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Demographic determinants of car ownership in Japan

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ABSTRACT

This study empirically examines the demographic determinants of car ownership in Japan between 1980 and 2009. Unique car cohort data, composed of the car age and 11 car types, at the prefectural level, is analyzed. The primary reason for examining the demographic determinants of car ownership in Japan is because Japan is projected to face radical demographic changes in the next few decades. These projected changes include depopulation and an aging population with diminishing household size. This study will be the first empirical study of the car cohort model with large countrywide observations in the recent literature. This study classifies the demographic determinants into five categories: (I) longitudinal factors, (II) economic factors, (III) natural factors, (IV) social factors, and (V) other transports. Although some tendencies vary among car types, this study finds the following tendencies of ordinary car ownership (compact four-wheel drive trucks and regular and compact passenger cars). Regarding the longitudinal factors, the long-run effect is much higher than average in the recent literature, whereas the semi elasticity of car age is approximately −7%. Regarding the economic factors, the elasticities of income and fuel price on car ownership tend to be less intense than in earlier studies. Regarding the natural factors of population increase, the elasticities of population and average household size on car ownership tend to be negative. This indicates that a decrease in population and household size in Japan will accelerate car ownership. In addition, the ratio of elderly people has various effects depending on car types. Regarding the social factors of population increase, car ownership tends to be encouraged by the concentration of population within prefecture, and increased and decreased for relatively new (aged 2–11) and old (aged 12+) cars, respectively, by the concentration of population across prefectures. The former is probably due to a composite effect in urban and rural areas, whereas the latter may be a quick update cycle due to an effect of urbanization. Regarding other transports, the degrees of train and bus use tend to be negatively associated with ordinary car ownership. However, these effects are considerably small and often insignificant as in the literature.

1. Introduction

This study examines the determinants of car ownership in Japan between 1980 and 2009, by constructing and analyzing a unique database. Focus is placed on the demographic determinants of car ownership at the prefectural level, including the population, population density, and income, because Japan is projected to face radical demographic changes, such as an aged society with a smaller population, in the near future (e.g., toward 2060; see National Institute of Population and Social Security Research (IPSS), 2012). The study data consists of an aggregated number of registered cars (i.e., car cohort data), which are decomposed into prefectures, the initial registered year (i.e., car age), and car types. The data is obtained from the Automobile Inspection and Registration Information Association (AIRIA) in Japan, and is available for the years of 1980 through 2009. This study uses a dynamic regression model to analyze the data. The data is divided into two age groupings: cars aged between 2 and 11 years (ages 2–11) and cars aged 12 and over (ages 12+). There are 11 type of cars, and hence, 22 specifications.

The prediction of car ownership is considered important, especially for the industry and the government, because the automobile industry is a key industry in Japan. Table 1 shows key economic and demographic variables in Japan from 1970 to 2010. According to the Economic and Social Research Institute (ESRI), Cabinet Office, Government of Japan (various years), the gross

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Table 1
Key economic and demographic variables in Japan from 1970 to 2010.

Variables	Unit	1970	1980	1990	2000	2010	Later or projection	Source
GDP share of transportation equipment	%	4.1%	3.6%	2.9%	2.4%	2.9%		ESRI (various years)
# of new vehicle sales (four wheels)	million	4.1	5.0	7.7	5.9	4.9	5.5 (2014)	JAMA (2015)
# of owned cars	million	16	37	57	74	78	80 (2014)	JAMA (2015)
(Except for light vehicles and light motorcycles)	million	–	31.7	43.7	53.8	50.0 (2009)		AIRIA (1981–2010)
Population (whole of Japan)	million	104	117	123	127	128	116 (2030) and 87 (2060)	IPSS (2012, 2015)
Population over 65 years	million	7.3	10.6	14.9	22.0	29.5	36.9 in 2030 and peak at 38.8 in 2042	IPSS (2012, 2015)
Population over 65 years (%)	%	7.0%	9.1%	12.0%	17.4%	23.0%		
Population in DID	million	56	70	78	83	86		IPSS (2015)
DID rate (population in DID divided by total population)	%	53.5%	59.7%	63.2%	65.2%	67.3%		
DID area	km^2	6444	10,015	11,732	12,457	12,744		IPSS (2015)
Population density (whole of Japan)	People/km^2	280	314	332	340	343		IPSS (2015)
Population density within the DID	People/km^2	8690	6983	6661	6648	6757		IPSS (2015)
Average household size	Person	3.41	3.22	2.99	2.67	2.43		MIAC (2012a; 2012b)

Notes: Population projection in IPSS (2012) is based on the assumptions of medium fertility and medium mortality. DID stands for the population located in a densely inhabited district, which is the basic area unit holding more than 4000 people per km^2.

domestic product (GDP) share of transportation equipment in Japan, where the automobile industry accounts for a large percentage, has been relatively constant for four decades, indicating the economic importance of the automobile industry. It had consistently decreased between 1970 and 2000 (4.1%, 3.6%, 2.9%, and 2.4% in 1970, 1980, 1990, and 2000, respectively). It then slightly increased to 2.9% in 2010.

According to the car data from 1970 through 2010, new car sales peaked in 1990, while car ownership (i.e., the registered number of vehicles) has consistently been increasing. According to the Japan Automobile Manufacturers Association, Inc. (JAMA, 2015), the number of new vehicle sales, except for motorcycles, increased annually from 1970 (4.1 million) through 1990 (7.7 million) (Table 1). It then decreased to 5.9 in 2000 and 4.9 million in 2010 and increases to 5.5 million in 2014. On the other hand, car ownership in Japan has consistently increased since 1966 (AIRIA, 2015). The total number of owned cars, including light vehicles (i.e., with a cubic capacity of 660 cubic centimeters (cc) or less) and light motorcycles, is 16, 37, 57, 74, 78, and 80 million in 1970, 1980, 1990, 2000, 2010, and 2014, respectively (Table 1). While the growth rate has been decreasing recently, these values indicate that there is still a large demand for car ownership.

From an economic aspect, a prediction of car ownership is useful in relation to significant business demand. On the other hand, from an environmental aspect, the prediction is also important. This is because the 80 million registered vehicles in Japan (in 2014) cause huge externalities, such as greenhouse gas (GHG) emissions and traffic jams.

The primary reason to examine the demographic determinants of car ownership in Japan is because Japan is projected to face radical demographic changes in the next few decades (Table 1). According to the Statistics Bureau, Ministry of Internal Affairs and Communications (MIAC), Japan (2012a; 2012b; 2015a), the population in Japan increased from 1970 (104,665 thousand) to its peak in 2010 (128,057 thousand). It then started to decrease; in 2014, it was 127,083 thousand people. The population size is expected to decrease further over the next few decades, with the ageing of the population and the spread of smaller family types such as nuclear families (i.e., a pair of adults and their children), dual income no kids families, and single families. Consequently, it is important to examine the determinants of Japanese car ownership, even if it is just at the aggregated level, as it will help industry and the government to predict future demand.

In this investigation, we create prefectural level data, using aggregated vehicle data from 1980 through 2009. We apply a dynamic regression model. Note that this study has several advantages and limitations. Regarding the advantages, our dataset has a relatively large number of observations covering the whole nation; the data is divided at the prefectural level into car type, car age, car maker, and car brand. Car cohort is considered in this data set, which means that certain car groups are used as observations in the model, and they age 1 year in the next year. Car ages or age structure is seldom examined in the literature, due to data limitations. The car cohort data is aggregated data, which has some advantages. Generally, aggregated data has little sample selection bias and is suited to examine the determinants for predictions (de Jong et al., 2004). Note that disaggregated data is more popular than aggregate data in the recent transportation literature (Anowar et al., 2014; Ortúzar and Willumsen, 2011).

The contribution of this study is divided into two parts. Firstly, this study will be the first empirical study of the car cohort model with large countrywide observations in the recent literature. Several Japanese studies use car cohort information as part of a sequence of their simulation models, but they are not basic empirical studies. In addition, this study analyzes not only passenger cars, which are popular in the earlier studies, but also other vehicles such as trucks, buses, and motorcycles.

The other contribution is to examine the elasticity of car ownership with respect to demographic and social determinants because there are few recent studies examining demographic elasticities of car ownership in Japan (e.g., Sun et al., 2014). We classify the determinants into five categories: (I) longitudinal factors, (II) economic factors, (III) natural factors, (IV) social factors, and (V) other transports. We consider ordinary cars are compact four-wheel drive trucks and regular and compact passenger cars, and summarize the results as follows.

Regarding the longitudinal factors (I), we consider the long-run effect of car ownership and car age. The long-run effects are approximately 10 and 5.56 times at car aged 2–11 and 12+. They are higher than average in the recent literature (Goodwin et al., 2004; Graham and Glaister, 2004). Also, the semi elasticity of car age (1 year) is approximately −7%, which is seldom reported in the literature.

Regarding the economic factors (II), we use income and fuel price (gasoline price), considering the consumer price index (CPI) as a control variable for the general cost of living. The elasticities of income and fuel price on car ownership tend to be less intense than in the earlier studies (Goodwin et al., 2004; Dunkerley et al., 2014). Regarding the elasticities of income, the regular passenger cars have similar elasticity (0.766 in the long-run) as in the