated not only by age but also by gender for the purpose of accuracy improvement, because the ratio of male drivers tends to be larger than that of females; however, in Japan, the population of female driver’s license holders is increasing faster than the population of their male counterparts.

The population of driver’s license holders is disaggregated by age group by 5 years and by gender. By using the data for 2000 as a survival rate and cohort model, we have estimated the share of drivers by gender and by age group until 2030. Assuming that the growth rate of the population of driver's license holders is constant until 2030, the rate of driver license holder population by age group and by gender is estimated as shown in Eq 2. (Okamoto, Miyashita, Ohsawa, and Nakamura [28]). The drivers of both gender are assumed to start driving at the age of 20, instead of eligible age 18. The age group 18-20 was excluded because this age group has large variance of driving license acquisition, which results low accuracy for estimation. The drivers of both genders are assumed to stop driving at the age of 75 due to the physical limitations of our calculation. Since an increasing number of elderly people are dependent on vehicle usage, the population rate of driver's license holders is assumed to increase until 2030 by changing the survival rate.

$$D_{t,g} = a^{t/(t-M)} \quad \text{Eq 3}$$

D: Rate of driver's license holder population by age group and by gender
t: Age group
M: Maximum length Year for holding driver license by gender
a: Constant
g: Gender {m=male, f=female}

Eq 2 is converted into logarithmic form. Assuming that M is constant, various combinations of *t* and *p(t)* yield various results of *log a*. When *log a* is constant, there are several results of M by various combinations of *t* and *p(t)*. When we solve these simultaneous equations, we obtain *log a* and *M*. Eq 4 and Eq 5 provide the calculation results.

Male driver license holder population with the data of year 2000 $D_{t,m} = 1.05^{t/(t-54.5)}$ Eq 4

Female driver license holder population with the data of 2000 $D_{t,f} = 1.3^{t/(t-53.5)}$ Eq 5

Figure 4-1 illustrates the aggregated population of driver's license holders in Japan. With respect to population estimations, the World Energy, Technology, and Climate Policy Outlook (WETO) [15] estimates that the population of Japan will decrease after 2020 at the rate of –0.1% per year. Likewise, the IEO (EIA 2002, 2004 [12], EIA 2005 [13]) estimates a –0.1% population growth rate. The IEO additionally focuses on the aging population and low birth rate, which may increase transportation energy use by 0.2% per year. The Socio-Economic Research Institute estimates a peaking of the population around 2006 with a fall to 118 million in 2025. Based on the estimation of Institute's forecast at the year 2025, the output of the population of driver's license holders suggests a stable population at 59.4%–64.5% of the total population between 2010 and 2030.

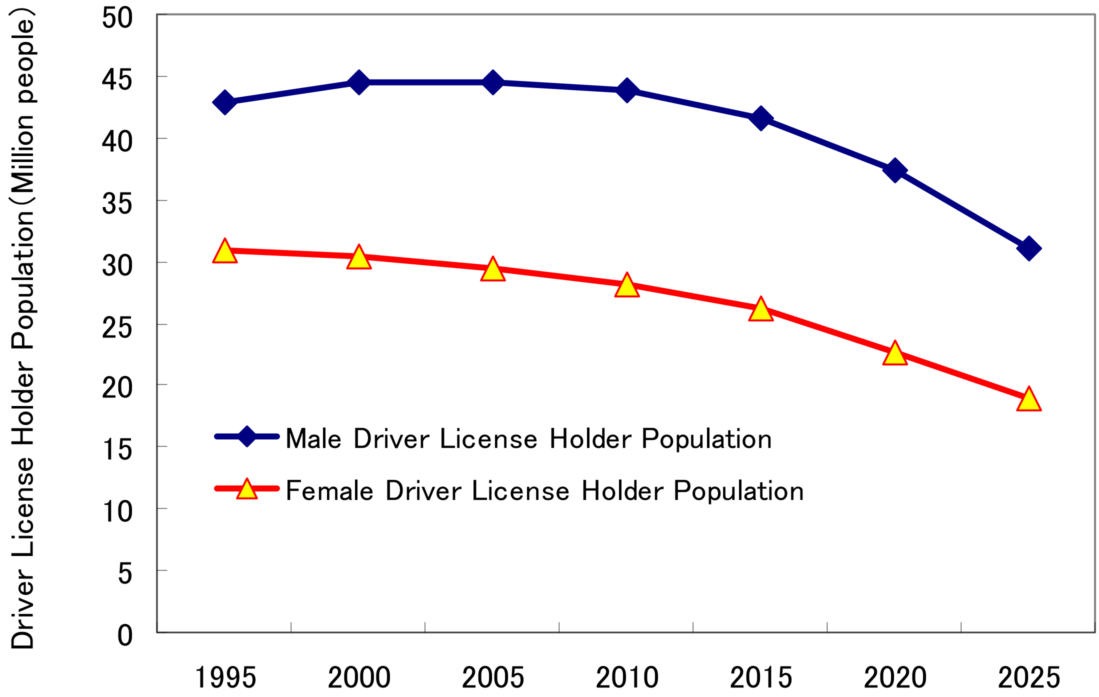

Figure 4-1 Driver License Holder Population Share in Total Population in Japan 2000-2030

4.2. Driver License Holder's Income

With respect to economic forecasts, the government of Japan announced a prolonged economic growth that was greater than the economic growth experienced in the 1960s. WETO (2003 [15]) estimates the income growth rate in Japan to be around 1% between 2000 and 2030. Meanwhile, the IEO's prediction is higher than those of the WETO and the government of Japan (EIA 2002 and 2004 [12], EIA 2005 [13]), with a growth rate of 2%. However, the rate of savings is decreasing since the 1990s and household consumption is increasing gradually.

The driver's average income is estimated from the income distribution and the population of driver's license holders based on gender and age. The database from the "employment structure and wages 2002

(Statistical Bureau, 2005 [34])" was employed to create the data of driver license holders' income levels based on age group and gender. The database includes ranks of income levels and the number of full-time/part-time workers of various industries. Drivers' income levels are determined by the percentage of drivers based on age group and gender from the highest income share. JARI BAU model reveals that the average income of male drivers is 7.54 million yen in 2030. The average income of female drivers is 4.95 million yen in 2030. Figure 4-2 shows the weighted average of drivers' income by gender.

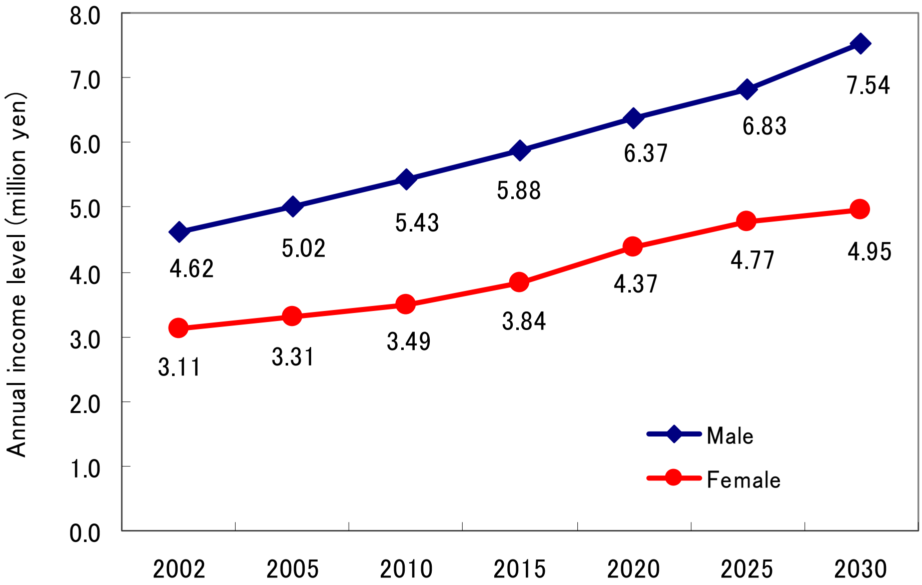

Figure 4-2 Average Driver license holders' income by Gender

4.3. Passenger Car Ownership in 2030

The coefficient *b* (Eq2) represents the elasticity of income. Train (1986 [41]) estimated the income elasticities of car ownership by income level with elasticities varying between 0.345–1.73 in the very long term. Pindyck (1979) estimated income elasticities of 0.3 for total vehicle ownership in 11 Western countries between 1955 and 1973 (Tanner [38]). Button et al. (1993 [3]) estimated income elasticities of 0.53–1.12 for passenger vehicles in 58 developing countries between 1968 and 1987. Johansson et al. (1997 [21]) estimated income elasticities of 0.75–1.25 for passenger vehicles in 12 OECD countries between 1973 and 1992. Finally, Ingram et al. (1999 [27]) estimated income elasticities for passenger cars in 50 countries in 1970, 1980, and 1990.

Our results are slightly higher than those in the literature survey. When the driver license holders' income increases by 1%, the car stock increases by 1.377% (data set: 1970–1980), 2.035% (data set: 1980–1990), and 2.158% (data set: 1990–2002). When the driver license holders' income increases by 1%, the car stock increases by 1.834% using the 1970–2002 data set. The t-values are estimated at a 1% significance level. Further, income elasticity is estimated at a 1% significance level.

Table 4-1 provides the results based on the multiple regression equations produced by Eq 2. In order to revise the model, Table 4-2 lists the R^2, Adjusted R^2, coefficients, and the t-values with a limited time series. The estimated results are strictly examined by t-value and whole data set (1970–2003) and limited data set. The t-values for all the variables are estimated at a 1% significance level. All variables have been transformed to natural logarithms and the regression coefficients are interpreted as constant elasticity. Using the created data of the drivers' income levels, the BAU model estimates passenger car ownership at 61.59 million in 2030, as shown in Figure 4-3. From the viewpoint of accuracy, the deviation is between –4% and +8% as compared with the track record. The accuracy has improved in comparison to our previous model.

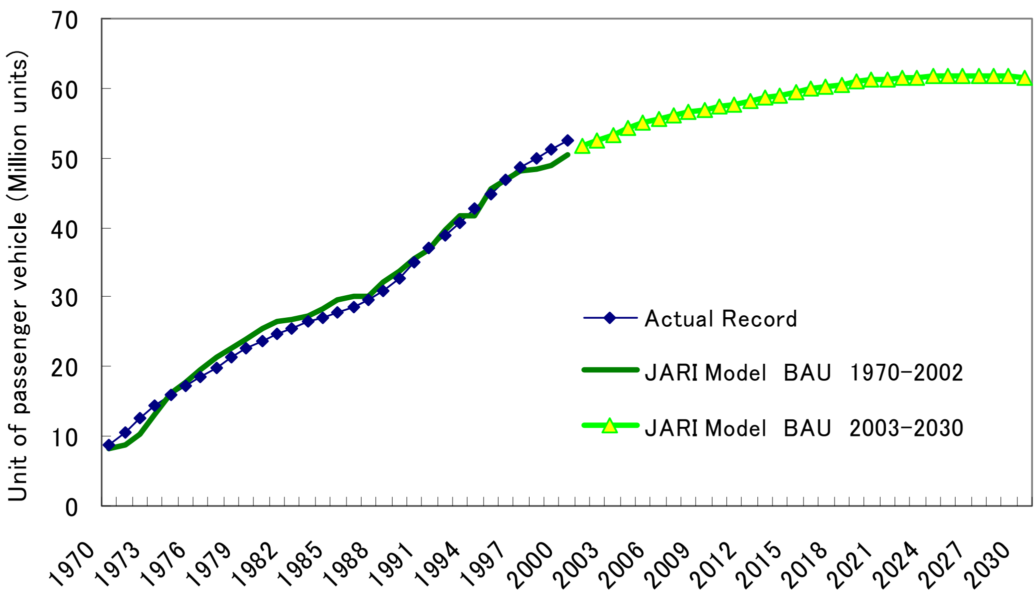

Figure 4-3　The Result of JARI BAU Model (Estimate 2003-2030 with variable of 1970-2002

Table 4-1 R^2, Adjusted R^2, coefficients and T values with the limited times series

( ): T value

	R2	Adjusted R2	Coefficient of a Constant	Coefficient of b Drivers' income
1970-1980	0.975	0.972	-20.780 (-19.826**)	1.377 (18.649**)
1980-1990	0.978	0.976	-30.282 (-20.511**)	2.035 (20.121**)
1990-2002	0.986	0.985	-32.099 (-28.624**)	2.158 (28.875**)
1970-2002	0.990	0.990	-27.280 (-62.311**)	1.834 (60.821**)

** Significant at 1% level

Table 4-2 Outputs of JARI BAU Model

	2005	2010	2015	2020	2025	2030
Driver license holder population (Million people)	73.08	75.73	77.41	76.29	74.91	75.81
Drivers' income (Million yen)	4.16	4.46	4.86	5.36	5.08	6.24
Passenger car ownership(Unit)	55.13	57.28	59.42	61.21	61.73	61.59

5. Conclusion

The passenger car ownership model is an attempt to include the average driver license holders' income as "Business as Usual" (BAU). From the viewpoint of a standard attitude toward private vehicle ownership, we observed that consumers typically purchase vehicles after they obtain their licenses. In this paper, acquiring a driver's license and possessing a vehicle are treated as two separate issues. We assume that the polarization of income distribution affects the polarization of the population of driver's license holders due to the socioeconomic trend in Japan. A license holder will decide to own a vehicle when it becomes affordable.

According to a survey of the literatures, income level appears to be the most important economic variable determining passenger car ownerships. This paper focuses not only on economic variables but also on the drivers' lifestyles. In order to make a forecast until 2030, we employed the driver's average income. As an estimation of the driver's license population, we employed the "survival rate." The income distribution and the data of the population of driver's license holders by gender and age create the variable "driver's average income." Passenger car ownership was estimated using the S-shaped function.

The JARI BAU model estimates 60.09 million passenger vehicles in 2010 and 61.59 million in 2030. The estimation model improves both the accuracy and statistical estimation. From the viewpoint of accuracy, the deviation is between –4% and +8% as compared with the actual record. The t-values of the estimation for the whole data set and limited data set (the 1970s, 1980s, and 1990–2002) are significant.

The scenario analysis of JARI BAU model excludes policy implementation factors such as the technological standard and price (tax) incentive. Since JARI BAU model does not include these factors, it is necessary to introduce a submodel in order to analyze policy impacts.

By incorporating improvements into the accuracy of the JARI BAU model, it will become possible to evaluate more specific values for energy consumption, global warming gasses, emission gasses, and LCA in the automobile sector. This methodology may also be applied to Asian countries. In the future, the model should include a variable of policy analysis that would allow consumers to consider environmental factors in the introduction of policies and measures.

The limitation of JARI BAU model is that the scenario analysis for policy implementation factors such as technological standard and price (tax) incentive is not considered. Since JARI BAU model does not include these factors, it is necessary to introduce a submodel in order to analyze policy impacts.

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