

## THE EFFECT OF WEALTH LEVEL ON INDONESIAN VEHICLE OWNERSHIP RATE

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### Abstract

The discussion in this paper is part of a research study of vehicle ownership characteristics in Indonesia. In this paper, the effect of wealth level on vehicle ownership rates will be explored. This knowledge is needed for various transportation and energy policies. Data from a group of 21 municipalities and 27 regencies in Indonesia will be analysed separately. The main sources of the data are Indonesian Central Agency of Statistics, the Indonesian Police Force and other related government agencies. Per Capita Gross Regional Domestic Product (GRDP) is used to represent the wealth level of an area. It is found that the effect of per capita GRDP on car and motorcycle ownership rates is greater in municipalities than in regencies. At a certain per capita GRDP, car and motorcycle ownership rates tend to be higher in a municipality than in a regency. A possible cause for this outcome is that the highway network development in a regency is usually not as good as that in a municipality. Car ownership rates in Indonesia are far from saturation. They are far below levels in developed countries. However, the national motorcycle ownership rate is estimated to be one of the highest in the world. The highest rate exceeds 300 motorcycles per 1000 population. It should be noted that the motorcycle is used in daily life as a multi-purpose vehicle. The use of motorcycles in Indonesia may range from school / work trips to goods delivery trips. Moreover the highway network in Indonesia is still very limited both in length per km<sup>2</sup> of area and in quality. Therefore, more flexible vehicles (in terms of manoeuvrability) such as the motorcycle will be preferred.

### Introduction

As in any other developing country, in Indonesia there is an increasing degree of motorization. High road investment expenditures, inadequate road user charges systems and insufficient public transport services encourage the use of private vehicles including private motorized vehicles. Considering the significant impact of the growth of this type of vehicle on many aspects of life, developing appropriate Indonesian private motorized vehicle ownership rate models has considerable importance both to related government agencies and vehicle manufacture industries.

Indonesian private motorized vehicle ownership rate models are needed for many purposes such as producing rough predictions of the demand on the highway network and consequent energy consumption, introducing appropriate transportation demand management and predicting income obtained from car purchasing tax / car registration tax and the contribution of vehicle manufacture industries to public wealth. Such models have been derived in many developing countries for decades but have not been comprehensively developed in Indonesia. In this paper only models considering the level of wealth (represented by per capita Gross Regional Domestic Product, GRDP) as a factor affecting vehicle ownership rate will be discussed.

### Previous Studies

Several factors have been found to affect car ownership, as can be concluded from a study including 37 cities world-wide by Kenworthy and Laube (1999), a study including 26 countries world-wide by Dargay and Gately (1999), a study including USA and Netherlands by Bhat and Pulugurta (1998), a study in Japan by Niilo (1987), several studies in the UK by Bates et al (1981), Hopkin (1981), Oldfield (1979) and Fowkes (1977), i.e.:

- wealth (personal and regional)
- cost of vehicle ownership and use
- age structure of the population
- population density
- public transport services
- support to non-motorised transport
- road density

The factors affecting motorcycle ownership are similar to the factors affecting car ownership, with several additional factors according to several studies in the UK by Broughton (1987), Hobbs et al (1986), and a study in the UK and the USA by Tanner (1977), i.e.:

- weather
- topography
- riding licence application procedures

The outcome of these studies will be considered in the development of proposed full models for Indonesia.

### Structure Of The Model

Based on the findings of previous studies, for the proposed full models, 10 different independent variables will be considered as factors, which could possibly affect the car and motorcycle ownership rates in Indonesia. One of the models is a pooled model that can be formulated in general terms as follow:

$$COR_{i,k} \text{ or } MOR_{i,k} = a + b_1x_1 + b_2x_2 + \dots + b_jx_j + \dots + b_nx_n$$

$COR_{i,k}$  = car ownership rate

$MOR_{i,k}$  = motorcycle ownership rate

$i$  = year 1990, 1991, 1992, ..., 2000

$k$  = area no. 1, 2, 3, ..., m

$m$  = 27 (for regency model), 21 (for municipality model)

$a, b_j$  = coefficients

$x_j$  = independent variables

Three broad categories of independent variables will be considered in the full model, i.e.:

- socio-economic variables (per capita GRDP, consumer price index, minimum regional wage per minimum living needs, percentage of population who are employed, percentage of population aged between 15-24 years)
- land use / transportation system availability variables (population density per  $km^2$ , length of road (km) in 1,000  $km^2$  area, number of bus seats per 1,000 population)
- topography / climate variables (average ground level above sea level in m, yearly rainfall in mm)

In this paper only the effect of per capita GRDP will be discussed. This variable is chosen to be presented here considering the significance of its effect on vehicle ownership rate in areas outside Indonesia proven by previous research (Prevedouros and An (1998), Button and Nge (1991), Tanner (1983), Kenworthy and Laube (1999), Dargay and Gately (1999)). However, this is not necessarily the best variable for Indonesia. Although the available datasets for this research cover yearly data from 1990 to 2000, only the 1997 dataset will be modelled as the most complete dataset. Therefore the model can be simplified as follow:

$$COR_{i,k} \text{ or } MOR_{i,k} = a + b_1x_1$$

$COR_{i,k}$  = car ownership rate

$MOR_{i,k}$  = motorcycle ownership rate

$i$  = year 1997

$k$  = area no. 1, 2, 3, ..., m

$m$  = 27 (for regency model), 21 (for municipality model)

$a, b_1$  = coefficients

$x_1$  = per capita GRDP

However, it should be noted that the model may not necessarily linear. Any other form of models, which better fit the data and provide a sensible trend will be considered in this paper.

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### **Method of Sampling**

Indonesia consists of more than 300 regencies and municipalities. In order to ensure that the models will cover various conditions in different parts of Indonesia, the following sampling procedure was conducted:

1. 17 provinces were selected mainly based on variation in 1996 provincial per capita GRDPs in 1993 constant prices. These figures ranged between 700,000 rupiahs and 2,200,000 rupiahs (according to Oanda Corporation (2001), average interbank currency rate in 1993 is £ 1 = 3,126 rupiahs or US\$ 1 = 2,103 rupiahs). With few exceptions, only one province will be selected in every 100,000 rupiahs wide group, i.e. one for 700,000-800,000 rupiahs group, one for 800,000-900,000 rupiahs group and so on. Only regencies and municipalities in these provinces had a chance to be selected in the next step of sampling. The number of samples selected from a province was proportional to the number of regencies and municipalities in that province.
2. Systematic sampling was done for each selected province using a standard list of regencies and municipalities obtained from provincial offices of Central Agency of Statistics (e.g. BPS Propinsi Lampung, 1999). This list is assumed to be free from recurring patterns, such as areas beginning with a certain letter, areas with a certain wealth level, etc. Systematic sampling is considered as a type of probability sampling. It will be similar to random sampling if the starting point is randomly chosen. In this research, the starting point was not randomly chosen (Fink, 1995). However, this sampling method was used in order to enable representation in a simple way. An exception was made for South Sulawesi, North Sumatra and Papua due to poor data accessibility for several regencies originally selected. In this situation, in order to maintain the original sampling quota of each province, other regencies, which have sufficient available data, replace the original regencies.

For a comprehensive discussion of the method of sampling please refer to Putranto (2001). Table 1 lists the final selection of regencies and municipalities.

### **Reliability of the Data**

There were two main sources of data for this paper, i.e.:

- Central Agency of Statistics and its regional offices
- National Police and its regional offices

The data collection was done in Indonesia. It was necessary to personally visit Indonesia in order to collect the data as these data are in general not available on "public domain" sources.

In this research, per capita GRDP was chosen instead of per capita income considering data availability in most areas. The calculation of GRDP needs a lot of different data from various institutions, such as the Ministry of Trade, the Ministry of Mining, the Ministry of Finance, etc. Therefore, it takes considerable time to collect the required data, make appropriate calculations and publish the final statistics. As a result, this figure can only be published not earlier than a year later. In most cases, on first publication the per capita GRDP figure for a particular year will be reported as a temporary figure due to incompleteness in the required data for its calculation. A revised figure is given in the next year's publication. The revision is usually done twice. Therefore the most up to date figure should always be used. Per capita GRDP can be mainly found in certain Municipality or Regency in Figures publication e.g. (Statistical Office of Jakarta, 1990 et seq) or in a publication concerning specifically GRDP of a certain area. It can be published by national, provincial or regency/municipality governments. If there are any differences in figures between sources, more specific publications and publications from the lowest level of government, i.e. regency or municipality, should be selected (presumably because they are closest to the original data collected).

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**Table 1.** Selected Regencies and Municipalities

Province	Municipality	Regency
West Nusa Tenggara	Mataram	East Lombok
Southeast Sulawesi	Kendari	Muna
Lampung	Bandar Lampung	North Lampung
Bengkulu	Bengkulu	Rejang Lebong
South Sulawesi	Makasar	Pinrang
		Luwu
		Bantaeng
Jambi	Jambi	Sarolangun Bangko
Central Java	Surakarta	Wonosobo
	Semarang	Sragen
		Demak
West Java	Bandung	Bekasi
		Garut
		Sumedang
Yogyakarta	Yogyakarta	Bantul
East Java	Malang	Lumajang
	Mojokerto	Sidoarjo
		Bojonegoro
South Kalimantan	Banjarmasin	Tapin
North Sumatra	Tanjung Balai	Dairi
	Tebing Tinggi	Simalungun
Bali	Denpasar	Gianyar
Nanggroe Aceh Darussalam	Banda Aceh	Aceh Tengah
Papua	Jayapura	Paniai
		Yapen Waropen
Riau	Batam	Kepulauan Riau
Jakarta	The Whole Province	
East Kalimantan	Balikpapan	Kutai

We should also carefully examine the base year of each dataset. The base year of the annual data is changed every 10 years. The 1983-1992 data can only be found in 1983 base year and 1993-2002 data are in 1993 base year. In this research 1990-2000 data were considered. In order to make all yearly data comparable 1993 base year is chosen and the 1990-1992 data are adjusted. The adjustment was done using following procedure:

$$\text{Per capita GRDP}_{1993}(i) = \frac{\text{Per capita GRDP}_{1993}(1993) \times \text{Per capita GRDP}_{1983}(i)}{\text{Per capita GRDP}_{1983}(1993)}$$

i = year 1990, 1991, 1992

The year in the smaller font indicates base year.

If a per capita figure is not available, this can be calculated by dividing the GRDP with mid-year population. A region rich with oil and gas should be treated carefully since the real locally usable income might be different from the published GRDP figure. About 60% of Kutai Regency GRDP for example comes from oil and gas. According to Indonesian Oil and Gas Legislation No. 22/2001 the income from oil and gas should be shared as described in Table 2.

It can be calculated from Table 2 that a regency or municipality producing oil or gas can only receive a very small share of oil or gas income. In the Kutai case (located in East Kalimantan Province, which has 4 Regencies and 2 Municipalities before 1999), the oil income share should be 7% ( $6 + 6/(4+2)$ ) and the gas income share should be 14% ( $12 + 12/(4+2)$ ). This research is using 1990 – 2000 data at which time this legislation had not yet been implemented and the regency or municipality share during that era was considerably smaller than the current share. There is no guarantee that the central government share will be redistributed to develop the oil or gas producer

areas. Therefore, to avoid overestimation of the wealth of an area, in this research, it was decided to exclude oil and gas income from GRDP of regencies or municipalities rich in oil and gas resources.

**Table 2.** Oil and Gas Income Distribution

Type	Oil or Gas Income Share (%) by Governmental Level			
	Central Government	Province in which Oil/Gas Regency or Municipality Producer Located	Other Regencies/Municipalities in the Province	Regency or Municipality Producing Oil or Gas
Oil	85	3	6	6
Gas	70	6	12	12

Motorized vehicle data can be obtained from various sources. The main source is the National Police and its regional offices. For further details of vehicle classification public transport and goods vehicles we may refer to data from the Ministry of Transportation and its regional offices. Since vehicle registration is related to vehicle tax payment, offices of Regional Revenue may also provide useful data. The Central Agency of Statistics and its regional offices publish motorized vehicle data from any combination of these institutions.

The first serious problem is that vehicle registration data is not aggregated according to local government administrative areas such as municipality and regency but by regional police areas. For example, before September 1997 Luwu Police was not only responsible for the registration of vehicles from the Luwu Regency residence but also covered the registration of vehicles from smaller nearby regencies, e.g. Enrekang. Starting from September 1997 vehicle registrations in the Enrekang Regency were moved to another regional police area nearby. Therefore very careful examination should be made before using any data reported by particular regional police areas. Relevant notes given in the vehicle records indicating any inclusion or exclusion of certain area should be critically noticed.

Another serious problem is the vehicle classification system. There is no standardized system of vehicle classification across databases. In most areas the distinction between private vehicles and public transport is sufficiently clear. However, in several areas vehicles are classified directly into vehicle types such as passenger car, multi purpose vehicle, jeep and pick up. The passenger car class may include both private passenger cars and taxis. Multi purpose vehicles may include both private vehicles and public transport. As a result, justification given by local experts (i.e. local transport researchers, transport engineers, etc.) is used to produce the most appropriate assumption on classification. Details regarding government or company vehicles are very limited. However, since cars and motorcycles owned by the government or companies are used daily even outside working hours or working days, they are considered as private vehicles in this research. From the limited available data, government cars are about 10-20% of private cars and government motorcycles are less than 5% of private motorcycles. It should be noted that the discussion of public transport in this section is provided to make the reader aware that in parts of the Indonesian motorized vehicle database, we cannot easily distinguish between private and public transport categories.

The local names for certain types of vehicles may also be confusing. Public transport vehicles with up to 10 seats operating on fixed routes in several cities in Sumatra are called 'Taxis', whilst in Makassar such vehicles are called 'Pete-Pete'. In Java 'Taxi' has absolutely the same meaning as a Taxi in western terms.

There are also some vehicles that operate as illegal public transport and are still used daily for private transportation by the owner or driver. The validity of using vehicle registration as the basis for determining vehicle ownership is also debatable. In some remote areas, some vehicles are not registered regularly and / or legally. In some cases used vehicles are sold without any appropriate legal registration.

### Municipality and Regency Vehicle Ownership Models

The decision to produce separate models, i.e. municipality and regency models in this research models is based on the observation that the effect of per capita GRDP on car and motorcycle ownership rates in municipalities is greater than in regencies. At a certain per capita GRDP, car and motorcycle ownership rates tend to be higher in a municipality than in a regency. A possible cause for this phenomenon is that the highway network development in a regency is usually not as good as in a municipality. Better highway network development in a municipality is triggered by its high level of activities, e.g. office, shopping, leisure activities etc.

Another justification for the decision to separate the models is that the range between lowest and highest vehicle ownership data in municipalities and regencies is quite different (Table 3). Separate models will allow more detailed understanding of the trends for each type of area, especially for regency models, which have a relatively narrow vehicle ownership data range (concentrated in low ownership).

**Table 3.** The Summary of Differences between Regency and Municipality Vehicle Ownership Rate

	Municipality + Regency			Municipality			Regency		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Car Ownership Rate	2	47	159	4	88	159	2	8	23
Motorcycle Ownership Rate	7	108	723	23	172	723	7	43	161

Notes: The rate is defined as number of car or motorcycle per 1000 population in 1997

Dargay and Gately (1999) found that countries having a low income tend to have high income elasticity, whilst countries having a high income tend to have low income elasticity. They suggested the use of separate models for groups of countries having different income elasticity. This procedure will facilitate the comparison of long term trend (including income level in which ownership saturation reached) between different groups of income elasticity. Income elasticity in this paper can be formulated as follows:

$$\text{Income Elasticity} = (x/y) \cdot (\delta y / \delta x)$$

x = per capita GRDP1993 in 1996

y = car or motorcycle ownership rate in 1996

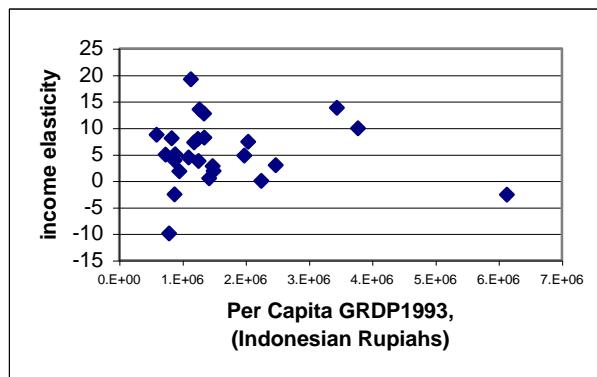
$\delta x$  = difference between per capita GRDP1993 in 1997 and in 1996

$\delta y$  = difference between car or motorcycle ownership rate in 1997 and in 1996

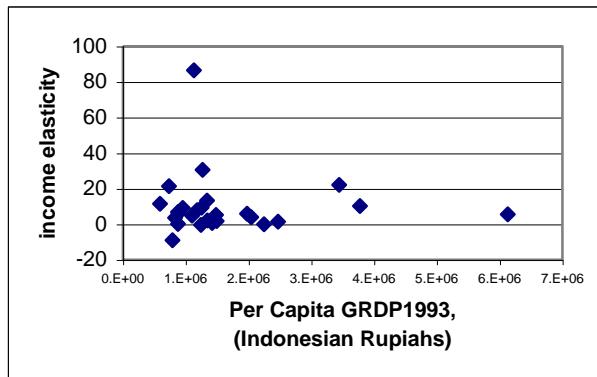
Alternatively it can be defined as the proportionate change in the quantity of a commodity demanded after a unit proportionate change in the income of consumers with prices held constant (Bannock, 1998).

However, Figures 1 to 4 show that there is no clear relationship between income level and income elasticity. Therefore, no grouping will be taken using income elasticity as a criterion. The result of income elasticity calculation will only be used as a basis for determining outliers. Any value falling in any 1% tail of the normal distribution of income elasticity (Table 4.) is considered as an outlier.

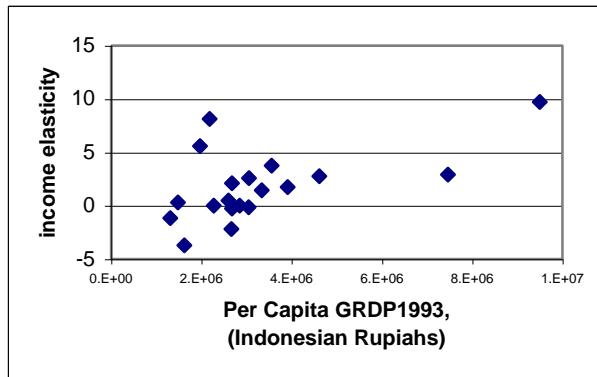
Figures 5 to 8 show the models classified by area type and vehicle type. Outliers are shown as data points, but not included in the model. Figure 9 provides a comparison between models. In general, it can be seen that the effect of per capita GRDP on car and motorcycle ownership rates in municipalities is greater than regencies. At a certain per capita GRDP, car and motorcycle ownership rates tend to be higher at a municipality level than at a regency level. A comparison between models should be made carefully. It seems that the models may provide unrealistic long-term trend. They should be corrected by considering ownership saturation levels. The use of models to cover outside the range of the dataset may provide overestimates or underestimates of future trend. It should be noted that most regencies and municipalities had per capita GRDP below Rp.4,000,000.-



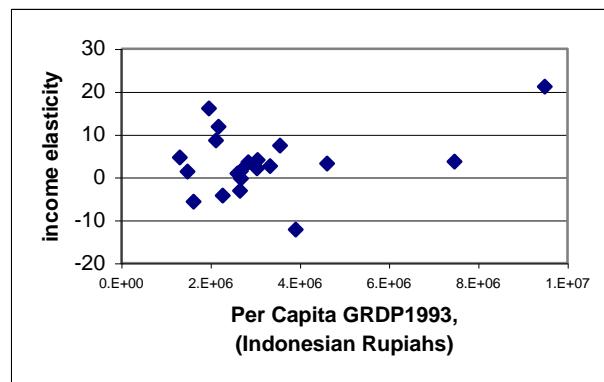
**Figure 1.** Relationship between Income and Income Elasticity of Car Ownership in the Regency



**Figure 2.** Relationship between Income and Income Elasticity of Motorcycle Ownership in the Regency



**Figure 3.** Relationship between Income and Income Elasticity of Car Ownership in the Municipality



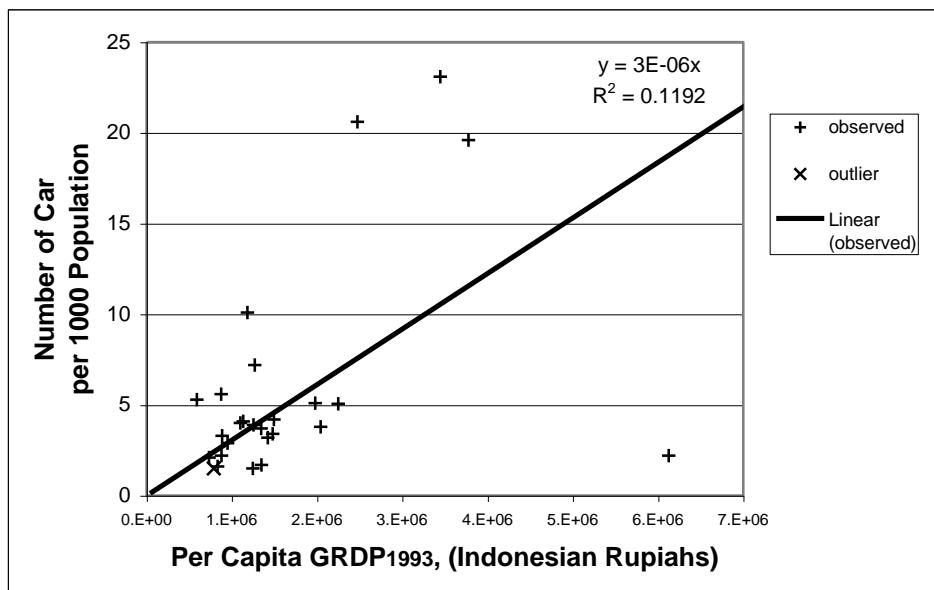
**Figure 4.** Relationship between Income and Income Elasticity of Motorcycle Ownership in the Municipality

**Table 4.** The Criteria for Outliers

Area	Vehicle	Income Elasticity			
		$\mu$	$\sigma$	1% left tail	1% right tail
Regency	Car	5.3238	5.99404	<-8.618	>19.266
	Motorcycle	10.0327	17.55546	<-30.801	>50.867
Municipality	Car	1.7932	3.31257	<-5.912	>9.498
	Motorcycle	3.3715	7.42535	<-13.900	>20.643

Note: - z value for 1% tail is 2.326

- Except for the income elasticity of owning motorcycle in the municipality, all income elasticity distributions can be considered as normal since the ratio of skewness to its standard error and the ratio of kurtosis to its standard error are less than -2 or greater than 2



**Figure 5.** Regency Car Ownership Model

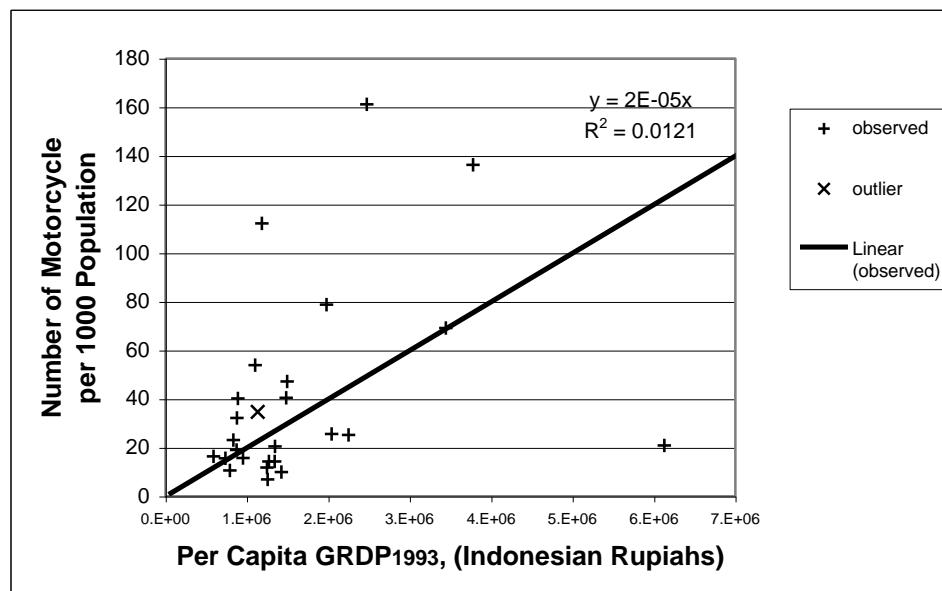


Figure 6. Regency Motorcycle Ownership Model

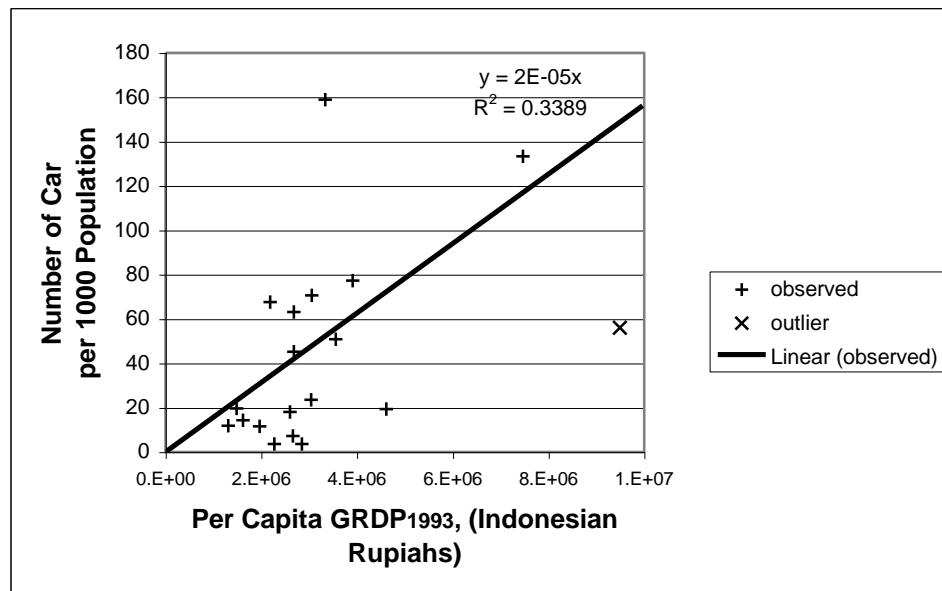
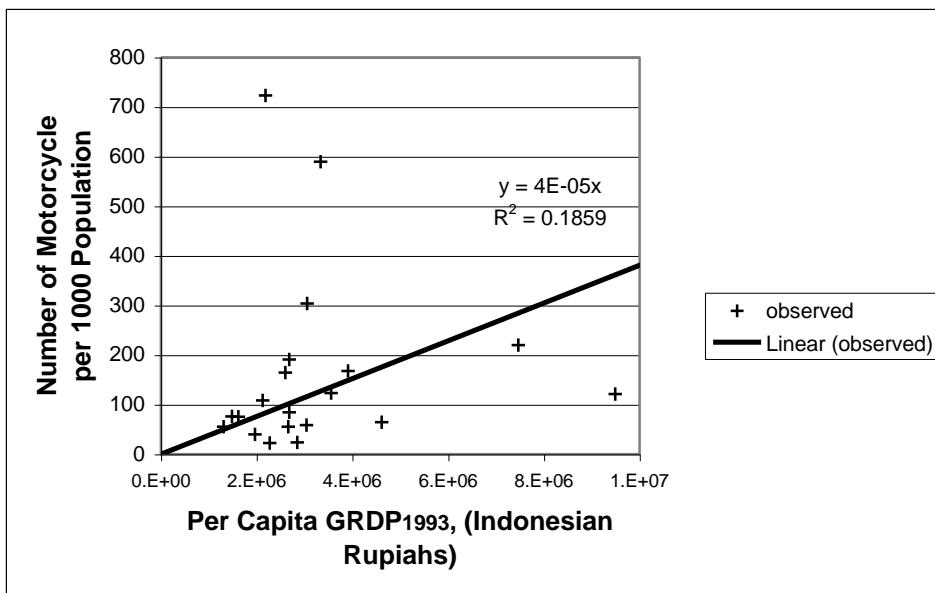
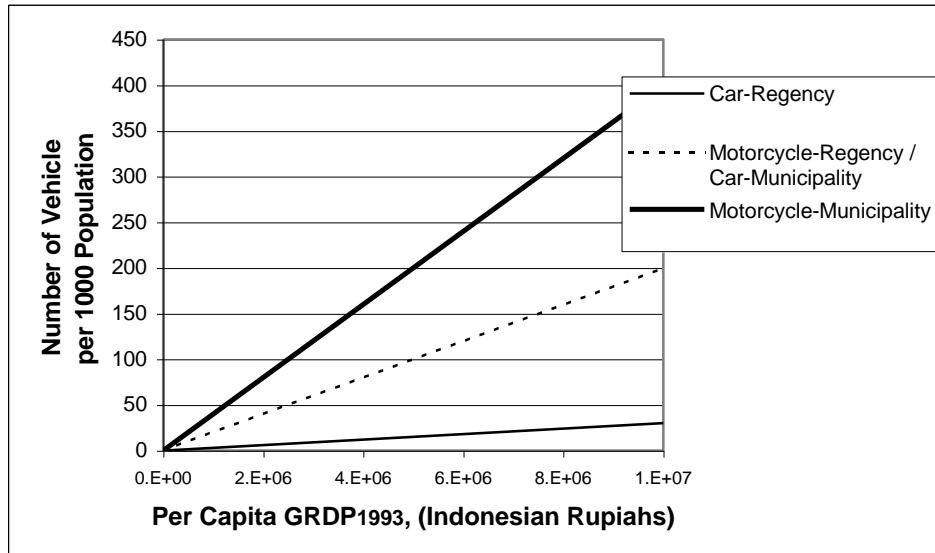


Figure 7. Municipality Car Ownership Model



**Figure 8.** Municipality Motorcycle Ownership Model



**Figure 9.** Comparison between Models

### Concluding Remarks

Using per capita GRDP as a single variable to explain the variation in car and motorcycle ownership rates in Indonesia is not appropriate despite the fact that this had been a successful variable in other studies based outside Indonesia. Further development of the model should incorporate other socio-economic variables, land use / transportation system availability variables and topography / climate variables. These variables are expected to have considerable effect on car and motorcycle ownership rate. The use of a predetermined vehicle ownership saturation level should be considered, since demand on vehicles follows the principle of a logistic model, i.e. there is a limit of the number of particular commodities to be owned. Producing separate models for regencies and municipalities will also be done on the proposed comprehensive models considering significant difference between level of car and motorcycle ownership in municipality and regency.

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